ANALYSIS OF CHARCOAL VALUE CHAIN IN SEMI-ARID CENTRAL POKOT SUB COUNTY, KENYA

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(Reg. A56/88527/2016)

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN RANGE MANAGEMENT

DEPARTMENT OF LAND RESOURCE MANAGEMENT AND AGRICULTURAL TECHNOLOGY (LARMAT)
FACULTY OF AGRICULTURE
UNIVERSITY OF NAIROBI

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DEDICATION

To my loving mother, Ayitso M. Jayne, my siblings, Charlotte, Shantal, Molly, Alexis, and the little ones Ayllah, Christian and Lerato. You are more than a blessing. Thank you, ladies.

ACKNOWLEDGMENTS

I am grateful to God for seeing me through my Master of Science studies. It has been a journey of fieldwork, learning new experiences, a new language, making new friends and acquiring the art of scientific writing supported by several people!

This study was made possible thanks to the financial support of the German Research Foundation within the project "Producing charcoal in the sub-Saharan drylands". Special thanks to colleagues from the University of Nairobi undertake this research project and for all our honest conversations and patience with me. undertake this research project and for all our honest conversations and patience with me. Special thanks to you! Asante Sana. Thanks also to my second supervisor Dr. Christoph Bergmann for your input despite the distance and different schedules.

The field study would literally not have been possible without the gracious and patient collaborations of all participants who kindly took their time to show up and repeatedly answer my questions... *Söro nyo wow!* I am indebted to Dinah Kortom who became my friend/assistants translator. She made me laugh, shared her knowledge with me and with whom I have made indelible memories. Thanks to the motorbike riders, through the long bumpy rides I got to know more about West Pokot and got to places I had not thought of.

Special thanks go to my friends Margaret, Miriam and Mrs. Muigai who were so kind to read through some of my publications and presentations and to give me suggestions on the method section. I am glad I could share this journey with the three of you. Thanks to Mama, Dr. Paul Roden and the staff of Marich Pass Field Studies Centre for their hospitality and for creating the most productive working environment, a home away from home. Thank you, Maike, for sharing the study area maps, Muoki family and Elvis for helping me with the many IT related issues that I faced during my data analysis. I am also thankful to my family for your prayers and support. *Echinyogora!*

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LIST OF ACRONYMS AND ABBREVIATIONS

AEZ	Agro-ecological zones
ASALs	Arid and Semi-Arid Lands
CBO	Community Based Organizations
KNBS	Kenya National Bureau of Statistics
CIDP	County Integrated Development Plan
CPAs	Charcoal Producer Associations
FAO	Food and Agriculture Organization
FGD	Focus Group Discussions
GoK	Government of Kenya
ICRAF	World Agroforestry Centre
IPCC	Intergovernmental Panel on Climate Change
KALRO	Kenya Agriculture and Livestock Research Organization
KEFRI	Kenya Forestry Research Institute
KII	Key Informant Interviews
KSH	Kenya Shillings
MDG	Millennium Development Goals
NGOs	Non-Governmental Organizations
PISCES	Policy Innovation System for Clean Energy Security
SDG	Sustainable Development Goals
SPSS	Statistical Package for the Social Sciences
TLUs	Tropical Livestock Units
UNDP	United Nations Development Program
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States Dollar
VCA	Value Chain Analysis
VIF	Variance Inflation Factor

ABSTRACT

Pastoral and agro-pastoral communities in the drylands of Kenya are faced with many challenges dominant of them being recurrent and prolonged droughts which have triggered a number of responses aimed at enhancing the resilience of pastoral households against such shocks. In the past three decades, charcoal production has increasingly gained popularity as a livelihood diversification strategy and source of income among rural communities in the drylands of Kenya, in most cases ranking second after livestock production. Nonetheless, there is inadequate empirical evidence on charcoal production in the Arid and Semi- Arid Lands (ASALs), which has led to a lack of understanding and proof to guide promotion of sustainable charcoal production in pastoral areas. This study therefore analyzed the production and marketing of charcoal in Central Pokot Sub-County, and the challenges along the charcoal value chain. Data was collected from 100 households through interviews using a semi-structured questionnaire. Additionally, focus group discussions and key informant interviews were conducted to compliment information from individual interviews. The results revealed over 10 categories of actors who were directly and indirectly involved in the charcoal production and trade. These included, producers, bulking agents, transporters, retailers, wholesalers, and law enforcers (police and Kenya Forest Service (KFS) guards). Charcoal production was done mainly using traditional kilns. The dominant actors in charcoal trade were found to be bulking agents. Charcoal prices varied widely from USD4 per 100kg of charcoal at the point of production to USD20 per 50kg bag in urban centers. The higher prices at the urban centers were partly attributed to extra costs associated with illegal fees paid to the law enforcers at road blocks during transportation. Additionally, female and youth headed households were found to be more likely to engage in charcoal production than households with male and older heads. Households with limited livelihood sources were more likely to produce charcoal than those with multiple alternatives. Charcoal theft by other producers or travelers at the bulking centers, respiratory diseases associated with inhalation of smoke during charcoal burning process and tediousness of the production process were found to be the main challenges faced along the value chain. In sum, this thesis recommends the need to formalize charcoal trade to ensure: standardization of prices and minimize exploitation of producers by middle traders and corrupt law enforcers. Furthermore, there is need to enhance entrepreneurial skills of women and the youth on alternative business opportunities other than charcoal production.

Keywords: Practices, charcoal production, charcoal trade, actors, alternative livelihoods.

CHAPTER ONE

1.INTRODUCTION

1.1 Background Information

Drylands are characterized by natural and semi-natural vegetation, which provide habitat and pasture to herds of free-ranging wild and domestic animals (Blench et al., 2015). Most of these areas are less suitable for arable farming due to physical limitations such as low rainfall, high evaporation rates, poor soils, and rugged terrain. They cover about 41% of world's terrestrial ecosystems, and are inhabited by 2 billion people, (Blench, 2015).In Africa, drylands cover 70% of the land surface (United Nations Environment Programme, 2012) ,and support approximately 268 to 325 million people, over 40% of the population of the continent (Blench, 2015; UNEP, 2012).

Drylands mainly support pastoralism that is mainly characterized by extensive livestock production system, on which millions of populations within and outside drylands depend for livestock and related products. In the Horn of Africa, pastoral livestock production accounts for an average of 40% (IGAD, 2015) of agricultural GDP of individual countries. Besides livestock production, dryland biomes provide a host of ecosystem services that are important for biophysical sustainability. They, for example, act as watersheds; support various flora and fauna of cultural, economic and ecological values; have some of the world's important spiritual and cultural heritage sites; and as act as carbon sinks.

In Kenya, drylands support 34% of national population; 61% livestock, 75% wildlife, and contributes 23% to agricultural GDP through livestock production Njenga et al. (2017) and International Livestock Research Institute (ILRI,2013). Despite the enormous contributions to our economies, drylands are facing a number of challenges among them, land degradation and consequent loss of livelihoods ascribed to changes in land use, land tenure, lack of supportive policies, all which are exacerbated by climate change (Mewnr et al., 2013). Pastoral communities have increasingly diversified their sources of livelihoods in response to the changing socio-economic and biophysical environments (Ndegwa et al., 2020).

Whereas these adaptation mechanisms are intended to enhance their resilience against extreme climatic events, there are trade-offs involved as some of the alternative livelihood activities have been reported to undermine the environment and eventually the very mainstream livelihood they are meant to compliment. One such economic activity is charcoal production, which is increasingly being adopted as one of the major alternative sources of livelihood in the drylands (Khundi et al., 2011).

Charcoal production provides employment to thousands of people from wood producers/tree owners, charcoal producers, transporters, and vendors – approximately 1 million people in Kenya both on part-time and full-time basis with a total revenue of USD427 million that profit grassroots communities (Iiyama et al., 2017). However, a better understanding of the value chain is crucial for guiding its sustainability while conserving the environment and enhancing livelihoods.

1.2. Problem statement

Charcoal production has been reported as one of the commonly practiced poverty alleviation and livelihood diversification option in Sub Saharan Africa (SSA) (Ndegwa et al., 2020). However, its sustainability as a low cost and readily available source of energy requires evidence-based policy formulations and appropriate regulations and other interventions on production process and trade.

Studies indicate that a total of 72% of the metropolitan population and 98% of homes in the rural area in SSA use fuelwood for energy Iiyama et al. (2017), especially charcoal whose production is traditionally done in earth or brick kilns. The charcoal industry in the region is largely considered "informal" because commercialization is carried out under limited regulation. Illegally produced charcoal is transported and merchandized illicitly in an attempt to elude authorities, taxation, and fines. In both Senegal and Mozambique, the vast majority of charcoal received in the country's capital is alleged to be illegal (Malimbwi et al., 2007) making the respective governments to lose revenue.

Revenue distribution along the charcoal value chain varies extensively between countries. Ribot et al. (2017) studied the distribution of benefits from charcoal from its origin to end-use in Senegal. The results indicate that distribution of proceeds among the several stakeholders was skewed and dependent on the degree of market access control that stakeholders command. Urban merchants

were found to hold a tight grip on the market, and their average yearly profit was higher than that of other stakeholders in the chain. A case study carried out in Tanzania on income distribution among the charcoal supply chains showed that on average, producers earn approximately one-third of the final end price of charcoal, with transporters and wholesalers earning about half, retailers earned one-sixth of the retail price (World Bank 2009). In Kenya, an increase of 64 % in charcoal consumption has been reported in the urban areas in the last two decades Ndegwa et al. (2020) with the majority of the charcoal consumed being produced in Arid and Semi-Arid Lands (ASALs) GoK, (2018) and Liyama et al. (2017), on private farmlands and non-protected government and common lands (Ndegwa et al., 2018; Liyama et al., 2017; KFS ,2013). Charcoal-producing regions have been expansively studied due to their significance in supply and localized effect of charcoal production on the ecosystem. In Kenya, Kitui and Makueni counties are some of the most studied charcoal production zones (Ndegwa et al., 2017; Liyama et al., 2017; KFS ,2013). Kajiado County, the central region, Dakacha woodlands in Kilifi and Shimoni forest in the South Coast of Kenya are the other key charcoal production areas characterized as charcoal production hotspots Alinovi & Romano (2010).

Some of the reported impacts and concerns raised on charcoal production in the various areas in Kenya comprise dilapidation of water catchments resulting to a drop in water levels in rivers originating from these areas (Jones et al., 2016). Loss of biodiversity, loss of environmental services, and diminution of tree species preferred for charcoal and land degradation are the other impacts described by the studies as resulting from unselective felling of trees for agriculture and charcoal production (Mwampamba et al., 2013). The role of the charcoal industry in the national economy is often ignored, and as a result its real and latent contribution to economic development is steadily undervalued (Zulu & Richardson, 2013). When deliberated in energy policies by the National Governments at all, wood fuel (including charcoal) is often reckoned a “backward” and ecologically risky energy source. In addition, National Forest policies tend to emphasize forest use for timber production, not for charcoal production.

With wood fuel utilization and value escaping official statistics, the forest sector’s input to the national economy is often peripheral and as a result forest governance receives diminutive consideration and meagre budgetary allocations (Mewnr, 2013). Consequently, local branches of the forest service display low human, technical, and implementation capacities.

The aforementioned problems are often exacerbated by haphazard regionalization of forest governance, which leaves local administrators ill equipped for the challenge of upholding community participation. Such institutional flaws lower the drive of local staff, and invite corruption, which when coupled with vague policy and legal frameworks is seen as a major source of unfettered or even illegal charcoal businesses (Ndegwa et al., 2020). The challenges facing charcoal value chain require in-depth studies to inform policies and interventions, especially in the drylands where most of the charcoal is produced.

1.3. Justification of the study

Several studies have been conducted on charcoal value chain in Tanzania Malimbwi & Zahabu (2009), Uganda Khundi et al. (2011), and Kajiado and Baringo counties in Kenya (Mewnr, 2013). However, little is known about stakeholders involved at different levels, their roles and the challenges faced along the charcoal value chains, especially in the drylands from which most of the charcoal consumed in Kenya's urban areas originate. For instance, while Mewnr et al. (2013) studied the opportunities and constraints at different levels of the value chain in Kenya, besides the obvious fact that households produce charcoal to earn income, the social and demographic factors that dictate households' participation in charcoal production are still largely unclear.

Smith et al. (2017) in their study in Uganda established that factors that determine involvement in charcoal production and trade vary from one place to the other and from one individual or household to the other depending on different aspects of the population and the area of study. Stakeholders in the charcoal value chain have also been found to vary from one location to the other depending on the length of the chain, socio-demographic aspects, among other factors (Mewnr, 2013). It is, therefore, indispensable to generate location-specific data with respect to determinants of household participation in charcoal production. Furthermore, analysis of the actors and their roles along the charcoal value chain is crucial in guiding interventions in the sector. In addition, due to the inadequate information about the real value of charcoal and lack of awareness of sustainable ways of managing wood resources, the charcoal industry is yet to be fully understood and mainstreamed into economies of most developing countries.

In order to fill the above-mentioned knowledge gaps, this study was conducted in Central Pokot County, North Western Kenya to understand the production practices, actors, marketing channels,

prices and quantities as well as determinants of households' adoption of charcoal production in the study area. The findings are expected to inform policies that seek to inform more sustainable and resilient pro-poor value chains.

In-depth understanding of the charcoal industry is crucial as it has numerous social, economic and environmental impacts that are interconnected and influence achievement of a number of sustainable Development Goals (SDGs), among them, SDG 1 (poverty reduction), SDG 3 (to ensure good health and wellbeing), SDG7 (to promote sustainable energy), SDG15 (sustainable management of forests to halt and reverse land degradation and biodiversity loss), and SDG 13 (to address climate change arising from the impacts on forests degradation or emission of greenhouse gases during charcoal production process).

1.4. Objectives

1.4.1. Broad Objective

The broad objective of this study was to analyze the production and marketing of charcoal in Central Pokot Sub County for the purpose of informing policy and practices on sustainable charcoal production in the drylands of Kenya.

1.4.2. Specific Objectives

The specific objectives of this study were to:

i) Characterize charcoal value chain in Central Pokot County on the basis of production, actors and their roles, marketing channels, and prices at various stages.
ii) Analyze social and economic factors that determine households' participation in charcoal production and challenges faced in the charcoal value chain in the study area.

1.5. Research Questions

i) What is the charcoal production practices; who are the actors and their roles; and which are the marketing channels and prices at various stages of the charcoal value chain in Central Pokot?

ii) What are the social and economic factors that determine households' participation in charcoal production; and what are the challenges faced by actors in the charcoal value chain?

1.6. Thesis organization

This thesis is structured into five chapters (Figure 1.1). Chapter one presents the overall background information linked to charcoal production and marketing, as well as the research problem, justification, objectives and research questions of the study. Chapter two provides literature review on charcoal production in the arid and semi-arid lands (ASALs) of Kenya, the role of charcoal production in the pastoral and agro-pastoral households and factors that influence households' participation in charcoal production in the drylands of Kenya. The third chapter presents charcoal value chain in semi-arid Central Pokot Kenya: analysis of practices, actors and marketing channels, study area, study design, data collection and analysis.

Chapter four entails factors that determine pastoral and agro-pastoral households' participation in charcoal production in Central Pokot Sub-County, Kenya. Conclusions and recommendations are summarized in chapter five. References and appendices are presented at the end of the thesis.

