2024

Factors influencing adoption of purchased livestock feeds by pastoralists in arid and semi-arid lands of Kenya.

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FACTORS INFLUENCING ADOPTION OF PURCHASED LIVESTOCK FEEDS BY PASTORALISTS IN ARID AND SEMI-ARID LANDS OF KENYA

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MPPM/146700/2021

A Dissertation Submitted in Partial fulfillment of the requirements of the degree of Master of Public Policy and Management of Strathmore University Business School

MAY 2024

DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

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ACKNOWLEDGEMENT

I would like to express my deepest appreciation to Prof. Simon Wagura Ndiritu for his invaluable guidance and support. My sincere thanks also to Dr. Castro Gichuki and the team at the Strathmore Agri-Food Innovation Center for their support. Finally, I am grateful to the pastoralists who participated in the survey. Their contributions were essential to this research.

DEDICATION

This work is lovingly dedicated to my husband, Michael Waimiri and our three wonderful children Gabi, Kaari and Wakagia. Their love, support and encouragement has been my strength and inspiration throughout this journey. I would also like to dedicate this to my father, Dr. John G. Kariuki and my mother Margaret Gachuki whose dedication to their profession has always inspired me. Lastly, I extend this dedication to my mother-in-law, Minnie Waimiri, my entire family and friends, whose encouragement has been invaluable. This accomplishment would not have been possible without all of you. Thank you.

ABSTRACT

Pastoral production is important in the attainment of food security, nutrition, and incomes for the economy and vulnerable pastoral communities. The adverse effects of climate change are increasingly becoming a challenge for livestock production in arid and semi-arid lands where pastoral households mainly depend on depleting natural pasture. This calls for adoption of purchased livestock feeds as a complementary or substitute option to cope with recurrent drought and pasture scarcity. The study was undertaken in the Arid and Semi-Arid regions of Marsabit, Kajiado, Wajir, Isiolo and Garissa counties. The study's main objective was to assess the factors influencing adoption of purchased livestock feed practices by pastoralists with regards to female headed households, common interest groups and household income. Multistage sampling technique was employed to collect quantitative data from 1053 pastoralists households stratified from five selected counties. Data was collected through an administered questionnaire and analyzed using the Multivariate Probit Model. Female household headed pastoralists were found to have a positive influence on the adoption of dry maize stover and green maize stover indicating decision making on livestock feed practices among female headed households. Membership in common interest groups was also found to have a positive influence in the adoption of hay/straw, dry maize stover and minerals highlighting the importance of collective action. Household income was found to be positive and significant for dry maize stover indicating that reduced incomes because of drought influenced livestock feed practices. The research contributes to granular data that supports the Agricultural Sector Growth Transformation Strategy in Kenya. It indicates willingness among pastoralists to purchase feeds marking a shift from reliance on natural pastures. The study underscores the need for private sector involvement on backward integration by off takers to promote livestock feed interventions that support female headed households involvement in the feed value chain and promotion of agropastoralism which is practiced by 30 percent of households. It advocates for the use of remote sensing technology to track pastoralist migration and promote public-private partnerships to enhance feed options.

Key words: Pastoralists, Multivariate probit, Arid and Semi-Arid Lands, Livestock Feeds

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

1.1.1 Livestock Production in Pastoralism Areas

Agricultural production, particularly livestock production, is a key driver in achieving the objectives of the Sustainable Development Goals. It directly supports Goal 2 on Zero Hunger by contributing to food security and Goal 13 on Climate Action by necessitating adaptation strategies in response to climate change (Thornton et al., 2018). Livestock production, a vital subsector of agriculture, supports approximately one billion livelihoods worldwide and accounts for about fifty percent of the global Gross Domestic Product (Herrero et al., 2016). This rapidly growing sub-sector in many developing countries produces essential food items like meat and milk, thereby promoting food and nutrition (Rehman et al., 2017).

Livestock production relies heavily on various feed sources, including naturally grown pasture in rangelands and a combination of produced and purchased feeds such as hay/straw, green maize, dry maize stover, maize germ and mineral supplements (Baltenweck et al., 2020). However, the recurrent droughts induced by climate change have severely impacted the availability of these feeds, especially natural pasture, which is crucial for sustaining livestock production (Habte et al., 2022). In pastoralist areas, the extensive livestock production system takes advantage of the environmental instability where water and nutrients from natural feed options are scarce and unpredictable (Nyariki & Amwata, 2019). The magnitude of losses experienced by pastoralists due to drought is significant, underscoring the urgent need for effective adaptation strategies, including the diversification of livestock feed options.

1.1.2 Feed options for Pastoralists

Livestock production, a crucial component of agricultural production, is expected to double by 2050 to meet the growing demand for meat and milk. This necessitates the adoption of high-quality, protein rich feeds to boost livestock productivity (Makkar, 2016; Rustis et al., 2023). In countries like Pakistan, animal nutritional requirements are fulfilled through fodder crops, shrubs, grasses and agro-manufacturing wastes. However, in low- and middle-income countries where

pastoralism is the main form of livestock production, the availability of livestock is a major constraint in sustaining livestock production needed to support food, nutrition and security. In East Africa, smallholder livestock systems utilize various grasses, herbaceous legume forages, and fodder trees. However, the high cost of feeds, which represents a substantial percentage of production costs, poses challenges in the adoption of livestock feeds (Njuguna-Mungai et al. 2022). In countries like Ethiopia pastoral production constitutes 60 percent of the land mass (Debela et al., 2015). Similarly in Kenya pastoral production is dominant in the arid and semi-arid lands, which covers 80 percent of the land and hosts 70 percent of livestock, and the potential to drive an estimated 14 million of the population out of poverty and mainly dependent on natural pasture (Omollo et al., 2018). The heavy reliance on natural pasture which is affected by prolonged drought because of climate change, justifies the need for pastoralists to diversify to purchased feeds.

1.1.3 Factors influencing adoption of livestock feed options

The adoption of livestock feed options is influenced by a multitude of socio-economic and climate factors. Key household decisions related to livestock production are primarily made by men, who often have strong bargaining power, thereby increasing the likelihood of adopting livestock feeding practices (Muricho et al., 2017). However, livestock holds significant importance for households heads especially for women who are approximately two-thirds of impoverished livestock keepers worldwide. Unlike other household assets such as land, women find it relatively easier to own, accumulate, or manage small ruminants. This accessibility is vital as livestock contribute to women's ability to provide nutrition and support livelihoods and increased decision-making roles (Njuguna-Mungai et al., 2022).

Group membership among pastoralists leads to gaining access to essential market information crucial for livestock production (Mohamed Sala et al., 2020). Consequently, membership in groups significantly influences the decision-making process regarding participation in feed markets and extent of that participation. In India, participation in groups is observed to influence adoption on livestock feeds (Singh et al., 2020). In Africa and Asia, group membership alongside level of education and incomes from livestock enterprises, are evidenced to influence high rates of adoption (Baltenweck et al., 2020). In the case of fodder production in dryland areas of Makueni and Kajiado counties group membership, gender, and education is seen to be important factors (Omollo et al., 2018).

Households with a higher proportion of income are noted to adopt purchased feeds as a risk mitigation strategy (Muricho et al. 2015). With increasing cases of livestock feed scarcity from prolonged drought, the emergence of markets for purchasing feed is on the rise to meet the deficit from reliance on natural pastures (Konlan et al. 2018).

Analysis of these factors that influence purchase of feed as an alternative for livestock feed options in the face of recurrent drought is therefore vital for designing targeted policy interventions.