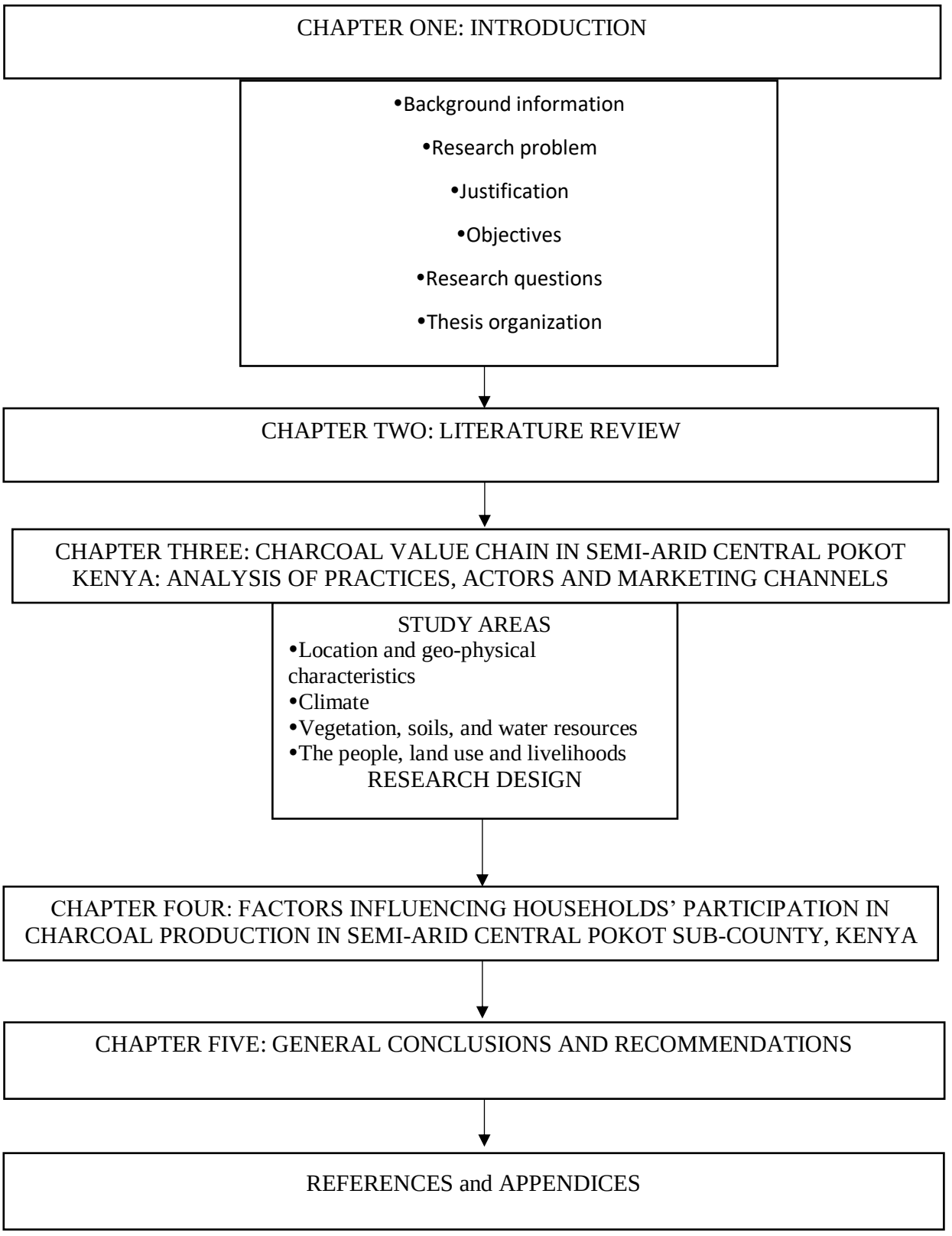

Figure 1.1 :Thesis map

CHAPTER TWO

LITERATURE REVIEW

2.1. Charcoal production in Kenya: Sources of wood and preferred trees species

Charcoal production has been embraced in the drylands of Kenya as an alternative source of income to supplement the mainstream livelihood (Ndegwa et al., 2020), in the face of changing environment, climate and socio-economics among the agro-pastoral and pastoral communities. Charcoal production is ranked fourth after tourism, horticulture and tea, representing an approximate of over USS420 Million "Ksh 32 billion" annually, almost an equivalent of USD460 Million "Ksh 34 billion" from the tea industry (Mutimba and Barasa, 2005).

Charcoal is normally produced in rural areas, close to the wood sources either private lands/farms or protected areas and then sold onsite or transported to wholesalers and retailers in urban areas (Mewnr et al., 2013). Contrary to the belief that most charcoal originates from protected forests (Ndegwa et al., 2020), findings from previous studies show that charcoal produced from wood obtained from producers' own farms and private land has been on the increase (Mewnr et al., 2013). Charcoal production from privately owned land is done by the owners but most often than not it is a by-product of other activities (Mutimba and Barasa, 2005). For instance, in wheat and coffee producing areas like Narok and Kericho Sub-Counties, when large parcels of lands are cleared for production, outsiders can come in and produce charcoal on the land as a compensatory mode of payment (Mutimba and Barasa 2005). In marginalized areas like Turkana County, communities produce charcoal from invasive species like *Prosopis juliflora* to save pastures for their livestock (Butynski et al., 2016). Illegal production from protected lands occurs next to forests, for instance in the areas of Mt Kenya Forest, Mt Elgon Forest, Kakamega Forest, and Mau Forest which contributes up to 13 % of total charcoal production in the country (Mutimba and Barasa, 2005). Almost all the charcoal produced in the country is from indigenous species with more than 100 tree species being used. Vachellia species (*Vachellia tortilis, V. nilotica, V Senegal, V. mellifera, V. polyacantha, and V. xanthophloea*) are the most widely used and preferred.

Other popular species include Croton, Olea, Manilkara, Mangifera, Eucalyptus, and Euclea (Mutimba and Barasa 2005). According to Mutimba and Barasa (2005) the most preferred tree species for charcoal production nationally are *Acacia spp*, (45%), *olea spp* (9.5%) and *Croton megalocarpus* (7%). Other trees commonly used in localities where they are in abundance include *Prosopsis juliflora* in Baringo, Turkana, and Garissa counties (KFS, 2013), *Terminalia brownii* in Kwale county Wanjala et al. (2016), *Olea africana* and *warbugia ugandensis* in Narok county Tesot et al. (2012), and *Terminalia prunoides*, *Terminalia brownii*, *Senna abbreviata* and *Balanites aegyptiaca* in Kitui county (Luvanda et al., 2016; Ndegwa et al., 2016). The *Vachellia* species, among other hardwood trees, are preferred for charcoal production because they produce high-quality dense charcoal that lasts long in the cooking stove (Ndegwa et al., 2018). While tree harvesting in Narok and Kajiado counties is usually through clear-felling to open land for agriculture (Iiyama et al., 2017; KFS, 2013), harvesting in the eastern and coastal regions is normally selective where preferred hardwood trees like *Vachellia* are harvested, leaving the less desirable softwood trees like *Commiphora* (Iiyama et al., 2017). The latter has led to depletion of targeted species, and consequently loss of biodiversity in the woodlands (Ndegwa et al., 2010).

2.1.1. Charcoal production as an alternative livelihood in the drylands

The high and consistent demand for charcoal in the urban centers contradicts the age-old misconception that charcoal is a last resort type of livelihood activity for those with no much option. Minimum investment of money/capital required coupled with basic expertise (Schure et al., 2014) are some of the driving forces behind rural production of charcoal to supply to urban centers (Ndegwa et al., 2010).

Proceeds from charcoal production are a haven for the poor, and provide capital for those who produce on large scale to broaden their asset portfolios (Smith et al., 2017). Income from charcoal helps to supplement agricultural income shortcomings, and is especially invested in livelihood diversification, including beekeeping, improved agricultural production, therefore enhancing poverty alleviation and resilience among rural households against natural calamities like droughts.

Despite the potential for charcoal to contribute to poverty alleviation and ease the effects of material deprivation, several negative impacts of charcoal production and dependence have been noted. Excessive extraction of forest resources for fuel threatens the sustainability and integrity of

forest ecosystems that underpin the very livelihood opportunities that support poverty alleviation and food security (Richardson et al., 2010) in different ways. Tangible ecosystem goods provided by forests such as timber, firewood, charcoal and non-wood products, for example, honey and medicines contribute to the well-being of human (FAO, 2010). Other services include water and air purification, carbon sequestration and provision of habitats for wildlife species (Sunderlin et al., 2005). Although indirect, the impacts of ecosystem services provided by forests to humans is significant for sustaining livelihoods for instance by minimizing both downstream flooding and drought conditions archived by intercepting rainfall, and absorbing the water into the underlying soil, and gradually releasing it into the streams and rivers of its watershed (IPCC, 2011). Forest degradation caused by charcoal production, affects both local livelihoods and national economies.

Charcoal production impacts the soil at different levels, at the kiln site, as a result of extreme heat generated during clearing of vegetation and soil disturbance during site preparation and management of the kiln. Few studies have assessed charcoal production impacts on soil at the kiln site. For example, Oguntunde et al. (2008) observed that soils at charcoal kilns sites in Ghana had low bulk density, higher porosity and soil-surface temperature. In addition, McLaughlin et al. (2008) found that carbonization had significant impacts on soil pH, water-holding capacity, texture and nutrient content and reduces percolation rates, water retention, as well as soil aggregates, which increases the risk of soil erosion.

Charcoal production also affects global warming through the production and emission of greenhouse gases, such as carbon dioxide (CO2) and methane (CH4) into the atmosphere (IPCC, 2007). Kammen and Lew (2005) have shown that emissions during charcoal production have a greater global warming contribution than emissions from cooking using charcoal. Additionally, indoor air pollution from charcoal stoves contributes to respiratory infections in children and lung diseases in adults (Bailis et al., 2005).

2.2. Actors and their roles in charcoal value chain in Kenya

A value chain approach entails the structural and operational linkages and the nature of interactions that exist between individuals or organizations (Mburu et al., 2015). Charcoal value chain reveals activities instigated by all actors that include production, carbonization, packaging and transport/distribution and sales, and consumption, as well as linkages by service providers (van

den Berg et al., 2009). The value chain analysis aims to understand the direction of the flow of economic goods and services among different actors at different stages of engagement in the production, distribution/transportation, trading and consumption (KFS, 2013; Ndegwa, 2010). Value chains vary in their length, the shorter the value chain, the higher the likelihood of the key actors getting more benefits, whereas the more stakeholders are involved in the value chain, the more the sharing of benefits among the actors, making charcoal more expensive for the final consumer (Ndegwa 2010; Ndegwa et al., 2011).

Charcoal producers are majorly based in the rural areas where trees are in abundance, they harvest wood and carbonize it into charcoal. Production activities like tree felling and kiln preparation are physically demanding and therefore regarded as more suited to men (Delahunty et al., 2012). Statistics showed that in 2000, 16% of charcoal producers in Kenya are women, while 84% are men (Mutimba and Barasa 2005). However, Ruuska (2012) in a study conducted in Kilifi County found that only 27.5% of the charcoal produced was done by women. Overall, women are increasingly getting involved in charcoal production as observed by KFS (2013).

Charcoal transporters typically buy and transfer charcoal from producers in rural areas and sell it to wholesalers or retailers (KFS, 2013; Ndegwa, 2010). In some instances, they also sell directly to consumers. Charcoal transporters are mostly men (86%) compared to women (14%) Mutimba and Barasa (2005). Women are reported to play a significant role in small-scale transportation especially where human labor, bicycles or donkey carts are used (Delahunty et al., 2012). Wholesalers purchase charcoal in bulk from either producers, transporters or brokers and sell to retailers, and in some cases to consumers in bags (KFS, 2013). On the other hand, retailers buy charcoal from either producers, transporters or wholesalers and sell to consumers either in bags or smaller units like buckets and tins. Consumers of charcoal include households, business enterprises and institutions. Charcoal is sold to businesses enterprises in 35-kg bags, while majority of households purchase in either 35-kg bags or 2-kg tins (KFS, 2013).

2.2.1. Charcoal Marketing: channels and income distribution

There are different and sometimes complex channels through which charcoal moves from producers to consumers. Mewnr et al. (2013) and Kambewa et al. (2007) reported five similar channels that are common in places where charcoal producer associations exist. The channels include: i) movement of produced charcoal from producer directly to the consumer; ii) flow of raw materials (wood) from wood owner to charcoal producer, and the product (charcoal) to the consumer; iii) flow of wood from the owner to charcoal producer, and movement of charcoal to transporter, retailer and finally to consumer; and iv) flow of wood from owner to charcoal producer, and flow of charcoal to transporter, wholesaler, retailer, and finally to the consumer. The fifth channel is a complex one in which brokers play a role in linking the various actors throughout the entire chain.

The broker's roles in the chain are mainly loading and off-loading, linkage to buyers and negotiation of prices with the buyers (either transporters or wholesalers). By ensuring ready markets of charcoal on production and delivery, the brokers facilitate faster sales and higher rates of stock turnover. The brokers earn about Ksh 50 per bag for the services. While the entry of the brokers ensures faster transactions, they often influence the prices, leading to lower prices offered to producers and in the process increase their own profit margins.

Cases where the producer sells directly to the consumer are common along the highways and in places where the production sites are not far from towns. The buyers are the travelers and lorry drivers along the highways who buy in small bags (packaged in 50kg capacity sugar sac) (Iiyama et al., 2017). The consumer prices are much lower owing to reduced costs of transportation and shorter channels.

Because most producers cannot afford to transport the produced charcoal to market, they normally have to accept lower prices from the retailers who then meet transportation costs themselves. In Kitui, Baringo and Laikipia counties of Kenya, average costs associated with charcoal handling include security for charcoal of Ksh 3.000 per month, a movement permit fee of Ksh 20 per small bag, equipment hiring fee of Ksh 1.250 per month, purchase of standing trees at Ksh 600 per tree, store rent of Ksh 500 per month, labor charges of Ksh 400 per person per day, daily trading fee

paid to the county government(cess) fee of Ksh 50 per small bag, membership fees of Ksh 300 per year and transport charges of Ksh 240 per small bag (Luvanda et al., 2016; Mewnr et al.,2013).

Middle-men are frequently portrayed as the most exploitative actors in the value chain, yet they play essential entrepreneurial roles connecting producers and consumers (Schreckenberg et al., 2003). Highest profits often accrue to urban-based 'elite' businessmen as they typically own motorized transporting links, monopolize the trade and are politically connected (Schure et al., 2013).

2.3. Factors determining households' participation in charcoal production in drylands of Kenya

Households' participation in charcoal production is dependent on several factors (Njenga et al., 2015), which vary from one region to the other, as well as from one household to another (Mewnr et al., 2013).

In their study on factors influencing household participation on charcoal production, Mwangi et al (2005) reported legality of charcoal trading, age and difficulties in accessing secure resource tenure as the main determinants of charcoal production by households. Mewnr et al. (2013) reported that education level of the household head coupled with market security and start-up costs (e.g., capital required and license fees) were some of the factors that determined household participation in charcoal production. A study by Mulenga et al. (2017) that assessed livelihood alternatives for marginalized communities found that age, limited livelihood alternatives, gender of household head and marital status were the main factors that determine whether a household participates in charcoal production or not (Ndegwa et al., 2016).

2.4. Charcoal Policies and governance in Kenya

Charcoal industry is still largely considered a "hidden" and "informal" sector, getting little policy attention. Its role in the national economy is almost always overlooked, and as a result its actual and potential contribution to economic development is systematically underestimated. Policies aimed at addressing the sustainability of charcoal production technologies such as the National Environment Policy 2014 tend to focus on one dimension, attempting to control activities on

specific levels such as ban on production and trade or formalizing regulations. Such one-dimension interventions are bound to fail because they ignore the complexity of the charcoal chain (Beukering et al., 2007). Government of Kenya (GoK) (2005) legalized charcoal as a forest product giving Kenya Forest Service (KFS) the directive to enforce charcoal production as a forest utilization activity with two documents being used to control production and transportation: a certificate of origin and a movement permit. The forest Regulations were then developed by the Ministry for Forestry and Wildlife, under section 59 of the Forests Act 2005, to re-emphasize that transportation will require a valid permit that can only be issued by KFS (GoK, 2005). However, clear lines were not established on responsibilities between the different ministries. Ministries therefore have overlapping responsibilities with regard to policies formulation and implementation related to charcoal production (Sepp et al., 2008). Furthermore, the sectors through various regulatory frameworks such as Forest Act of (2005), and Energy Bill 2015 have different roles and priorities with regards to budgetary and human resource allocations which creates a major challenge on effective and timely policy implementation and enforcement.

Failure from previous policies can be attributed to erroneous assumptions, variations in the legality of charcoal trading, limited understanding and punitive political attitudes towards charcoal trade coupled with difficulties in accessing secure resource tenure among other factors. A comprehensive approach that recognizes the multifaceted dimensions in the charcoal value chain is needed for policies to be effective. Policies should be able to not only reflect on the governments' development objectives and priorities but also on stakeholder involvement and recognize charcoal as a main energy source. There is therefore a need for further empirical evidence on charcoal production in the Arid and Semi-Arid Lands (ASALs through value chain analysis to inform policies that seek to promote sustainable and resilient pro-poor value chains. The analysis should consider how factors such as gender, education, age and other socio-demographic aspects influence participation along the value chain.

A study by Mewnr (2013) showed that charcoal value chain actors and factors influencing individual participation in charcoal production vary from one location to the other. It is, therefore, important to generate location-specific data with respect to determinants of households' participation in charcoal production. In addition, analysis of the actors and their roles along the

charcoal value chain is crucial in identifying the different challenges faced and finding entry points for engaging stakeholders at different levels. This study was therefore conducted to fill the above-mentioned knowledge gaps by analyzing the production practices, actors, marketing channels, prices and quantities, as well as determinants of households' adoption of charcoal production in the study area. The findings are expected to inform policies that seek to inform sustainable and resilient pro-poor value chains.