1.1.4 Arid and Semi-Arid Areas of Kenya

In Kenya, initiatives such as the Agriculture Sector Growth and Transformation Plan, National Climate Change Action Plan, and Range Management and Pastoralism Strategy have been implemented to strengthen livestock feed adoption in Arid and Semi-Arid Areas (Kimaru et al., 2023). The National Feed Inventory and Feed Balance Assessment provides evidence- based research to address livestock feed security. The assessment is based on the National Livestock policy which acknowledges the need to address the feed deficit which it estimates at 30 million metric tons for produced feed and 700,000 metric tons for purchased feeds (GOK, 2020). The policy recognizes livestock feeds as materials which are either single or multiple, raw or processed to any degree which is consumed by animals and the importance of groups established to promote livestock feed options and additionally notes the need to address the gaps in gender disaggregated data to better understand the factors influencing adoption as it leads to increased incomes and achievement of Sustainable Development Goals on gender equality and food security.

1.2 Statement of the Problem

Livestock feeds are recognized as pivotal in enhancing livestock productivity, thereby contributing to improved livelihoods, food security, and nutrition and government efforts increasingly acknowledge this role. Within Arid and Semi-Arid lands, where livestock production is crucial, the necessity of livestock feeds becomes even more apparent in addressing interconnected challenges (Balehegn et al., 2020). Despite the diverse livestock feed options available to sustainably enhance production and resilience to climate change, policies supporting pastoralists in diversifying livestock feed options are lacking. An annual feed deficit of 3.6 billion bales limits livestock productivity due to inadequate and costly feeds (Kimaru et al., 2023).

Groups in pastoral areas are noted to significantly influence livestock feed adoption in drylands which face climate vulnerabilities (Omollo et al., 2018; Mohamed Sala et al., 2020). Increased

adoption of livestock feed practices is incentivized by incomes from livestock production (Salmon et al. 2018). However, scarcity of livestock feeds during drought leads to the migration of men and animals in search of pastures, leaving women without milk to sell, affecting household incomes (Opiyo et al., 2015; Gebremichael et al., 2019). Women, who play a significant role in livestock management, are constrained in their decision making on feed practices by the proximity of feed sources (Mohamed Sala et al., 2020). Studies on factors influencing the adoption of multiple feed strategies during prolonged droughts are limited (Rustis et al., 2023; Ng'ang'a et al., 2020).

To enhance pastoral productivity and overall food security, pastoral systems need to integrate purchased feeds. However, existing literature tends to focus on fodder production, neglecting factors influencing pastoralists decision to purchase fodder (Koech, 2014; Koech et al., 2016; Omollo et al., 2018; Lugusa et al., 2016; Omollo et al., 2017). Pastoralists heavily rely on communal grazing resources with low use of purchased feeds (Wanyoike et al., 2018). Yet, natural pastures, their primary fodder source, are unreliable during dry seasons. Therefore, analyzing factors influencing the decision to purchase livestock feeds is crucial in designing policy intervention aligned with dynamic pastoral lifestyles amidst climate change.

Pastoralists heavily rely on communal grazing resources with low use of purchased feeds (Wanyoike et al., 2018). Yet, natural pastures, their primary feed source, are unreliable during dry seasons. Therefore, analyzing factors influencing the decision to purchase livestock feeds is crucial in designing policy interventions aligned with dynamic pastoral lifestyles amidst climate change (Mohamed Sala et al., 2020). Emerging feed markets serve as a vital complementary source of livestock feeds, emphasizing the importance of understanding factors influencing adoption of purchased feed options.

1.3 Research Objectives

1.3.1 General Objective

The main objective of this research was to assess the factors influencing adoption of purchase of livestock feeds by pastoralists in Arid and Semi-Arid Lands of Kenya.

1.3.2 Specific Objectives

To address the general objective, the study attempted to answer the following specific objectives:

i. To determine the extent to which female household headed pastoralists influence the adoption of purchased livestock feeds in the arid and semi-arid lands of Kenya.
ii. To investigate the effect of membership in common interest groups on the adoption of purchased livestock feeds by pastoralists in arid and semi-arid lands of Kenya.
iii. To analyze the effect of household income on the adoption of purchased livestock feeds by pastoralists in arid and semi-arid lands of Kenya.

1.4 Research Questions

The study answered the following research questions:

i. What is the extent to which female household headed pastoralists influences the adoption of purchased livestock feeds in the arid and semi-arid lands of Kenya?
ii. What is the extent to which membership in common interest groups influences the adoption of purchased livestock feeds by pastoralists in the arid and semi-arid lands of Kenya?
iii. How does access to income influence the adoption of purchased livestock feeds by pastoralists in the arid and semi-arid lands of Kenya?

1.5 Scope of the study

The study focused on five counties; Kajiado, Garissa, Isiolo, Marsabit, Wajir to represent pastoralism archetypes in Kenya. The study focused on the factors influencing adoption of purchased livestock feeds by pastoralists in arid and semi- arid lands in Kenya. The unit of study is the households.

1.7 Significance of the study

The primary beneficiaries of this study are the pastoralists. By understanding the factors that influence the adoption of purchased feeds, pastoralists can make informed decisions that enhance their livestock productivity, especially during recurrent droughts. This could lead to improved

livelihoods, increased food security, and better adaptation to climate change. At the national and county levels, the findings of this study can guide the development of targeted policies and interventions aimed at promoting the adoption of purchased feeds. This is particularly relevant given the increasingly frequency and severity of droughts due to climate change. In the case of development partners interested in supporting the ASAL areas, this study offers insights into how to increase the uptake of purchased livestock feed options. It identifies opportunities to encourage adoption based on empirical data, which can help pastoralists better cope with climate change. Lastly, for the academia, this study serves as a valuable resource for future research exploring the interplay between different purchased feed options. It contributes to the body of knowledge on sustainable livestock production in the face of climate change. By focusing on the decision making process of purchasing feeds, the study not only fills a critical gap in literature but also provides practical insights that can directly benefit pastoralists and inform policy making. It underscores the importance of purchased feeds in enhancing pastoral production.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discussed the literature on adopting of purchased livestock feeds by pastoralists in Arid and Semi-Arid Lands. The Chapter presented theoretical framework of the study, the empirical review, and the conceptual framework of the Study.

2.2 Theoretical review

The theoretical foundation of this study is grounded in the Theory of Planned Behavior (TPB), a well-established framework that explains human behavior (Ajzen 1991). The theory suggests that an individual behavior is determined by their intention to perform the behavior, which is influenced by their attitudes towards the behavior, subjective norms and perceived behavioral control.

In this context, the theory elucidates how these factors within female-headed households influence their intentions and decisions to adopt purchased livestock feeds. For instance, attitudes may be shaped by the perceived benefits and drawbacks of using purchased feeds, while subjective norms may reflect societal expectations or pressure regarding their use (Ajzen 1991). Perceived behavior control could be influenced by factors such as access to resources, knowledge of feed practices and past experiences with feed adoption practices.

The theory also provides a lens through which to view the influence of common interest groups and income on the adoption of purchased feeds. If group members perceive the adoption of purchased feeds as a normative behavior, this could create a positive subjective norm. Similarly, if group members provide access to resources or information that enhances the ability to adopt purchased feeds, this could increase perceived behavioral control. If income levels affect the ability to afford purchased feeds, this could influence perceived behavioral control.

The adoption of various livestock feed options is influenced by multiple factors such as rational thinking of the households, climate risks, incentives and local institutional support (Aryal, Sapkota, Jat, & Bishnoi, 2018; Baltenweck et al., 2020). Pastoralists may adopt feed options to cope with recurrent drought and pasture scarcity. Therefore, there is a need to identify the determinants influencing adoption of livestock feeds.

The study aimed to contribute to the knowledge on the determinants of purchased feed options as a feed option in the face of scarcity of natural feeds because of recurrent drought. The study also focused on the participation of female headed households, access to income and the channels of engagement through membership in common interest groups.

The theory was relevant to this study as it provides a robust theoretical framework to understand and predict the adoption behavior of pastoralists towards purchased livestock feeds (Ajzen 1991). It allows for a comprehensive examination of the various factors that influence this adoption behavior, thereby providing valuable insights that inform policy and practice.