CHAPTER THREE

CHARCOAL VALUE CHAIN IN SEMI-ARID CENTRAL POKOT KENYA: ANALYSIS OF PRACTICES, ACTORS AND MARKETING CHANNELS

ABSTRACT

Global charcoal production has more than quadrupled over the past 50 years from 17.3 million tons in 1964 to 53.1 million tons in 2014. Sixty one percent (61%) of the present global charcoal production occurs in Africa, mostly to satisfy demand for cooking fuel from urban and peri-urban households. Despite the adverse environmental impacts associated with charcoal production, a significant global population rely on it for energy needs, while a number rely on it as a livelihood source. Whereas this calls for efforts to promote sustainable charcoal production practices, this has to be informed by in-depth understanding of the charcoal value chain to guide interventions aimed at making it a sustainable economic activity. This study used household interviews, key informant interviews and focus group discussions to gather data on the practices, actors, prices and quantities of charcoal traded at different nodes of the value chain in Central Pokot County of Kenya. The results revealed over 10 categories of actors who were directly and indirectly involved in the charcoal production and trade. These included tree owners, producers, bulking agents, transporters, brokers, retailers, wholesalers, and law enforcers (police and Kenya Forest Service (KFS) guards). The findings showed that the producers mainly used traditional kilns. Charcoal trade was mainly dominated by middle traders who determined prices along the value chain, and charcoal prices varied widely from USD4 per 100kg of charcoal at point of production to USD20 per kg in urban centers. The higher prices at the urban centers were partly attributed to extra marketing costs associated with illegal fees paid to the law enforcers at road blocks during transportation. As affordable and green alternative energy sources are sought, the findings point at the need to improve the production efficiency through improved charcoal production technologies and regularization of charcoal trade. This will not only ensure sustainability, but also standardization of prices and minimization of exploitation of producers by brokers and corrupt law enforcers.

Key words: Charcoal production; traditional kilns, dry lands, actors, practices

3.1. Introduction

Global charcoal production has more than tripled over the last 50 years from 17.3 million tons in 1964 to 53.1 million tons in 2014 (Malimbwi & Zahabu, 2009; FAO,2016). About 60% of this increasing volume is obtained in Africa (FAO, 2016), where it is primarily used to fulfil demands for cooking fuel from urban and peri-urban households (Ghilardi et al., 2013; Mwampamba et al., 2013). Current projections indicate that the total population of Africa is likely to double between 2015 and 2050 (UN, 2015), which is anticipated to further increase the demand for charcoal due to rural-urban migration. Urban centers in Kenya have already recorded an increase in charcoal consumption by 64% over the last two decades (KIPPRA, 2010). In Kenya the charcoal industry provides direct employment to approximately 700,000 people that include wood producers/ tree owners (land owners who cultivate multipurpose trees to meet different commercial needs), charcoal producers, transporters and vendors (Mewnr, 2013). Annual revenue of approximately USD427 million has been collected by the county and national governments from charcoal licenses and business permits. This figure is projected to increase to well over USD12 billion by 2030 (Iiyama et al., 2014). However, this can only be achieved for as long as charcoal remains inexpensive and readily available in comparison to alternative energy sources like liquid petroleum gas (LPG), kerosene, and electricity (Sola et al., 2017).

As in many other parts of Sub-Saharan Africa (SSA), the production and marketing of charcoal in Kenya largely evade the legal and fiscal instruments of the state. Most of producers are positioned somewhere along the spectrum of 'legal-informal' (for instance, when resource ownership and access are regulated through non-codified customary practices) and 'illegal-informal' (such as when state authorities tolerate the unwarranted extraction of resources against petty bribes) (Bergmann et al.,2019). In order to curb illegalities and corruption along the charcoal value chain, the Government of Kenyan passed the Forestry (2005) and Energy (2006) Acts, which specify a number of legal requirements and rules regarding the production, transportation and marketing of charcoal. This process of regulation of the charcoal value chain received further impetus with the adoption of the Forest (Charcoal) Rules in 2009. The policy provided for the introduction of a licensing scheme, investments in efficient production technologies and the establishment of formal institutions to regularize charcoal production (RoK, 2009).

The widespread implementation of such policies has been curtailed by a number of misconceptions about the charcoal sector Mwampamba et al. (2013) and numerous impediments resulting from highly bureaucratic procedures Ghilardi et al. (2013) and informality, including customary tenure regimes (Bergmann et al., 2019). The Kenyan government has attempted to control informal production by means of bans, most recently in 2018. However, as experiences gained in other sub-Saharan countries show, neither formalization of existing practices Schure et al. (2013) nor a complete ban of informal production Jones et al. (2016) warrants enhanced sustainability of the charcoal sector. Charcoal value-added potential (including options for taxation) is not fully tapped, available resources are often not used efficiently, and gross proceeds are far from being distributed equitably along the value chain. This study analyzed charcoal production practices, actors and their roles, and prices at various stages of the charcoal value chain. The empirical case study focuses on Pokot Central sub-county, a rural dry land region in north-western Kenya.

3.2. Methodology

3.2.1. Study area

3.2.2. Location and topography

The study was conducted in West Pokot-County, which falls within Longitudes 34^0 47'and 35^0 49' East and Latitude 1^0 and 2^0 North, located in the Rift Valley region of Kenya. The County covers an area of approximately 9,170 km2 with a population of around 621,241(Kenya National Bureau of Statistics (KNBS), 2019). It is situated in the north rift along Kenya's Western boundary with the Uganda border. The study area borders Turkana County to the North and North East, Trans Nzoia County to the South, Elgeyo Marakwet County and Baringo County to the South East and east respectively (RoK, 2012c). The altitude of the county ranges from less than 900 m above sea level, in the North Eastern and Northern sides which are dry plains, to an altitude of 3,370 m above sea level in the south-eastern side that comprise the Cherangani Hills. West Pokot-County is divided into four sub-counties, North Pokot, South Pokot, Pokot Central, and Pokot West. The exact study site was in Central Pokot, Sub-County, which covers an area of 2,380.1km^2 and is home to 114,097 persons (KNBS, 2019) and neighbors three counties, Baringo to the east, Turkana South to the north, and North Pokot to the west (Figure 3.1).

3.2.3. Climate

West Pokot-County is largely semi-arid and the climate is characterized by high-temperatures, erratic . The rainfall pattern is bimodal, with the long rains falling between April and August, and the short rains between October and February. There is, however, great variation in the total amount and distribution of the rainfall received in the county with the lowlands receiving 600 mm per annum, while the highlands receive 1,600 mm per annum. The county experiences great variations in temperature with the lowlands exhibiting temperatures of up to 30^0 C and the highlands experiencing moderate temperatures of 15^0 C. The high temperatures in the lowlands cause high evapotranspiration, which is unfavorable for crop production. The high-altitude areas with moderate temperatures experience high rainfall and low evapotranspiration hence suitable for crop production.

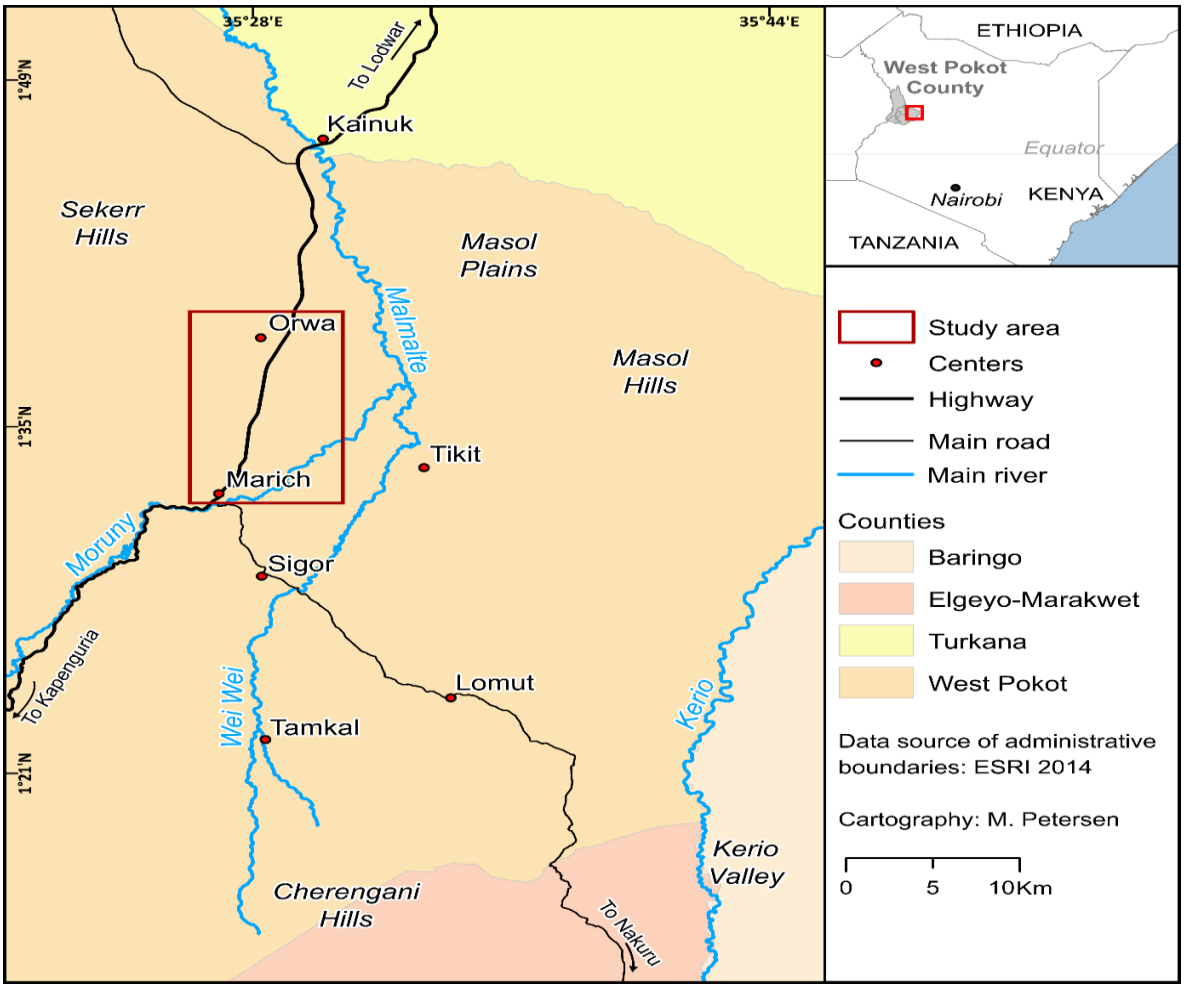

Figure 3. 1:Study area

3.2.4. Ecology and Vegetation

The study area is a semi-arid rangeland and lies within agro-ecological zones (AEZ) IV and V (FAO 2019), comprising mainly of Vachellia species dominated bushed and wooded grasslands. The land cover comprises mainly savannah woodlands and grassland, croplands, bare grounds, wetlands and water bodies, as well as settlement areas (GoK, 2016). The main forests in the county are Lenan and Kamatira forests which form part of Cherengani hills, with other natural forests scattered all over the county dominated with tree species like cedar (*Juniperus procera*) and bamboo (*Aredinaria alpina*). Most of the natural vegetation therefore serve as forage for livestock, especially goats and camels (Mochabo et al., 2005), sheep and cattle. The area is characterized with weakly developed soils, with low organic matter (Gilbert et al., 2014), and well to poor drainage with exception of the soils that neighbor the Ugandan border, which are mainly Cambisols which are fine, highly fertile and suitable for crop production.

3.2.5. The people and livelihood activities

Majority of the people living in Central Pokot belong to the Pokot ethnic community, followed by Turkana community and a mix of other ethnic groups. The dominant source of livelihood in the area is nomadic pastoralism characterized by extensive livestock production (contributing 84% of households' income), which is complemented by crop farming around water sources and in the irrigation schemes managed by the National Irrigation Board (Nyberg et al., 2015). The pastoral production system is characterized by low external input livestock production that relies on strategic use of natural pastures that are variably distributed in space and time. Pastoralists keep cattle, sheep, goats and camels, while those practicing agriculture mainly grow maize, potatoes, fruits (mangoes, papaya, watermelon, oranges), onions, tomatoes, and beans (CIDP 2018). Other alternative livelihood activities include charcoal production, especially along the Lodwar - Kapenguria highway. Additionally, gold panning, and plants products from Aloe *turkanensis*, *A. secundiflora* and *A. scabrifolia*, and firewood trade are other sources of income for the communities living in the area (FAO 2020).

3.3. Research design

Central Pokot County was purposively selected because of the predominance of commercialized charcoal production in the area. Data was collected through household interviews using a semi-

structured questionnaire and was complemented by key informant interviews (KIIs) and focus group discussions (FGDs), with communities in the region between Marich Pass and Orwa trading centers –an area bounding the highway that leads to the main charcoal market of Kitale, some 100 km to the south. The sample population for the study involved charcoal producers, traders, County government officials, middlemen, as well as households that were not participating in charcoal production in the County. The KIIs and FGDs participants were purposively identified based on their key roles and involvement in the charcoal value chain. In total, 6 FGDs of 9-12 participants each, and 42 KIIs were conducted. This study also used direct observations to understand processes involved in production and marketing of produced charcoal. This included on-site observations of the production process from wood harvesting, kiln preparation and firing, and charcoal harvesting. In addition, it involved traveling with the track drivers to passively observe and record activities and capture challenges during transportation of charcoal between Lomut market and Moi's Bridge trading center. A pre-tested questionnaire was administered to 100 households selected through systematic random method using face-to-face interviews between March and April 2018 to capture information on the socio-economic and demographic characteristics of the respondents. The first household was randomly chosen and the subsequent respondents were systematically selected after every two households. The sample size for this study was determined using the probability proportional to size formula developed by Kothari (2004) as follows:

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

In this study, a p-value of 0.5 was used because a proportion of 0.5 gives a statistically adequate and reliable size particularly when the population proportion is not known, as it was in this case. The 95% level of confidence was adopted.

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Using a p-value of 0.5, the Z value was 1.96 (two-tailed), an allowable error of 0.1 was used in this study given the difficulty in locating the households because of the rough terrain, highly scattered homesteads and the nomadic nature of respondents. In addition, the fact that the time of

the study coincided with a drought period, made it difficult to reach those who had either migrated in search of grazing and water or alternative sources of livelihoods.

These values were substituted into the formula as follows:

$$\frac{1.96^2\,(1-0.5)0.5}{0.1^2} = 96.04 \quad \text{.....(3.2)}$$

Four respondents were added to take care of attrition, therefore making a total sample size of 100 households.

3.3.1. Sampling Procedure and Data Collection

The study combined information gathered through focus group discussions (FGDs), key informant interviews (KIIs) and participant observation. Focus Group Discussions (FGDs) were centered on participatory value chain mapping. During the stakeholder mapping exercise, participants were asked to identify and link stakeholders to roles at different levels, marketing channels, and indicate the volumes of charcoal traded at various nodes of the value chain.

A total of six FGDs were conducted in this study. Two FGDs of 12 participants each were conducted at Sub-County level, and involved representatives of National Police Service, charcoal wholesalers, drivers, local chiefs, teachers, former and current charcoal producers and end users. One FGD was conducted at the county level and involved 6 participants, including official representatives from the National Environmental Management Authority (NEMA), the Kenya Forest Service (KFS), a retired teacher and wholesaler and a business man/ current retailer. Three FGDs, each involving 14 participants were conducted with producers, middlemen, loaders, wholesalers, record keepers and security personnel. The FGDs included both genders and at least one or more representatives from each village. Additionally, 42 KIIs were conducted at various levels to complement the information collected from FGDs. The FGDs and KIIs were used to compliment information gathered through individual interviews, and to gain in-depth understanding of the value chain actors, involved practices, production and marketing channels, traded volumes and prices at various nodes of the chain.

3.3.2. Data Analysis

Information from key informant interviews and focus group discussions were collated and summarized to characterize charcoal value chain, illustrating key players at various levels, their roles a s well as marketing channels and estimated prices.

3.4. Results

3.4.1. Source of wood for charcoal production

Commercial small-scale charcoal production emerged as an important livelihood activity in Central Pokot Sub-County, Orwa location, during the 1990s. Today charcoal production is one of the key sources of regular and reliable income for a majority of households in the study area. Whilst the registration and titling of individualized parcels of land is rapidly advancing in the area, the wood resources for charcoal production are predominantly sourced from communally owned land. The community has established a number of socially permitted wood harvesting strategies, for instance producers normally identify and claim ownership of fallen or dead trees for the purpose of producing charcoal by tagging them using personal identification such as a piece of cloth or paint. Whereas such claims are generally respected, one might further obtain a letter of ownership from the area chief, which then confirms that the trees intended for charcoal production was either dead due to termite infestation or fallen (for instance, after stormy weather). Before issuing permit to harvest wood, the chief would visit the site to verify the claim (trees' condition).

3.4.2. Preferred tree species for charcoal production

The results show that producers prefer tree species that produce quality charcoal. However, in their abscence producers opt for whatever is available. The tree species preferred for charcoal production are presented in Table 3.1. Based on the information collected from FGDs and KIIs, the preferred Acacia species included *Vachellia tortilis* (*Ses*), *Vavhellia elatior* (*Atat*), *Senegalia mellifera* (*Talamogh*) and *Vachellia reficiens* (*Panyarit/Arekayan*), while preferred non-acacia species were *Celtis africana* (*Kamanowo*), *Ficus sycomorus* (*Makongwe*) and *Lannea schwanfurthii* (*Moino*).

Table 3. 1:Tree species preferred for charcoal production

Scientific name	Pokot Name	Family	Other uses	Percentage of respondents
Vachellia tortilis	*Ses*	Fabaceae	Leaves and pods are fodder	81
Vavhellia elatior	*Atat*	Fabaceae	Wood used to make drinking vessels	77
Senegalia mellifera	*Talamogh*	Fabaceae	Roots are used for basket weaving	75
Vachellia reficiens	*Panyarit/Arekayan*	Fabaceae	Thorns are used for ear piercing	76
Faidherbia albida	*Sangak/ Adurkoit*	Fabaceae	Thorny branches used for fencing	68
Celtis africana	*Kamanowo*	Cannabaceae	Wood used for furniture and construction	66
Ficus sycomorus	*Makongwe*	Moraceae	Sacred tree	61
Lannea schweinfurthii	*Moino*	Anacardiaceae	Leaves are used as animal fodder	60
Terminalia brownii	*Koloswo*	Combretaceae	Roots treat allergies	57
Trichilia emetica	*Kreteswo*	Meliaceae	Leaves used as soap	56
Balanites rotundifolia	*Lomion*	Zygophyllaceae	Fruits are edible (eaten ripe or boiled)	52
Berchemia discolour	*Mochukwo*	Rhamnaceae	Red dye obtained from the bark	49
Commiphora africana	*Katagh*	Burseraceae	Burnt resin used as an insecticide	47
Cordia sinensis	*Adomeyon*	Boraginaceae	Fruits mixed with Tamarind to make beer	45
Diospyros scabra	*Tuwot*	Ebenaceae	Bark extract treats cough	42
Ehretia cymosa	*Ponponot*	Boraginaceae	Sticks are used as tooth brush	37
Grewia bicolor	*Sitot*	Malvaceae	Bark is used to purify water	24
Kigelia africana	*Rotin*	Bignoniaceae	Wood used to make fruit storage boxes	26
Maerua crassifolia	*Tuwio*	Capparaceae	Folliage used as fodder	23
Maerua triphylla	*Ohokowa*	Capparaceae	Roots boiled and prepared as porridge	18
Salvadora persica	*Asiokonion*	Salvadoraceae	Sticks used as toothbrush	14

Table 3. 1: Continuation,tree species preferred for charcoal production

Meyna tetraphylla	*Tulungwo*	Rubiaceae	Fruits are edible	13
Tamarindus indica	*Oron*	Fabaceae	Pulp from the fruits used in making juice	11
Ximenia americana	*Kinyotwo*	Olacaceae	Fruits are eaten raw	9

Source: Key informant interviews (N=42) and FGD (N=72)

3.4.3. Kiln preparation and charcoal production process

Interviews within producers reveal that back in the early days, charcoal was prepared by simply burning a log of tree then burying the charred wood in the sand or sprinkling with water to cool it down before breaking it into pieces for subsequent use. This was a slow and long process to fill a debe (4kg tin) or karai (an equivalent of a 10litre basin) of charcoal for sale. Wanjala, a 77 years old migrant from Busia County, who had started to produce charcoal in the early 1980s, is said to have introduced a more convenient and efficient production process that involved making of an earth-mound kiln. He had learned the preparation of such kilns from the wazungu (European settlers) who had employed him as a laborer during the construction of the Kapenguria-Lodwar road. He later settled down in the area and the local communities learned from him the earth-mound kiln preparation skills that are in use in the area to date.

The process of charcoal production is presented in Figure 3.2. As narrated by key informants, charcoal production using the traditional kiln involves preparing the wood (freshly cut or fallen tree) and selecting the kiln site close to the source of the wood, possibly close to the river to provide sand and water for cooling the charcoal once the carbonization is complete. Once the vegetation at kiln site is cleared to the ground level, the wood is cut into logs and stacked together alternating horizontal and vertical arrangements as tight as possible, all gaps between large logs are filled with smaller branches and twigs. Several layers of green leaves and grass are used to cover the stack of wood. A thick layer of soil is then added on top of the leaves and grass cover to ensure complete pyrolysis during the burning process. The lighting and ventilation points are however left open.

The lighting points are stuffed with dry grass and pieces wood to facilitate ignition of the fire, while the ventilation points are later used for monitoring the burning process. Once lit, the lighting points are sealed off with grass and green leaves before adding a layer of soil. Regular inspection

of the kiln is done to monitor the progress and to ensure the stack is evenly covered and that no openings emerge. Whereas emission of a dense white smoke from the ventilations indicates moisture escape from the wood, grey or black smoke indicates that carbonization is in progress. In three to four days, the kiln collapses into close to half its original height and the smoke emission fades. Emission of a light blue smoke indicates complete carbonization, which calls for complete sealing of ventilations to allow for cooling to take place.

Any opening can hinder the cooling process and cause the charcoal to catch fire. Depending on the season, the use of river water or sand may be necessary to fasten the cooling process and to stop the pyrolysis since if unstopped any further carbonization would reduce the charcoal yield and quality. Sand or soil is however preferred for cooling as water is believed to affect the quality of charcoal. At the end of the process, the kiln is subsequently uncovered to allow harvesting of the charcoal. Small kilns that yield up to four large bags of charcoal (packaged in 90kg capacity sugar sack) take an entire day to prepare, and burn for approximately three days. The time taken to complete the process depends on both the kiln size and the weather, with bigger kilns of up to five to six big bags taking two to three days to prepare and about four days to burn to completion. Charcoal is allowed to cool before packaging into second hand sacks ready for transportation to the roadside for sale or to a nearby charcoal depot. At the depots, charcoal is repackaged into smaller bags for transportation to the urban or peri-urban centers.

Assembly of tools

Assembled tools

Selection of kiln site and cutting of wood into sizeable logs

Wood at a kiln site

Vegetation clearing and leveling of ground

Stacking the wood

Covering of kiln with grass and soil

Kiln covered with thick layer of soil

Firing of kiln

Carbonization in progress (evidence of grey smoke)

3-4 Days of carbonization

Removal of soil to allow cooling and harvesting of charcoal

Packaging in readiness for transportation

Charcoal in bags at a bulking point

Figure 3. 2:Charcoal production process

(Source: Key informant interviews (N=42) and FGD (N=72))

3.4.4. Seasonality in charcoal production

The key informant interviews and focus group discussions revealed that charcoal production takes place throughout the year, though quantities produced vary with the season. Whereas the demand for charcoal in the urban areas' peaks during the rainy season, most producers choose to concentrate on farming activities until the season is over before embarking on complementary livelihood activities such as charcoal production and gold panning. In addition, producers reported difficulties in charcoal production at this time as the burning process takes long given the wet conditions. However, some producers (those with limited alternatives) prefer the wet season given the higher demand and prices for charcoal compared to the dry season. Such producers also preferred producing charcoal during the wet season when the soils are wet and easier to dig for the preparation of the kiln; green leaves are readily available; and when weather permits them to work for longer hours as compared to the scotching sun during the dry season. During this period there are also plenty of Chesarang (tree logs that have been swept downstream following heavy rains) to provide ready raw materials for charcoal production.

3.5. Value chain actors and their roles

The results revealed various actors who are directly or indirectly involved in the charcoal value chain, their roles and interactions (Figure 3.3). Whereas the direct actors are involved in production and trade at different levels, indirect actors influence the functioning of the value chain, for instance by providing specific support services or implementing legal provisions. Charcoal producers are the main stakeholders at the production stage and, therefore, key for the entire industry. Participants of the FGDs categorized producers into two, small scale and medium-to-large scale producers. Small scale producers rely on own or household labor, whereas medium-to-large scale producers engage hired labor for all or specific production steps.

Besides charcoal producers, there are numerous other actors who claim their stake in the charcoal value chain at different levels (production, transportation, marketing and consumption) differentiated by the main activities that take place at the different levels.

3.5.1. Production stage

At production stage, there are a number of actors that include the Kenya Forest Service (KFS), chiefs, country government, village elders who play the regulatory and oversight roles. The KFS is mandated by the law according to the Forest conservation Act, 2016 (No.34) to establish, develop and ensure sustainable management, conservation and rational utilization of forest resources for the socio-economic development. The institution is responsible for licensing of charcoal production. The Chiefs are mandated by law according to the Chiefs Act 2012, No.43, to regulate the cutting of timber and to prohibit wasteful destruction of trees, cancel and penalize any person who fails to comply with the regulations without lawful excuse. They have a regulatory role in tree harvesting for charcoal production by confirming the status on the ground to ensure there is responsible exploitation of trees for charcoal production. On the other hand, County government manages community land on behalf of the local people according to the Community land Act, 2016 No.27, that stipulates the county government shall hold in trust community land on behalf of the community and shall not sell, dispose or transfer or convert the land for private purposes. Village elders on their part, are responsible for supervision and surveillance to ensure that tree resources are conserved and only the fallen, dead, or trees that have been washed downstream and those infested by termites are used for charcoal production.

Charcoal producers are the main stakeholders at the production stage and as far as the entire industry is concerned. They obtain trees free of charge from communally owned land according to Kenya Forest Conservation and Management Act No 34 of 2016 that allows communities living within communal land to cut down a tree other than those specified in first schedule for personal rules. Three categories of producers were reported in this study namely; small, medium and large-scale producers.

Small scale producers were found to use household/own labor for charcoal production and had no alternative sources of income, whereas medium and large-scale producers engaged hired laborers in cutting the wood and transporting to the kiln site, preparation and firing up the kiln, managing the process of carbonization, extraction, cooling and packaging of charcoal in bags.

Although no formal institutions were reported at the production stage, producers often formed informal producer groups to collectively produce higher quantities of charcoal and are therefore able to meet market demands.

Discussions further revealed that most actors at the production end wish to belong to registered groups. Such groups ensure no one individual bears the burden of all tasks involved in charcoal production as roles are instead shared among the members of a group.

3.5.2.Transportation of charcoal

Several actors are directly or indirectly involved in transportation charcoal, including bulking agents, County officials, sewers of bags(responsible for sewing the top of packed bags of charcoal),overnight night guards, loaders. According to the Kenya Forest Harvesting Rules 2009 Section 11(1), persons are not allowed to transport forest produce without a valid license issued by the County Ecosystem conservator showing the source of the produce. The ricemeals known as transportation permit is valid for 3 to 5 days from the date of issuance.

The County government issues business permits/ license (Ksh 50/ bag) for vendors from Ksh 2500 for retailers as stipulated in the West Pokot finance Act NO.8 of 2016 that is required by any persons who intends to carry out a business or provide a service. The county government is also responsible for maintenance of checkpoints along the main roads and scrutiny of permits to confirm compliance with County laws. Bulking agents create a link between producers, wholesalers and retailers by buying charcoal from producers to later sell to wholesalers and retailers, and sometimes operate collection points (depots) on the roadside and in the forest. Sewers of bags, security personnel and loaders work together at the collection points on behalf of middle traders.

They guard charcoal against theft and deal with passing buyers, repackage and sew charcoal bags before transportation, load charcoal onto trucks and keep records of collected and sold charcoal.

The interviews revealed two types of charcoal transporters namely; those who are paid to transport charcoal bags from the kiln sites to the roadside or forest depots either on their heads, backs or using motorbikes; and transporters hired by wholesalers to collect charcoal from producers and deliver to stores or sell on behalf of the wholesalers.

Other actors involved at the transportation level include the police at check points, who ensure adherence to both traffic and environmental rules, for example those that require that neither alive nor dead forest products should be transported before six in the morning and after six in the evening. The police also conduct roadside inspections of trucks that transport charcoal, check

validity of permits, although they are quite often associated with soliciting bribes from truck drivers.

The key informant interviews and focus group discussions revealed that corruption along the charcoal is rampant. Corruption at checkpoints along the transport routes undercuts both the county and national government revenues. A wholesaler has to pay between USD2 and 3 (Ksh 200-300) per bag of charcoal as bribe at checkpoints along the transport routes. This cost is passed on to consumers in terms of the higher price they have to pay for a debe/bag of charcoal, ranging from USD 11 -18 (Ksh 1100-1800) when there is no charcoal ban, to USD 15-25 (Ksh 1500- 2500) when there is a government imposed charcoal ban that are normally accompanied with increases in bribes.

3.5.3. Sales and distribution stage

Wholesalers purchased charcoal either from producers or bulking agents and sold to retailers or end users. In some cases, both wholesalers and retailers sold their stock of charcoal directly to consumers. For instance, some wholesalers in Kitale and Moi's Bridge hired truck drivers who went around the residential areas in the urban centers selling charcoal on their behalf.

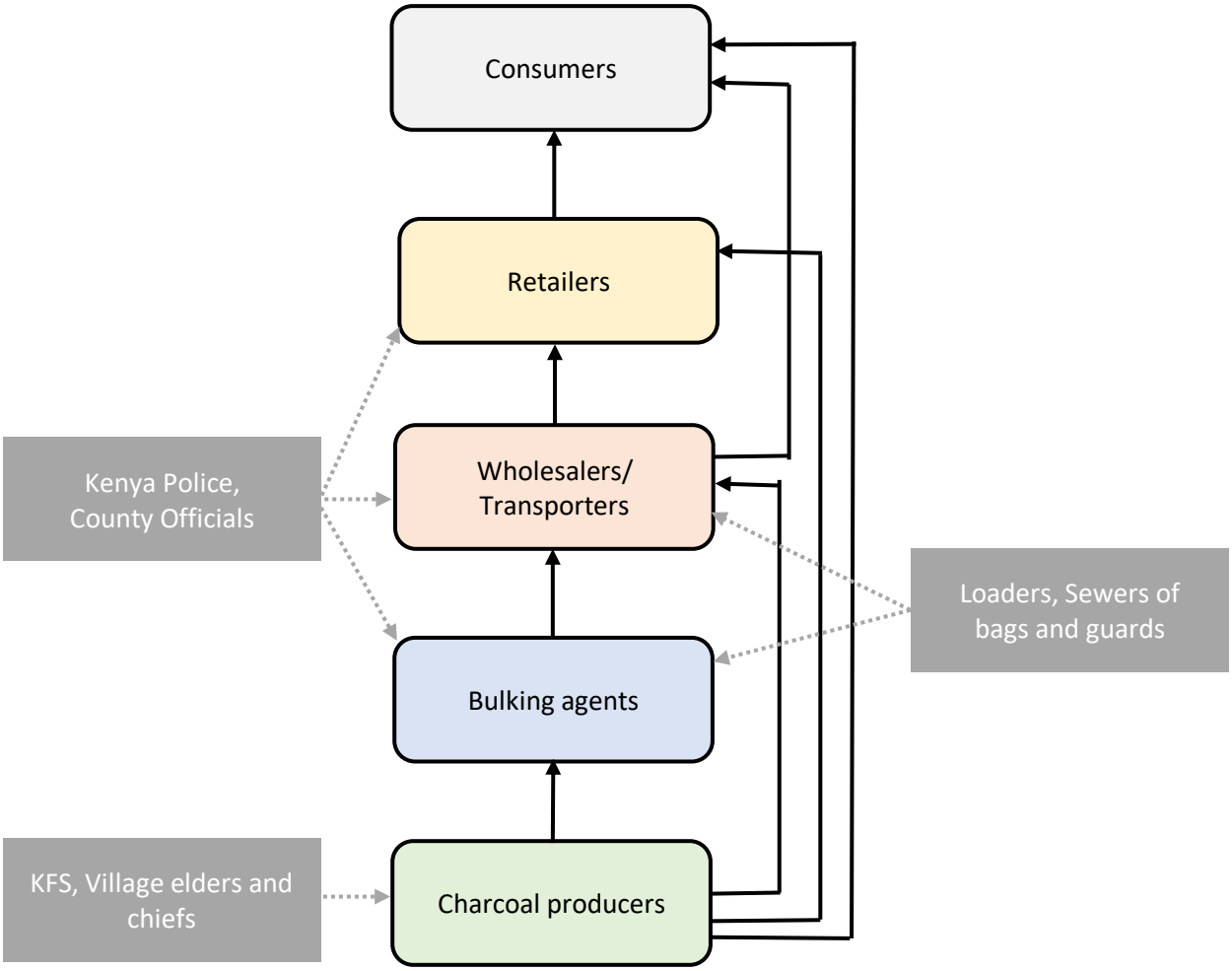
The vendors mainly targeted commercial consumers such as hotels and restaurants, Jua Kali entrepreneurs (small-scale informal traders and business enterprises), and public institutions like schools and hospitals. Wholesalers sell mostly larger quantities of charcoal, either directly to the end-user (especially to institutions and commercial enterprises) or to retailers.

Retail charcoal trade cuts across major markets in cities, from roadside sales to kiosks and larger supply depots. The interviews with retailers show that they sell charcoal in small bags of charcoal (packaged in 50kg capacity sugar sac) and smaller units of *karai* (Engl. basins, an equivalent of 10 kg) and 4 kg *debes* (Engl. tins). Whilst some retailers buy charcoal directly from producers, most of them source it from wholesalers. Typical retail customers purchase only smaller quantities (*karai* or debes) of charcoal for private household consumption. In order to compliment income from charcoal, majority of the retailers therefore also sell other household goods in addition to charcoal. Other actors involved at the marketing level include the County Government, which is

responsible for the issuance of business licenses to traders operating within their areas of jurisdiction. Retailers directly sell smaller amounts of charcoal to consumers.

3.5.4. Consumption stage

The charcoal trade was found to occur in a range of places, from roadside sales, to kiosks, depots and major markets in urban areas. The main charcoal consumers included households, public institutions like schools and hospitals, large scale commercial enterprises, jua kali entrepreneurs (small scale informal industries), and restaurants and hotels. The quantities of charcoal bought varied with the type of consumers, ranging from small bags bought by commercial consumers, public and private institutions, to 2kg *debes* and 10kg *karai* mainly bought by small business enterprises and households. The study however revealed that most of the charcoal produced is for commercial purposes than household consumption.



Source: Key informant interviews (N=42) and FGD (N=72)

Figure 3. 3:Actors and charcoal flow along the value chain1

3.6. Charcoal marketing channels

Several marketing channels for charcoal were identified in this study (Figure 3.4). These range from bi-directional exchanges, for instance between producers and middle traders, to more complex interactions that involve several actors along the chain.

Charcoal producers have four different possibilities to sell their charcoal; namely to 1) end-users; 2) bulking agents 3) wholesalers, or 4) retailers. An outstanding example of the latter type of

1 Broken lines indicate indirect interactions along the chain, while black solid lines indicate direct ones.

interaction are producers who have four different possibilities to sell their charcoal, each of which might involve numerous other direct or indirect actors (Figure 3.4).

Channel 1: The first option for producers is normally to sell the produced charcoal directly to end-users by the roadside. Besides random customers such as passing lorry drivers, many producers have established relationships with potential customers in nearby urban centers. This marketing channel is common for small-scale and irregular producers along the highway and/ or in the vicinity of urban centers. The consumers usually purchase one or two big bags of charcoal (packaged in 90kg capacity sugar sac) bags of charcoal. Due to the saved costs of marketing when charcoal is sold locally, both the producers and the end-users benefit from these transactions, the former in terms of higher accruing profits and the latter in terms of the lower prices paid.

Channel 2: The second option for producers is to sell charcoal to retailers who then sell in small units such as debes or karai to individual consumers. This marketing channel is profitable for retailers even when considering that they have to meet the costs of transportation to the (sub-) urban sales locations.

Channel 3: An alternative marketing channel for producers is to sell charcoal to consumers via bulking agents, transporters, and wholesalers. Typically, bulking agents run readily accessible charcoal depots in Pokot Central and maintain close relations with both local producers and urban-based wholesalers. The latter would send hired truck drivers to collect an agreed quantity of charcoal and transport it either directly to the end-users or to interim urban storage facilities. The target market mainly includes public institutions such as hospitals or schools and commercial enterprises such as hotels that purchase charcoal in bulk.

Channel 4: Another option for producers is to sell to wholesalers, who sell to traders that retail charcoal to consumers. The interviews with traders reveal that middle traders may sometimes alter this flow creating a linkage between producers and wholesalers. By ensuring ready markets and/or delivery for produced charcoal, middle traders were reported to facilitate faster sales and higher rates of stock turnover. For their services, middle traders earn commissions of approximately USD 0.5-1(Ksh 50-100) per big bag of charcoal from wholesalers.

Whereas they facilitate transactions, they at times also take advantage of their key position to negotiate for lower buying prices in order to increase their own commission. Upon buying in bulks

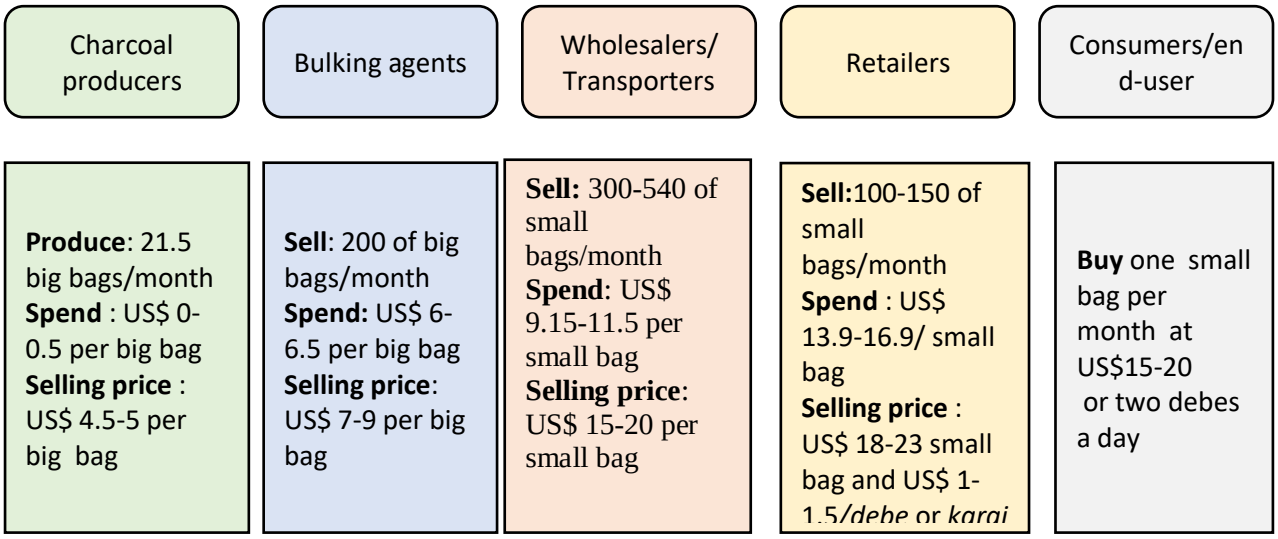
from the wholesalers, retailers directly sell smaller quantities of charcoal to consumers, mostly households and small-scale enterprises.

3.7. Estimated costs, charcoal prices and profits for actors along the value chain

Key informant interviews and FGDs revealed that a producer make an average of 21.5, big bags per month during the wet season when the weather is conducive. Producing one bag of charcoal costs USD0.5 (Ksh 50) and is sold for between USD4 and USD5 (Ksh 450-500), which translates into an average income of USD4-4.5 (Ksh 400-450) per 100 kg bag or an equivalent of USD120 (Ksh 12000) per month per producer. Considering an average selling price of USD 5-6 per big bag, and the cost of USD0.5 spent on packaging bags and transportation, a producer would earn an average profit of USD4.5-5.5 per bag of charcoal.

Interviews with the KFS officials show that between 5 and 10 lorries with a capacity of 150-180 bags of charcoal are granted permit weekly to transport charcoal from Masol, Lomut, Wei wei/ Sigor wards to urban centers of Eldoret, Kitale, and Kapenguria, and sometimes to Kakamega town and Kisumu city, with meager sales to small scale traders in between the major towns. This excludes the illegal trade volumes that go uncaptured. Figure 3.4 presents estimates of costs incurred, traded volume and prices at different levels of the value chain.

Producers might sell part of charcoal directly to end-users, usually when they store their commodities along the highway. With an average selling price of USD5 and 6 per big bag, this earns them an estimated profit of between USD4.5 and 5.5 (a cost of USD0.5 spent on bags). Even though producers incur other costs in terms of time and labor, the only cost that they quantify in monetary terms is, at times, the cost of an empty big bag for packaging which is USD0.5 (Ksh 50). When old bags are used, there are no costs involved and therefore making their cost range to be between USD0 and 5.



Source: Key informant interviews (N=42) and FGD (N=72)

Figure 3. 4:Average charcoal prices and traded volumes per actor at various nodes of the chain as reported by key informants and FGD participants2

Bulk traders buy a bag of charcoal from producers at between USD6 and USD6.5 (Ksh 600-650). A big bag of charcoal costs between USD4.5 and USD5 (Ksh 450-500), an additional cost of USD0.5 (Ksh 50) was (at times) spent on the purchase of a new big bag. USD 0.1 (Ksh 10) per bag was paid for loading and offloading of charcoal bags. Sealing of the charcoal bags and overnight guarding of the charcoal collection points costs USD0.1 (Ksh 10) and USD0.1-0.2 (Ksh 10-20) respectively per bag. USD0.5 (Ksh 50) was paid to the County as a daily trading permit (all costs are subject to variations). Producers sell to wholesalers at an average price of between USD7and USD9 (Ksh 700-900), earning them a profit range of approximately USD0.5-3 (Ksh 50-300). On average, producers were found to trade between 150 to 200 bags of charcoal per month.

Wholesalers buy a big bag of charcoal at approximately USD 9.15-USD11.5 (Ksh 915-1150) from bulk traders and repack the charcoal to 90kg bags. Transport to Kitale costs them USD1.5/ (Ksh 150) per small bag if they use a lorry or USD2 (Ksh 200) per small bag by a van (Probox).

They acquired a transportation permit at USD0.5 (Ksh 50) per small bag, they also paid USD 0.2-0.5(Ksh 20-50) per bag for Municipal Cess trading permit. In addition to this, wholesalers paid

2 Recorded average prices of charcoal and traded volumes per actor along the charcoal value chain in Central Pokot Sub-County.

between USD 2 and 3/ (Ksh 200-300) per bag of charcoal for rent during charcoal ban and USD0.25-0.3 (Ksh 25/20)/bag to the track driver.

Wholesalers sold a small bag of charcoal between USD15 and 20 (Ksh 1500-2000) earning them approximately USD3.5 and 10.85 (Ksh 350-1085) per small bag in proceeds.

Retailers incur approximately USD13.9-USD16.9 (Ksh 1390-1690). The costs incurred by retailers include Cess/county council charges of between USD0.5 and USD1.5 (Ksh 50-150) per day depending with the town, USD1 (Ksh 100) for bags used for repackaging and USD0.4 (Ksh 40) was paid for every small bag repacked. Wholesalers sell charcoal to retailers at an average price of between USD10 and USD12 (Ksh 1000 and 1200).

3.8. Discussion

The results of this study reveal that charcoal production in the rural Central Pokot County is entirely done using traditional earth kilns as opposed to improved technologies. This may be attributed to relatively high investment and maintenance costs associated with the modern technologies. This finding is however contrary to those reported from various studies conducted in Laikipia Kenya, and Morogoro region of Tanzania that indicated increased use of energy efficient technologies such as improved/ Casamance, which are similar to the traditional earth kilns but are more energy efficient) and metals kilns (Demibras, 2009; Kammen & Lew, 2005; Malimbwi & Zahabu, 2009). The results of this study reveal that at the time of the study, there were no functioning CPAs registered by KFS as provided for in section 5 (2) of The Forest (Charcoal) Rules, 2009 (Pisces, 2011). This finding is however contrary to those of other studies conducted in Tanzania, and Laikipia, Baringo and Kitui counties of Kenya that indicate the existence of CFAs, CPAs, CPGs and other interest groups, and their potential benefits to the members (Mewnr, 2013; Mwampamba et al., 2013).

The findings of the current study corroborate those reported by Agyeman et al. (2012) from a study done in Ghana which found out that charcoal production is done throughout the year although there are seasonal variations in production quantities with most producers preferring the dry season. Contrary to these results, Zulu & Richardson (2013) in their studies conducted in different

regions in Sub Saharan Africa reported that production is highest during the rainy season due to the high demand.

Similar to findings by Butz et al. (2013), in a study conducted in Tanzania, the main sources of wood for charcoal production were found to be Vachellia trees species harvested from the communal pastoral land. This however differs with observations made by Demirbas et al. (2009), but corroborates the findings of Njenga et al. (2013) from a study conducted in Kenya, where they reported that Acacia comprised 65% of the wood used in charcoal production. Studies by Khundi et al. (2011) and Mewnr et al. (2013) conducted in Uganda and Kenya, respectively reported that harvesting of wood for charcoal production was done on private lands, with additional encroachment to protected areas. Contrary to this finding, this study found that wood for charcoal production was harvested from communal pastoral land where access to resources is regulated by traditional elders and local chiefs to ensure sustainable exploitation (Woollen et al., 2016).

The findings of this study contrast those by Ainembabazi et al. (2013) in Uganda; and Mewnr et al. (2013) in Kenya, which revealed fewer actors that included wood owners, charcoal producer, wholesalers, transporters, retailers and consumers. However, studies by Chiteculo et al. (2018) in Angola, Schure et al. (2013) in South Africa and Ishengoma & Abdallah (2016) in Tanzania reported more actors that included producers, middle traders, wholesalers, transporters, retailers, consumers and other actors who were not directly involved like wood cutters, distributers, community and urban bulking point owners, a finding that was similar to this study.

Studies conducted in Malawi (Kambewa et al., 2007), Tanzania (Malimbwi & Zahabu, 2009) and Kenya (Mewnr, 2013) showed that most charcoal transporters were owners of the charcoal being transported. This is in contrast to the findings of the current study that revealed that most transporters were hired by wholesalers to transport charcoal to certain destinations.

Similar to the findings of Mewnr et al. (2013), this study found that charcoal produced in Pokot Central is mainly supplied to Kapenguria, Kitale, Eldoret, Kakamega and Kisumu towns, and some smaller towns in between these urban centers. The results also show that an increasing amount of charcoal that is supposedly sourced from Turkana may actually be coming from Pokot Central. This is because traders acquire permits from Turkana County, where they are easier to obtain, but

undertake actual production in West Pokot County. Due to such complex arrangements, the latter county loses a substantial amount of revenue while leaving gaps and loopholes for corruption, which is exacerbated by insufficient cooperation between different government agencies.

In studies done by Chiteculo et al. (2018) in Angola, Jones et al. (2016) in South Africa, and Ndegwa et al. (2020) in Kenya, bulking agents were reported to be the most important actors as they linked the actors and influenced the market prices. The dominance of the trade by bulking agents was attributed the poor access to remote areas where charcoal production is done that implies high costs of transportation to the highway. The bulkers therefore offer readily available market and determine prices, leaving charcoal producers at their mercy. Producers and the bulking agents in Central Pokot have a relationship that go beyond business, making it easier for them to trust each other with charcoal and cash. This type of relationship is yet to be documented since most interactions are mainly cash transactions that involve exchange of money for charcoal. In other places like Kajiado and Baringo counties, middlemen usually have no such interactions as reported by Mewnr (2013), which can be attributed to the readily available market, better accessibility and bulk production.

Findings by Mewnr et al. (2013) in Kitui and Baringo counties found that production costs of charcoal were relatively higher compared to the study area. This could be partly attributed to the fact that at times producers in Kitui and Baringo counties have to buy wood for charcoal production from privately owned farms unlike in the study area where land is communally owned and therefore wood for charcoal production is freely acquired.

A study by Bailis et al. (2013) found that household consumption takes more than 16 % of the produced charcoal in Brazil, contrary to the results of this study and that by Ndegwa et al. (2020) which show that charcoal is mostly for commercial use. Additionally, Angola, Mozambique, Malawi, Tanzania and Zambia were also found to have slightly higher household charcoal consumption, ranging from 0.56% to 1.17% (Falcão et al.,2008).

A study by Bergmann et al. (2019) shows that producers mostly transport bags of charcoal on foot to specific selling points, many of which are located along the Kitale-Lodwar highway and maintained by local brokers. Urban-based wholesalers commission these brokers to ensure the availability of a stipulated number of charcoal bags, before hiring a truck to transport them. This

is contrary to the findings of a study by Malimbwi & Zahabu (2009) in Tanzania which reported that more than 64% of producers used bicycles.

Similar to finding by Agyei et al. (2018) and Tesfaye et al. (2011) in their studies in Afar region in Ethiopia and West Africa respectively, limitations on law enforcement and tax revenue collections coupled with corruption at checkpoints along the transport routes undercuts government revenue (Mewnr, 2013).

3.9. Conclusion

Charcoal production in the study area is entirely done using the traditional earth kiln, which the producers prefer because they have a higher capacity than metal kilns.

Thirteen actors are involved at different levels of the charcoal value chain that include production, transportation, marketing and consumption. Interactions amongst the different actors range from bi-directional interactions between two actors, to more complex interactions that involve several actors along the chain.

Vachellia tortilis, *Vachellia elatior*, *Senegalia mellifera* and *Vachellia reficiens* are the most preferred species for charcoal production.

While middle traders are key in linking the producers and consumers in the chain, their involvement increases charcoal price, a cost that is passed on to the consumers.

The charcoal value chain has got rather complex governance system that combines the traditional system at production site and formal institutions along the chain that are mainly regulatory.

Limitations on law enforcement and tax revenue collections coupled with corruption at checkpoints along the transport routes undercuts both the county and national government revenues.

CHAPTER FOUR

FACTORS INFLUENCING HOUSEHOLDS' PARTICIPATION IN CHARCOAL PRODUCTION IN SEMI-ARID CENTRAL POKOT SUB-COUNTY, KENYA

ABSTRACT

Charcoal production has been regarded as one of the alternative livelihood diversification strategies among rural communities in the drylands of Kenya for close to three decades, in most cases ranking second after livestock production. Despite the obvious need to generate income, little is known about the other drivers of household participation in charcoal production in the vast drylands. Even though previous studies indicate that determinants of households' adoption of charcoal production change from time to time, as well as from one location to the other, there is still inadequate empirical evidence to support this. This study was therefore conducted to assess factors that influence households' participation in charcoal production in Central Pokot Sub-County, and the challenges and opportunities in the charcoal value chain. Data was collected from 100 households through interviews using a semi-structured questionnaire. Additionally, reflexive analysis of cross-cultural interviews with multiple focus group discussions, key informant interviews and a follow-up workshop were conducted to validate collected data. Results indicate that female and youth headed households were more likely to engage in charcoal production as compared to households with male and older heads. Households with limited livelihood sources were more likely to produce charcoal compared to households with a number of alternatives. The results of this study reveal that the main challenge facing charcoal producers are theft of charcoal at bulking centers by other traders and locals, respiratory diseases associated with inhalation of smoke during charcoal burning process and tediousness due to the workload associated with the production process. It can be concluded that charcoal production is associated with lack of ownership and access to main productive assets such as livestock especially among the female headed households and youth that necessitate search for alternative sources of income to meet family needs. There is therefore need to sensitize women and the youth about women and youth

fund and build their entrepreneurial skills on alternative business opportunities other than charcoal production.

Keywords: Gender, education, charcoal burning, drylands, West Pokot

4.1. Introduction

Charcoal can no longer be ignored as a current and future major energy source Bantle et al. (2014) and Joseph et al (2015), especially with Africa's charcoal consumption expected to increase considerably and faster than other regions of the world doubling from 17.1 million tons by 2030 (FAO, 2013). Across sub-Saharan African (SSA), charcoal has the potential to provide accessible, affordable and reliable energy to millions of households, in addition to supporting millions of rural and urban livelihoods through income generation and contributing to the national economy. For example, in Malawi, the charcoal sector contributes an estimated USD40 million, roughly 0.5% of national GDP (Kambewa et al., 2007). In Tanzania, the industry contributes USD650 million to the economy, 5.8 times the combined value of coffee and tea production.

The charcoal sector provides income to several hundred thousand of households in both urban and rural areas globally (World Bank, 2009). Growing urban charcoal demand and markets provide opportunities for income generation from the production of charcoal in rural areas where it is often the most commercialized resource, and from the sale of charcoal in urban areas (Ghilardi et al., 2013; Kambewa et al., 2007). The charcoal market also provides urban households with an affordable, convenient and reliable source of energy and associated energy services (cooking, heating, small-scale industrial uses etc.) at relatively stable prices Arnold & Persson (2006). In Kenya, the charcoal industry is ranked fourth after tourism, horticulture and tea production representing an annual market value of over USD427m (Ksh32 billion), compared to USD467m (Ksh35 billion) in the tea industry (Bailis et al., 2013; Iiyama et al., 2017). This supports the local communities as the proceeds received is circulated within the Kenyan economy compared to the tea sector where 50 percent of the proceeds received is distributed to multinationals. The industry employs thousands of people (an approximate of 700,000), especially the rural young men and women (Neufeldt et al., 2018). According to Mewnr et al., (2013) charcoal producers alone are equivalent to an estimated 238,000 teaching workforce in the Kenya National government. Over

the last two decades, there has been an estimated 75% growth in urban areas (UN-Habitat, 2014), with concomitant rise in demand for charcoal as the main source of cheap energy.

In Kenya, most of the charcoal consumed in the urban and peri-urban areas is produced in the drylands (Sola et al., 2017).Pastoral communities living in these areas are increasingly getting involved in charcoal production, and in some areas, it is depicted as the second most important income earner after livestock production (Jones et al., 2016).Whereas it can be said, as studies have suggested that pastoral households mainly engage in charcoal production either as a fall back economic activity or a complementary source of livelihoods, little is known about other factors that may be driving the rising trend of charcoal production in the pastoral areas of Kenya. This study was therefore conducted in Central Pokot Sub-County to assess the socio-economic and demographic factors that influence households' participation in charcoal production, and the challenges along the value chain.

4.2. Methodology

4.2.1. Study area

4.2.2. Location and topography

The study was conducted in West Pokot-County, which falls within Longitudes 34^0 47'and 35^0 49' East and Latitude 1^0 and 2^0 North, located in the Rift Valley region of Kenya. The County covers an area of approximately 9,170 km2 with a population of around 621,241(Kenya National Bureau of Statistics (KNBS), 2019). It is situated in the north rift along Kenya's Western boundary with the Uganda border. The study area borders Turkana County to the North and North East, Trans Nzoia County to the South, Elgeyo Marakwet County and Baringo County to the South East and east respectively (RoK, 2012c). The altitude of the county ranges from less than 900 m above sea level, in the North Eastern and Northern sides which are dry plains, to an altitude of 3,370 m above sea level in the south-eastern side that comprise the Cherangani Hills. West Pokot-County is divided into four sub-counties, North Pokot, South Pokot, Pokot Central, and Pokot West. The exact study site was in Central Pokot, Sub-County, which covers an area of 2,380.1km^2 and is home to 114,097 persons (KNBS, 2019) and neighbors three counties, Baringo to the east, Turkana South to the north, and North Pokot to the west (Figure 4.1).

4.2.3. Climate

West Pokot-County is largely semi-arid and the climate is characterized by high-temperatures, erratic . The rainfall pattern is bimodal, with the long rains falling between April and August, and the short rains between October and February. There is, however, great variation in the total amount and distribution of the rainfall received in the county with the lowlands receiving 600 mm per annum, while the highlands receive 1,600 mm per annum. The county experiences great variations in temperature with the lowlands exhibiting temperatures of up to 30^0 C and the highlands experiencing moderate temperatures of 15^0 C. The high temperatures in the lowlands cause high evapotranspiration, which is unfavorable for crop production. The high-altitude areas with moderate temperatures experience high rainfall and low evapotranspiration hence suitable for crop production.

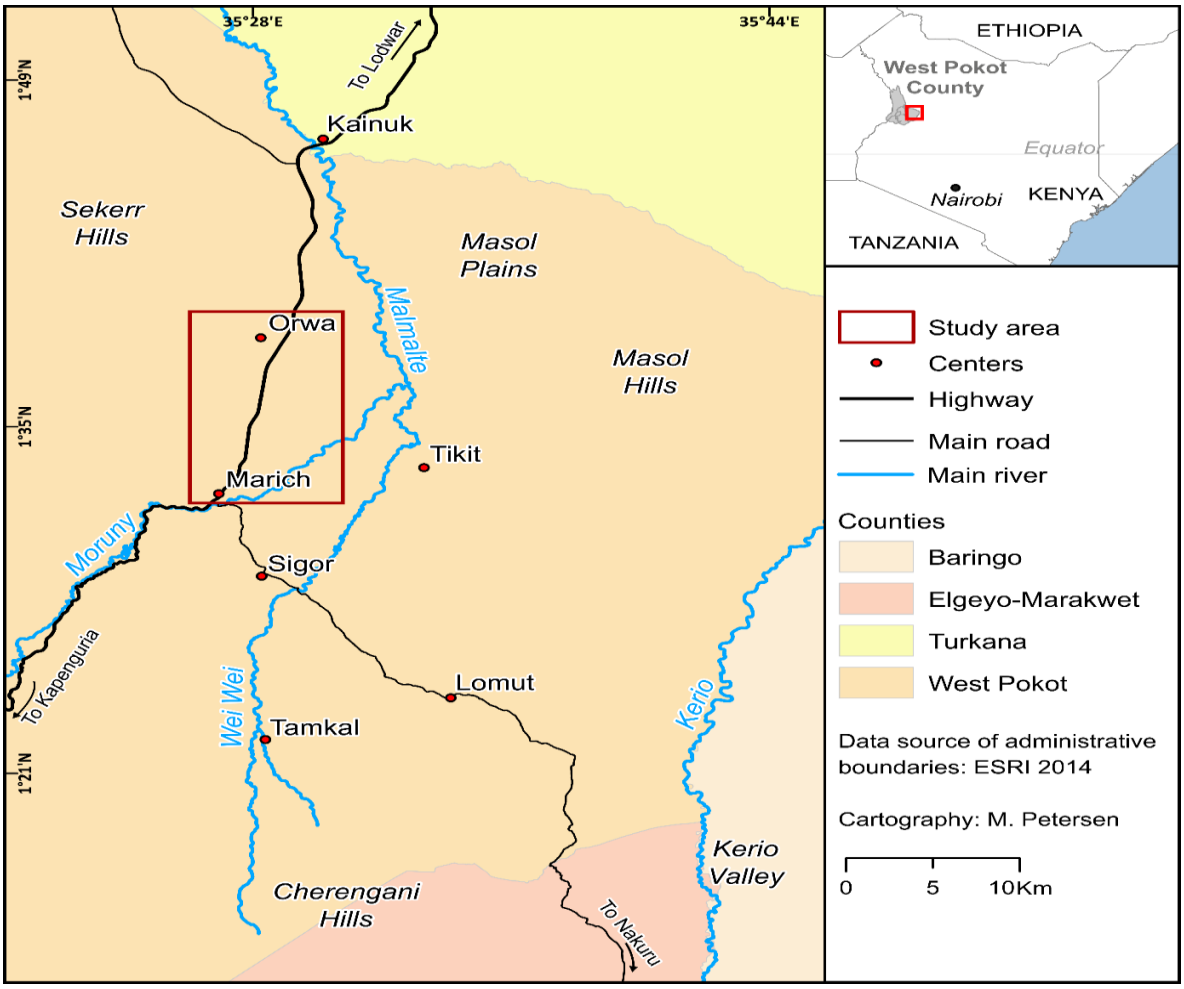


Figure 4. 1:Study area

4.2.4. Ecology and Vegetation

The study area is a semi-arid rangeland and lies within agro-ecological zones (AEZ) IV and V (FAO 2019), comprising mainly of Vachellia species dominated bushed and wooded grasslands. The land cover comprises mainly savannah woodlands and grassland, croplands, bare grounds, wetlands and water bodies, as well as settlement areas (GoK, 2016). The main forests in the county are Lenan and Kamatira forests which form part of Cherengani hills, with other natural forests scattered all over the county dominated with tree species like cedar (*Juniperus procera*) and bamboo (*Aredinaria alpina*). Most of the natural vegetation therefore serve as forage for livestock, especially goats and camels (Mochabo et al., 2005), sheep and cattle. The area is characterized with weakly developed soils, with low organic matter (Gilbert et al., 2014), and well to poor drainage with exception of the soils that neighbor the Ugandan border, which are mainly Cambisols which are fine, highly fertile and suitable for crop production.

4.2.5. The people and livelihood activities

Majority of the people living in Central Pokot belong to the Pokot ethnic community, followed by Turkana community and a mix of other ethnic groups. The dominant source of livelihood in the area is nomadic pastoralism characterized by extensive livestock production (contributing 84% of households' income), which is complemented by crop farming around water sources and in the irrigation schemes managed by the National Irrigation Board (Nyberg et al., 2015). The pastoral production system is characterized by low external input livestock production that relies on strategic use of natural pastures that are variably distributed in space and time. Pastoralists keep cattle, sheep, goats and camels, while those practicing agriculture mainly grow maize, potatoes, fruits (mangoes, papaya, watermelon, oranges), onions, tomatoes, and beans (CIDP 2018). Other alternative livelihood activities include charcoal production, especially along the Lodwar - Kapenguria highway. Additionally, gold panning, and plants products from Aloe *turkanensis, A. secundiflora* and *A. scabrifolia*, and firewood trade are other sources of income for the communities living in the area (FAO 2020).

4.3. Sampling Procedure and Data Collection

The study combined information gathered through household interviews (n=100), focus group discussions (FGDs) and key informant interviews (KIIs) in the region between Marich pass and Orwa trading centers in Central Pokot Sub-County.

Using a sketch map of the households provided by the village head as a guide, systematic random sampling procedure was used, where the first household was randomly chosen and the subsequent respondents were systematically selected after every two households along the Kitale-Lodwar highway, alternating right and left of the road. A pre-tested questionnaire was administered to the randomly selected households through face-to-face interviews.

Focus Group Discussions (FGDs) were centered on challenges along the charcoal value chain. Household interviews captured information on the socio-economic and demographic characteristics of the respondents to determine factors influencing households' participation in charcoal production, supplemented by KIIs. Participants were asked to identify the different challenges and opportunities at various nodes of the value chain. Direct observations were used to gain further understanding of the processes involved along the charcoal value chain. This involved traveling with the track drivers to passively observe and record activities and capture challenges during transportation of charcoal between Lomut market and Moi's Bridge trading center.

Pokot and, to a lesser extent, Swahili languages were used during the interviews for ease of communication with the community members who are more conversant with their local dialect.

Owing to the semi-legal nature of the charcoal trade, assurance was given to maintain the informants' anonymity. All names have therefore been concealed in this thesis.

4.4. Data Analysis

The information obtained from household interviews was subjected to descriptive and inferential statistical analyses using the Statistical Package for Social Science (SPSS) version 19.0. Descriptive statistics including means, standard deviation (SD), frequencies and percentages were generated for the selected socio-demographic characteristics of the sampled households. Binary logistic regression was used to determine factors that influence households' participation in charcoal production. Information from KIIs and FGDs was summarized under respective topics and tables were used to display the challenges reported in the charcoal value chain.

4.5. Description of the Hypothesized Variables Used in the Binary Logit Model

It was hypothesized that participation of households and individuals in charcoal production is a function of the household demographic characteristics that determine access to factors of production and assets. The independent variables hypothesized in this study were: education level

of household head, age of the household head, household size, and household herd size, number of income sources, gender of the household head, household land size, membership to social or development group and, access to extension services. The variables are described in detail in Table 4.1.

4.5.1. Participation in charcoal production (independent variable)

The independent variables hypothesized to influence the respondents' decision to adopt charcoal production in this study were: education of household head, Age of household head, Household size, Household herd size, Number of livelihood sources, Gender of household head, access to the market and membership in association. The dependent variable was assigned the value of 1 if a household participated in charcoal production and 2 if otherwise.

Table 4.1:Hypothesized variables and their expected influence on the dependent variable

Variable	Description	Measurement	Expected influence on households' participation in charcoal production (dependent variable)
Y	Participation in charcoal production	1=Yes 2=No	
EOH	Education of household head	0=No education 1=Primary, 2= Secondary, 3=Tertiary	-
AHH	Age of household head	Years since birth	+
HOS	Household size	Number of individuals in the family	±
HHS	Household herd size	Tropical Livestock Units (TLUs)	-
NLV	Number of livelihood sources	Number of economic activities	±
GOH	Gender of household head	[Male=1, Female=2]	-
ATM	Availability of the market	[1=Yes,0=No]	+
MAA	Membership in association	[1= Yes, 0=No]	-

4.5.2. Education of household head

Education level greatly influences major decisions at the household level. It was measured in terms of the number of years spent by the respondent in school. Households headed by an educated head have the ability to easily understand the importance of diversification (Wasonga et al.,2011; Zulu & Richardson, 2013) and conservation of natural resources especially trees to ensure sustainability. It was expected that education level has a negative relation with charcoal production as households with educated heads were hypothesized to have reliable and secure livelihoods probably through wage employment. The education level of a household head was assigned the value of 0 if not educated, 1 if attained primary education (at least 8 years of education), 2 if secondary education was attained (16 years) and 3 for post-secondary education (21 years).

4.5.3. Age of household head

Age of the household head influences productivity, wealth accumulation and access to resources (Lugusa, et al.,2016; Wasonga et al., 2011). Household heads above 40 years are therefore more likely to be richer, wiser and more invested and therefore less likely to be involved in charcoal production. Younger household heads are hypothesized to be risk-takers and may be more willing and ready to make changes to their normal day to day practices in order to advance their livelihoods and make ends meet compared to older individuals. This study treated `age as a continuous variable and was categorized as follows: 20 (children); 21-40 (youth); and 41-60 (middle age); over 60 elderly.

4.5.4. Household size

Charcoal production is relatively labor-intensive to mean the bigger the household size the more the family members and thus more (free/cheap) labor and fewer costs incurred in hired labor. This study hypothesized that the bigger the family size the higher the potential to practice charcoal production (Elhadi, et al.,2012). On the other hand, because bigger households require more resources for upkeep and chances of diversification of livelihoods are high, they were expected to less likely to engage in charcoal production as compared to smaller counterparts. This study therefore hypothesized both negative and positive relationship between household size and charcoal production.

4.5.5. Household herd size

Herd size is a measure of wealth in pastoral communities (Wasonga et al., 2011) therefore households with large herds are considered richer than counterparts with smaller herds. An assumption was made that participation in charcoal production is dependent on the number of assets a household has, the more the assets the less interest in charcoal production and vice versa. Herd size was measured in terms of Tropical Livestock Units (TLUs) per household (1TLU = 250kgs of a live and mature animal) (KARI/ODA, 1996). A bull was equated to 1.29TLU, a cow = 1TLU, a calf = 0.4 TLU and a sheep or goat = 0.11 TLU. Conversion of livestock numbers into TLU equivalents aids in the comparison of herd sizes between households by ensuring standardization of different types and kinds and classes of animals on a universal unit.

4.5.6. Number of livelihood sources

The resilience of a household to economic shocks varies from one household to the other depending on the number household's asset endowment, the disposability of the assets (social and material) and the diversification of the economic activities (Elhadi et al., 2012). Households with diversified sources of livelihoods (measured in terms of number of economic activities a household engages in) have higher resilience to shocks than those relying on one source of livelihood. Whereas households with diversified sources of income were expected to be wealthier and therefore unlikely to engage in charcoal production, given that they were already aware of the benefits of diversification of livelihoods, one would expect them to engage more in charcoal production than their counterparts with fewer or no alternative sources of income. The number of livelihood sources was therefore hypothesized to have both positive and negative relationship with households' adoption of charcoal production.

4.5.7. Gender of household head

Gender plays an integral part in decision making regarding income-generating activities. In Sub-Saharan Africa, female headed households, especially in the pastoral communities have limited access to certain resources compared to the male-headed counterparts (Delahunty et al., 2012). One would expect that because of limited access to productive assets, female headed households are likely to engage in charcoal production to make ends meet as compared to the male-headed

households who may be more endowed in resources and may have more avenues of earning livelihoods. The gender of the household head was a dummy variable where a value of 1 was assigned to male-headed households and 0 to female-headed households.

4.5.8. Market Availability

Ready market is an incentive to charcoal producers to continue producing, unlike instances where there are no ready market outlet or markets are far and therefore not easily accessible. This study hypothesized that ready markets positively influence charcoal production. Market availability was a dummy variable, assigned a value of 1 for yes responses (meaning availability of ready market), and 0 for No responses (meaning no ready market for charcoal).

4.5.9. Membership in associations

Membership in associations provides social capital and helps charcoal actors to pool their resources together for collective action. It also increases the capacity of group members to access services like information and credits. Association membership is believed to facilitate participation in charcoal production. This study hypothesized that membership in associations has a positive influence on participation of households in charcoal production. Membership in association was treated as a dummy variable where the value of 0 was assigned to households that are not members of any associations and the value of 1 to the households that are members of an association.

4.6. Specification of the Logit Model

Logit regression model was used to determine factors that influence households'' participation in charcoal production. The regression involved the dependent variable (participation in charcoal production) and a series of explanatory variables that were hypothesized to influence the participation of households in charcoal production. The dependent variable, participation in charcoal production was considered discrete in nature and exhibited a binary response of yes if a household participated in charcoal production and no if otherwise. Since the dependent variable in this model was not continuous, ordinary least square (OLS) regression was unsuitable since it could lead to wrong conclusions based on the parameter estimates due to the problem of

heteroscedasticity, which arises due to the assumption that the variance of the error term is not constant for all observations in the model (Ravallion et al., 2001).

The suitable method for analyzing discrete binary data in which the dependent variables evoke a yes or no response is binary regression. Logit and Probit models are appropriate when the dependent variable is discrete usually taking two values, 0 or 1 (Maddala et al., 2001). The logistic and normal distributions associated with these two models are similar and using either basically produces similar results (Maddala et al., 1983 and Salvatore & Reagle, 2002). However, in discrete choice modeling, the logit is commonly used and this model assumes that all alternatives have the same variance and that the unobserved factors are not correlated over alternatives. Despite this assumption being limiting, it provides a very suitable form for the choice probability since the formula for the choice probabilities is readily interpretable and takes a closed-form. The use of maximum likelihood estimation in this model assumes the standard logistic distribution of errors, which implies that the errors are independently normal (Train et al., 2009).

The behavioral model described in the equations 4.1 by Ameyima (1994) and Gujarati (1995) was used to evaluate factors that influence household participation in charcoal production.

$Yi = f(ti)$……..... (4.1)

The equation denotes that there is a functional relationship (f) between the survey observation (Yi) and the stimuli ti, where,

$t = b_o + \Sigma\, biX$……..……..... (4.2)

Y is the response for the i^{th} observation with binary variable 1 = producers and 2= non-producers. ti is the stimulus index for the i^{th} observation. It is presumed that there is a threshold index for each household, ti* such that if ti* >ti the household is observed as a producer of charcoal production and if ti*<ti then, the household is a non-producer. The probability of such a household participating in charcoal production was computed using equation 4.3:

$\{Pi = (e^{ti}) / (1+ e^{ti})\}$ ……... (4.3)

The model for the factors hypothesized to influence households' decision to participate in charcoal production was then re-written as:

$Y = \ln \{P(X_i) / (1- (P(X_i)\} = \beta i X_i + e_i$……. (4.4)

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

β_i= coefficient of factors influencing participation in charcoal production

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

e_i= error term

The linear regression model for this study was specified as shown in equation 4.5.

$Y = \beta 0EOHi + \beta 1AHHi + \beta 2HOSi + \beta 3HHSi + \beta 4NLVi + \beta 5GOHi + \beta 6DFMi + \beta 7MAAi + e_i$……. (4. 5)

Where *i* denotes ith household (1……101), EOH is the education level of the household head, AHH is the age of the household head, HOS denotes the size of the household, HHS is the household herd size, NLV is the number of household livelihood sources, GOH denotes the gender of the household head, ATM denotes access to market and MAA denotes the membership to support groups/associations, α is the constant term and β0…….. βk are coefficients representing parameter estimators of the variables in the model.

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

4.7. Multicollinearity Statistical Test

In order to ensure that the explanatory variables included in the model were not in any way correlated with each other, a Multicollinearity test was done through a variance inflating factor (VIF) computation. This was necessary because if two or more expounding variables in a regression model are highly correlated, it would be impossible to isolate their effects on the dependent variable

(Alin et al., 2010). If a predictor variable in a model has its variance overestimated by the occurrence of Multicollinearity, variance inflation factor (VIF) is able to show this (Long 1997). The VIF was calculated as shown in equation (4.6)

$$VIF = \frac{1}{1 - Ri^2} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (4.6)$$

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

4.8. Results

4.8.1. Results of Multicollinearity Test

The VIF range for the explanatory variables was from 1.095 to 1.421 with an average mean of 1.232 as shown in Table 4.2. Since the VIF for the independent variables was less than five (<5), the variables were justified to be included in the Logit model (Maddala et al.,2001).

Table 4.2:Estimated variance inflation factor

Variable	Tolerance(1/VIF)	VIF
Gender of household head	0.729	1.371
Education of household head	0.914	1.095
Household size	0.850	1.176
Number of livelihood sources	0.736	1.358
Membership to association	0.704	1.421
Age of household head	0.823	1.216
Market availability	0.892	1.121
Household herd size	0.893	1.119
Mean VIF		1.234

4.8.2. Socio-Demographic Characteristics of the Sampled Households

Table 4.3 shows the descriptive statistics of the explanatory variables used in the binary logit model. Most (88%) of charcoal producing households were female-headed, and most (80%) of non-producing households belonged to an associations/groups compared to producing

households (29%). Market availability was high for producing households (89%). Whereas 84% of non-producing households had alternative sources of income, only 23% of charcoal producing households had alternative income sources.

In addition, non- producers were found to be more educated with mean of 13.72 ± 3.48 years of formal education compared to producers with a mean of 7.17 ± 2.27 years of education. Most producer household heads were young (34.62 ± 2.59 years), and had averagely larger herd sizes (15.86 ± 3.55TLU) compared to non-producers (7.76 ± 4.48 TLU).

Table 4.3: Descriptive statistics

Variable	**Charcoal Producer (N=75)**	**Non-charcoal -producer (N=25)**
	Frequency (%)	**Frequency (%)**
Gender of household head		
Female	66 (88)	5 (20)
Male	9 (12)	20 (80)
Membership in association		
Yes	22 (29)	20 (80)
No	53 (70)	5 (20)
Market availability		
Yes	67 (89)	0
No	8 (17)	0
	Mean± SD 3	**Mean± SD**
Number of livelihood sources	25 ± 2.3	4.7± 1
Education of household head	7.17 ± 2.72	13.72 ± 3.48
Age of household head	34.62± 2.59	39.16 ± 2.68
Household herd size	15.86 ± 3.55	7.76 ± 4.48
Household size	9.79 ± 3.51	8.64 ±3.44

3 Mean and SD

4.8.3. Determinants of household participation in charcoal production

Factors that influence households' participation in charcoal production are presented in Table 4.4. The results show that gender of the household head (p=0.03), number of livelihood sources (p= 0.01) and availability of market (p=0.04) had positive and significant influence on households' adoption of charcoal production. On the other hand, education of household head (p=0.04), number school-going children (p=0.8), membership to association (p= 0.3) and age of household head (p= 0.03) had significant but negative influence on the participation in charcoal production by households.

Table 4. 4:Results of the binary logit regression

Variables	B	S.E	Wald	Exp(B)	Marginal effect	p-value
Gender of household head	0.579	2.727	6.045**	1.778	0.625	0.033
Education of household head	-0.784	0.430	3.324*	0.457	-0.087	0.048
Household size	0.188	0.305	0.381	0.829	0.258	0.537
Number of livelihood sources	0.355	0.378	2.111*	1.309	0.006	0.016
Number of school children	-0.106	0.594	0.032	0.900	-0.017	0.859
Membership to association	-0.228	0.265	0.740	0.796	-0.003	0.390
Age of household head	-0.136	0.254	5.285*	1.145	-0.325	0.015
Market availability	0.374	0.803	0.217*	0.688	0.431	0.041
Household herd size	-0.041	0.280	0.021	0.960	-0.006	0.884
Constant	0.576	2.727	0.045	1.778	-	-

Statistical significance levels: *1% and **5%; Chi-square=52.682; -2log likelihood= 106.117; Cox and Snell R^2 =62; Nagelkerke R^2 =91 ;(*) marginal effect is for a discrete change in the dependent variable following a unit change in the independent variable

4.8.4. Challenges faced by the charcoal producers

Figure 4.2 presents challenges reported by producers at the production and marketing levels in the charcoal value chain in the study area with corresponding testimonies from KIIs presented below.

The key informant interviews show that theft of charcoal at bulking points and along the highway stores and respiratory diseases associated with inhalation of smoke from charcoal kilns are the main challenges facing the producers. This corroborates the testimony of a former charcoal producer. Ali recounts and compares the distance he used to cover to charcoal burning site while helping the dad as a young boy, and the distance he had to cover as a grown up as he engaged in charcoal production:

"*Things have changed, the distance keeps increasing while the quality of the charcoal decreases". Today, producers are using species that would otherwise have never been used to produce charcoal. Diminishing quality tree species and increased distance to production sites has stirred up conflict ones in a while between neighbors. Mostly the conflicts often concerning ownership and boundaries, with some producers illegally harvesting trees too close to someone else's homestead, while others encroaching into protected areas like such as the Kamatira forest"* (Former charcoal producer, Poigh School area, 03/04/2018).

Stressing the health challenges associated with charcoal burning, one of the producers indicated that:

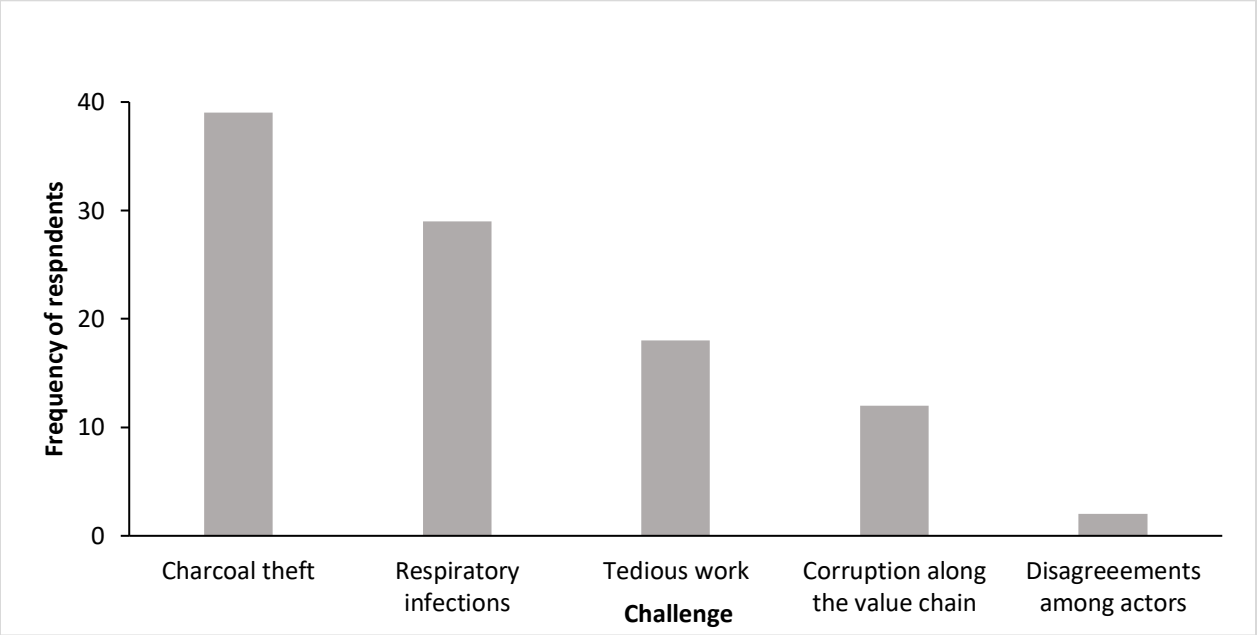
"Charcoal production is not a long-term venture, it's not healthy for the body and the environment. I am doing this to educate my children and I know they will get better jobs and I will not have to do this forever. I have Tuberculosis (TB), back pain and my hands have blisters making it hard to work" (Charcoal producer, Coastal area, 05/04/2018).

Just like many other producers, he associated TB to charcoal production but what they really meant is persistent coughs and chest infection. The producers described charcoal production as long and tedious.

Corruption was mentioned as the fourth main challenge to not only producers, but also traders. As indicated by various actors along the value chain, paying for permits and having all the necessary documents is no guarantee as the law enforcing officer would still find something that warrant payment of bribe. The police officers alike confess to the existence of illegal payments that the charcoal traders are subjected to, which also involve their seniors:

"Orders come from our superiors and you are not allowed to ask questions. Ours is to obey and do as order unless you want to lose your job or be transferred. Certain trucks can never be stopped

because they are known to belong to certain politicians or someone affiliated to them. Often times we are required to go back to the office with a certain amount of cash for the bosses, and at times it's for my personal needs, so we are forced to harass the charcoal producers and traders" (Police officer, Marich-Sigor junction, 09/04/2018).



Source: Household interviews (N=100)

Figure 4. 2: Challenges faced by charcoal producers during charcoal production and marketing

Even though corruption is rampant and affects all the stakeholders, transporters and wholesalers bear the burden, which they also pass to producers in terms of lower buying prices, and consumers in form of high prices in order to compensate for the high cost of transport related to the bribes along the highway. For the traders, a journey that would normally take a few hours, takes a day or more due to the countless stops at check points. This means unreliability in delivery of charcoal, which affects especially the large institutions that depend on the bulk supply of charcoal, most of which are currently considering other alternative energy sources to supplement charcoal use.

Disagreement is common among various institutions responsible for law enforcement in the charcoal value chain. In the words of an official from the Kenya Forest service:

"There is so much disparity in the different government agencies, whereas some are reluctant and inadequate in enforcing their authority, others invade into the jurisdiction of other authorities, for instance, the Turkana County Government issuing out charcoal transportation permits instead of the Kenya Forest service and without communication" (KFS officer, Sigor shopping center,11/04/2018).

The key informant interviews further revealed lack of coordination between different government agencies such as the KFS, the County Government and the National Environment Management Authority (NEMA). Each of them would assume that the other agency would take responsibility for certain issues. Limitations on law enforcement and tax revenue collections coupled with corruption at checkpoints along the transport routes undermines both the county and national government revenue collections.

4.8.5. Corruption at road blocks along charcoal transportation routes

Corruption at road blocks along the Kitale-Lodwar highway was mentioned by producers as one of the main reasons for unfavorable prices offered for the charcoal by traders. Interviews with the producers and traders show that the high costs associated with illegal payments made at a number of check points during charcoal transportation are responsible for the low prices offered by traders in order to compensate for the anticipated bribes.

The observations made during the trip in which a track driver transporting charcoal from Lomut market to Moi's Bridge trading center was accompanied reveal several unofficial police check points mainly set up to collect bribe from the charcoal traders. Table 4.5 presents the road block, activities, bribe recipients and the amounts paid at each check point. Six check points were recorded, all of them manned by police officers and some county officials. At each road block, the driver paid a bribe of between USD3 and USD30, a total of USD145 at the end of the journey.

Further observations show that whereas the driver was permitted to transport 180 bags of charcoal, the track was loaded with 60 more bags, a strategy for saving cost on permit which costs USD0.5/bag, therefore ending up paying less for more.

In order to avoid bribe payments at certain roadblocks, including the so-called 'god papa stops' (unofficial police checkpoints), the journey started at 4:30 o'clock in the morning and the driver

used various shortcuts. The driver constantly exchanged information with oncoming trucks about the road situation and the officers on duty at checkpoints ahead.

Table 4.5: Illegal payments observed at road blocks during charcoal transportation on Lomut-Moi's Bridge Road

Road block	Recipient of bribe	Description	Amount of bribe in USD(Ksh)
1. Marich-Sigor junction	One police officer	No permit verification or vehicle inspection. The officer approached the passenger side and was bribed by the turn boy	USD3 (Ksh 3000)
2. Chepareria	County Check unit officials with two police officers	County officers were initially offered KSh.1000 but declined. They held driver and the loader, but released the crew after receiving Ksh, 2500.	USD25 (Ksh 2500)
3. Maili Saba (Kitale Kapenguria Road)	Two police officers	The police officer was offered KSh.50, declined to take it but later accepted KSh.2000	USD20 (Ksh 2000)
4. Kitale-Kapenguria	Three police officers	The officer asked for KSh.5000 and confiscated the.3000	USD30 (Ksh3000)
5. Maili Saba (Mois Bridge)	Police officer	Boarded the track, sat on the passenger seat up to Simatwet shopping Centre. While aboard the track, no other police officer could stop the driver, so he was paid for escort (protection fees)	USD25 (Ksh 2500)
6. Mois Bridge market	One police officer	The driver had already parked the lorry when the officer got in and sat on the passenger seat. He got paid following some haggling.	USD15 (KSh.1500)
Total bribes paid by the charcoal transporter at the road blocks			USD145 (Ksh 14500)

Source: Passive participant observation (18/04/2018).

4.9. Discussion

The results of this study indicate that gender, market availability, alternative livelihood options, education and age are important factors in influencing decision by households to participate in charcoal production. These findings corroborate those of Mulenga et al. (2017) who reported similar factors amongst others to be primarily important in influencing the likelihood of households' adoption of charcoal production.

Gender of the household head showed a positive and significant influence on household participation in charcoal production, implying that female-headed households were more likely to participate in charcoal production than male-headed households. This is attributed to the fact that female headed households have limited access to productive resources, especially under pastoral set up, and therefore the likelihood of involvement in alternative livelihood activities such as charcoal production. In other instances, like in Tanzania, women are specifically engaged in charcoal production in order to obtain some financial independence from their husbands (Butz, 2013). In addition, this finding could be linked to increasing domestic responsibilities being taken up by women and the changing responsibilities in the social and economic standings of women in the society which pushes them to diversify their income sources to be able to meet their family needs (Jones et al., 2016) because they have fewer alternative income generating options available to them (Butz, 2013; Jones et al., 2016; Smith et al., 2017).

The education level of the household head had a negative but significant influence on the participation of households in charcoal production, meaning that household heads with higher education levels had lower chances of undertaking charcoal production, unlike their counterparts with no or less education. This could be attributed to the fact that education enhances the understanding and value for conservation and sustainability and therefore increases the chances of securing employment opportunities or engaging in skill demanding entrepreneurial activities as opposed those considered deleterious to the environment such as charcoal production (Lee et al., 2002). Specifically, the results show that a unit increase in education decreases participation in charcoal production by 9%. Contrary to these results, findings by Adeniji et al. (2015) in Nigeria show that 47% of charcoal producers had attained tertiary level of education. This may be associated to unemployment since charcoal production has been linked to lack of employment opportunities.

Household heads that were above 40 years were found to be unlikely to participate in charcoal production as compared to youth headed households. A unit increase in the age of household heads decreases the probability of their participation in charcoal production by 33%. It can be argued that the youth participate in the production of charcoal as a means to earn quick money to meet their daily needs, and as a means of diversifying their livelihood portfolios considering they are associated with the desire to make quick money. This could also be linked to the fact that productivity in terms of manpower tends to increase during the youthful years in the labor market before it stabilizes and often declines as one ages (Skirbekk et al., 2008), which limits the involvement of the elderly in charcoal production. In addition, the older household heads could be having access to more resources, having invested in alternative livelihoods (Khundi et al., 2011) as compared to the youths who in some circumstances, prefer charcoal production to lower-paying jobs (Jones et al., 2016).

The results of this study show that individuals with fewer livelihood sources were likely to engage in charcoal production compared to their counterparts with multiple livelihood options. This is partly explained by the observation that charcoal production in pastoral areas is largely practiced to complement the mainstream livelihood, which is livestock production, and therefore is more likely to be undertaken by households with limited sources of income as a way of enhancing their income portfolios. Jones et al. (2016) in his study in Mozambique highlights the importance of charcoal production as a livelihood diversification strategy. In his study, Smith et al. (2017) showed that engaging in charcoal production generates financial benefits associated with opportunities for livelihood diversification and risk management, factors that are important in enhancing pastoral households' resilience to crises or disasters.

Market availability was also found to have a positive and significant relationship with household participation in charcoal production. The relationship between market availability and charcoal production means that charcoal production by households is ideally dictated by market availability. This can be linked to the current demand for charcoal in the urban and peri-urban areas where charcoal is the most readily available and cheap alternative source of energy compared to other sources like gas (Ngui et al., 2011). As observed by Smith et al. (2017), there is always ready market for charcoal, and the production has to meet the market demand.

Respiratory diseases associated with smoke emission from charcoal burning and charcoal theft by traders, travelers and community members along the highway and at bulking points were the main problems facing producers in the study area. Theft of charcoal can be attributed to lack of coordinated producer associations in the study area, unlike in other areas where members of producer associations work in coordination to ensure smooth running of activities from production to marketing.

Charcoal production was reported to be a tedious job which was often accompanied by gaseous and particulate emission into the atmosphere, associated with smoke inhalation and carbon monoxide poisoning. This finding corroborates the findings of Arnold et al. (2006) and Kammen & Lew (2005). Findings by World Bank (2009) and Ghilardi et al. (2013) showed that Tanzania and Malawi lost at least $100 million and $17.3 million in uncollected charcoal-based revenues respectively, similar to findings of this study that the government is losing revenue from uncollected tax. This was attributed to corruption at roadblocks along the highways and harassment along the value chain because of lack coordination among responsible institutions such as KFS, CPAs, Kenya Police Service, County Governments and Environment committees.

Similar to the findings of the current study that indicate decline of tree species preferred for charcoal production, findings by Kiringe et al. (2005) in a study conducted in Amboseli Kenya, showed that the community reported a decline in preferred tree species for charcoal due to, among other reasons, charcoal production and agricultural expansion.

5. Conclusions

Charcoal production is associated more with lack of ownership and access to main productive assets such as livestock and land, especially among the female headed households and youth that necessitate search for alternative sources of income to meet family needs.

Income from multiple sources of livelihoods including employment of educated heads of household compliment livestock production and therefore reduces the chances of households' participation in charcoal production.

Women and the youth are more likely to participate in charcoal burning due to lack of employment opportunities in the region.

Interventions should be aimed at sensitizing women and the youth about women and youth funds and building their entrepreneurial skills on alternative business opportunities. In addition, there is need for promotion of viable value chains and education to provide alternative sources of income.

Collective action in production, transportation and marketing of charcoal through registered groups can be used to curb charcoal theft along the highway and has the potential to benefit the sector as seen in other counties like Kitui and Baringo.

Interventions should be aimed at sensitizing and empowering stakeholders on the legal provision of the Forest (Charcoal) Rules, 2009 and their rights to curb corruption along the charcoal value chain through a collaborative effort involving KFS, CFAs, and CPAs, Kenya Police Service, County Governments.

CHAPTER FIVE

GENERAL CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The following conclusions arise form the key findings of this study:

The traditional earth kiln, which is the main charcoal production technology used in the study area is cumbersome and tedious. However, the producers prefer it because it has a larger capacity than the modern portable metal kilns.

The most preferred trees species for charcoal production in the study area are *Vachellia tortilis*, *Vachellia elatior*, *Senegalia mellifera* and *Vachellia reficiens*.

There are 13 categories of actors involved in charcoal value chain in Central Pokot. The actors play different roles at different levels that include production, transportation, marketing and consumption. Their Interactions range from bi-directional interactions between two actors, to more complex interactions that involve several actors along the chain.

Even though no Charcoal Producer Association had been registered by KFS as provided for in section 5 (2) of The Forest (Charcoal) Rules, 2009 at the time of the study, charcoal production through CPAs has got the potential to benefit the sector as seen in other counties like Kwale, Kitui and Baringo.

While middle traders are key in linking the producers and consumers in the charcoal value chain, their involvement increases charcoal price, a cost that is passed on to the consumers while the producers are offered relatively low prices for the produced charcoal.

Charcoal production in the study area is associated with lack of ownership and access to main productive assets such as livestock and land, as is the case with female-headed households and the youth who therefore fallback to charcoal production as an alternative economic activity.

5.2. Recommendations

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

To enhance adoption of new production technologies that are less strenuous, the government should partner with research institutions such as KEFRI to support development of sustainable, cheaper and user-friendly wood carbonization technologies.

Considering women and the younger household heads are more likely to adopt charcoal production, building their entrepreneurial skills on alternative business opportunities will reduce dependance on charcoal production as an income generating activity.

In order to avert cases of corruption and harassment along the value chain there is need for more sensitization on the legal provision of The Forest (Charcoal) Rules, 2009. All responsible institutions including KFS, CFAs, CPAs, and CPGs, Kenya Police Service, County Governments and Environment committees need to work closely together for cumulative benefit. Better governance, institutional mechanisms and incentives to improve enforcement and compliance are urgently required if the sector is to contribute to both value chain actors' income and the national economy.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE FOR HOUSEHOLD INTERVIEWS: CHARCOAL PRODUCTION AND MARKETING

Section 1: General information **Questionnaire No:**

1.1 Date of interview:/……/…...… Name of enumerator: …….

1.2 County……. Sub-County…….……Village…….……Clan

1.3 Name ..... Age (yrs.) .....

1.4 Gender: 1) Male…….2) Female …….…….

1.5 Relationship of the respondent to the charcoal producer: 1) Self…….2) Spouse……...

3) Son……4) Daughter……5) Relative…….

1.6 Age……... Phone No ……

Section 2: Charcoal Producer Information

2.1 Name ..... Age (yrs).....
2.2 Gender: 1) Male ……2) Female……

2.3 Years of education……

2.4 Education Level: 1) None…..... 2) Primary……3) Secondary ……4) Tertiary…….

2.5 Marital status: 1) Married……...2) Single…….3) Divorced…….

2.6 If male how many wives……

2.7 If female how many co-wives…….

2.8 What livelihood options do you have? 1) Livestock……...2) Crop production…….3) Charcoal production 4) Trade (specify)……5) Formal employment…….6) Casual labor…….7) others (specify)……...

2.9 Which one of the above is your MAIN source of livelihood? .....

2.10 How many are you in the family? ……

2.11 Do you own livestock? 1) Yes…….….2) No……...

2.12 If yes, what livestock species do you own? Fill in the table:

Livestock Species	**Number**	**Reason for keeping**
Cattle		
Goat		
Donkey		
Camel		
Poultry		
Total		

2.13 If charcoal is the main activity, when did you join the charcoal business

1. Big drought in 2009
2. When Kibaki came to power in 2002
3. Pokot-Turkana fight in 1992
4. Yellow maize in 1985
5. Tar-rai 1980 to 1984
6. Other……
7. If the year is known……

2.14 If farming is the main activity what is the total size of the land you own? .....

Section 3: Charcoal production questionnaire.

3.1 Do you produce charcoal? 1)Yes …….2) No…….

3.2 If No, why?.....

3.3 If yes why?.....

3.4 What are your main production expenses and how much do you spend on it *(Transport, Local, taxes, Labor/time, rent. others (specify)*

3.5 Do you produce alone or are you a member of a group or both?

3.3 If YES. How many people are you in the group?

3.4 What is the basis of joining the group?

3.5 What are the benefits of belonging to the group?

Benefits	**Challenges**

3.6 Is there a demand for different charcoal tree types?

1)Yes…… 2) No…….

3.7 If yes, what are the types of trees preferred and by whom

Species (Pokot Name)	**Other uses**	**Preference**

3.8 Do you see yourself sourcing charcoal from the same place in the next 10 years?

1) Yes……2) No…….

3.9 If No, why?

Section 4: Charcoal marketing

4.1 Do you sell charcoal? 1) Yes……...2) No……
4.2 If No, why?.....
4.3 If yes, to whom do you sell to? 1) Local consumers……2) I take to market..... 3) Brokers ……...… 4) I sell through my group……. ….. 5) NGOs (name them) ……...6) other (specify)…….
4.4 Is there a demand for different types of charcoal quality?
1)Yes…….2) No…….
4.5 If YES what quality is preferred and by whom?
4.6 Do you sell charcoal alone or as a group?

1)Yes…….2) No…….

4.7 If yes, how many are you in your group?
4.8 What are the major constraints you face in charcoal marketing and what can be done to address these problems?

Marketing constraint	**Solution**

4.9 What costs (Ksh) do you incur in marketing your charcoal? (1) transport …… (2) local Taxes……. (3) Labor…….4) others (specify) ……
4.10 How do you determine the selling price of fodder/seed? 1) Fixed price….2) bargaining……
4.11 What costs (Ksh) do you incur in marketing your charcoal? (1) transport …… (2) local
Taxes……. (3) Labor…….4) others (specify) ……

Section 5: Consumer/end user questionnaire

5.1 Do you use charcoal? 1)Yes……2) No…….

5.2 If No, why?.....

5.3 If yes, why?.....

5.4 What type of consumer are you……... (household, commercial? institution)

5.5 Are you aware of the origin of the charcoal you use? 1) Yes……2) No…….……

5.6 Does the production conditions of the charcoal you are using concern you? 1) Yes…2) No

5.7 How much money are you willing to pay for a bag of charcoal? ……..

5.8 Who do you think profits the most from charcoal? Why
(Producers, Depots, middlemen, Truck drivers, Retailers, End-users, Police, KFS, County officials)

5.9 Do you see yourself using charcoal in the next 10 years?

1)Yes……2) No……...

5.10 If No, why?

THANK YOU FOR YOUR TIME.

APPENDIX 2: QUESTION GUIDE FOR FOCUS GROUP DISCUSSIONS

General Information

1. General introduction.
2. What is the history behind charcoal production in this region?
3. When did you start charcoal production?
4. Are their formally registered groups? If No, why?
5. What is the main objective in producing charcoal?
6. What is the main objective in producing charcoal?

Charcoal Production and marketing

1. What production practices/technologies do you use in charcoal production?
2. What factors determine the choice of production practices?
3. What costs do you incur in carrying out these activities?
4. How many kilns did you prepare in the last one week?
5. Where do you sell and at what prices per bale/Kg?
6. What selling arrangements do you have with your buyers? *(Freelance, contracts, both)*
7. What costs do you incur in producing and marketing your charcoal?
8. Who are other chain actors and what are their roles in charcoal production & marketing?
9. What are the various charcoal marketing channels in this County?
10. Are there any charcoal producer associations or marketing groups in this area?
11. Do you collaborate with them if any?
12. Do you get any support from the County to promote your charcoal production and marketing?
13. What constraints do you face in producing and marketing your charcoal?

APPENDIX 3: QUESTION GUIDE FOR KEY INFORMANT INTERVIEWS

Production

1. General information of the respondent? *(Probe: age, gender, education level, household size)*
2. Which year did you start charcoal production and where did you learn about it?
3. How many producers do you think are there in your area?
4. Which livelihood options do you have and which one of them is the main one?
5. What is your MAIN aim for charcoal production? (*For own use, sale*)
6. What species of tree species do you prefer for production?
7. What production practices do you use?
8. Who are the main actors and their roles?
9. What factors determine your production practices?
10. What costs do you incur in producing charcoal? *(Specify costs, their sources, and costs)*
11. Are there any charcoal associations or producer groups in this County?
12. How many bags of charcoal are sold per week?
13. Where do you obtain your licenses from?
14. What amount of charcoal do you consume your charcoal at home?

Marketing

1. Do you sell charcoal?
2. If yes, where do you sell and how do you choose buyers?
3. What amount did you sell in the last one year, and at what prices per bag?
4. How are the selling prices determined?
5. Are there any charcoal associations or marketing groups in this County?
6. How important are they, if any?
7. What are the various charcoal marketing channels in this County?
8. Who are the main actors and their roles?
9. What challenges do you encounter in producing and marketing charcoal?
10. Do you ever work with any institutions, NGOs or government agency in the charcoal production and marketing (list and indicate their roles)?
11. Where do you obtain your licenses from?
12. Have you received any support from the County government in charcoal production? (Probe; *Financial support etc.*)

Charcoal Traders

1. General information of the respondent (probe: *age, gender, education level, household size*)
2. What motivated you to start the charcoal business?
3. How does the value of charcoal increase from production sites in Central Pokot until it is sold to the end-user?
4. Where, in what quantities and at how much do you purchase your charcoal?
5. Do you prefer charcoal from any particular tree species (If YES *which tree species*)?
6. Who is your main client?
7. What amount of charcoal did you buy and sell in the last year?
8. How did you arrive at the buying and selling prices?
9. What costs do you incur in marketing charcoal? (Probe *sources of costs e.g., transport and quantify them legal or illegal payments*)
10. Where do you obtain your licenses from?
11. How do you organize the purchase of charcoal from your suppliers?
12. How do you transport charcoal for your buyers?
13. Who are other chain actors and what are their roles?
14. What are the various charcoal marketing channels in this County?
15. Do you collaborate in any way with other charcoal traders in the county?
16. What are the main challenges while undertaking your charcoal selling business?
17. What do you think should be done to make your work easier?
18. Do you see yourself sourcing charcoal from the same place in the next five years?
19. If not, what do you think should be done to ensure you have a charcoal supply for a long time?
20. What are the selling prices of charcoal at different levels of the chain?
21. Do you receive any support from the county government or other organizations?

THANK YOU FOR YOUR TIME.