2.3 Empirical Review

The empirical review explored research conducted across various livestock production systems presenting global, regional, and local perspectives on adoption of livestock feed options. In each of the study, the methodology and findings are presented, and the contribution of the study is described.

2.3.1 Influence of female headed household in adoption of purchased livestock feeds

Opiyo et al. (2016) measured the determinants influencing selection of adaptation strategies for pastoralists in the face of climate change. The study which employed Heckman Probit Model on data analyzed on 302 households in Turkana County revealed that female headed households were more likely to adopt to climate change adaptation strategies which included access to better pasture. Even though the study did not look explicitly into purchased feeds options as an adaptation strategy, the study underscored the prominent role of female headed household in livestock production.

In a different context, Ng'ang'a et al. (2016) conducted a study on 400 households in Ethiopia to examine the determinants influencing the adoption of agricultural practices which aimed to reduce the vulnerability of agro-pastoralists to climate change. The authors found that female headed households did not have a significant influence on feed conservation as an adaptation practice. These findings were similar to Konlan et al., (2018) who conducted a study in Ghana to identify

the various types of livestock feeds available in the emerging livestock feed markets and found that there was no gender bias in participation in the markets.

Omollo et al. (2018) explored the determinants of fodder production in Makueni and Kajiado counties, utilizing semi-structured interviews with 216 pastoral and agro-pastoral households. The findings analyzed using binary logistic regression model found that female headed households were less likely to participate in fodder production compared to the male counterparts. The authors who mainly looked at fodder production and not purchase feeds provided insights on the need for promoting participation of both genders which could enhance likelihood of adopting fodder technologies by 20 percent.

Mohamed Sala et al. (2020) studied the factors influencing the decision of pastoralists to purchase fodder livestock considering the cultural reliance on pastures for forage. The data on the 201 pastoralists of Isiolo was analyzed using Heckman two-step model. The findings revealed that gender of the household head negatively and significantly influenced household decision to participate in fodder market. Female headed households were 16 percent less likely to purchase fodder. Although the authors did not analyze adoption of multiple binary feed options, they concluded that women were less likely to participate because productive assets such as land, cash and water were mainly controlled by men.

Contrally, Nhundu et al. (2023) investigated factors influencing the decision to adopt improved fodder technologies in 224 respondents in Insiza District of Zimbabwe. Using Probit regression model, the results revealed a likelihood of 19.3 percent of female-headed households implementing livestock fodder technologies compared to male-headed households. This was attributed to government interventions, specifically the Zimbabwe Resilience Building Fund (ZRBF) efforts on women's empowerment.

Building on this existing body of literature, the study contributed to a quantitative understanding of the correlation between the participation of female headed households and the adoption of multiple purchased livestock feeds among pastoralists in Arid and Semi-Arid Lands of Kenya.

2.3.2 Effect of membership in common interest groups in the adoption of purchased livestock feeds

Value chain analysis on livestock feeds has been an increasingly avenue in understanding the supply of purchased livestock feeds. Lugusa et al. (2016) conducted a value chain analysis in Baringo to understand the challenged faced by the pastoral households. The study revealed that limited access to outlets and low prices offered by the households were among the challenges. The authors noted that fodder groups provided avenues for collective bargaining to overcome the challenges. The study provided insights on challenges the supply side of purchased feeds in the pastoral areas. Ng'ang'a et al. (2016) who looked at feed practices noted that membership in groups had a positive influence on households adapting feed practices.

Participation in groups was found to facilitate adoption of feed practices according to a study conducted by Omollo et al. (2018). Group membership had a positive and significant influence on participation of pastoralist households in fodder production in Makueni and Kajiado counties.
According to Kebebe (2019), purchase of feeds livestock feeds was found to be costly for livestock production especially for households which were not organized in common interest groups. Insights from the focus group discussions revealed that missing support from common interest groups limited the scaling of livestock production and marketing.

The case on insights was also emphasized by Mohamed Sala et al. (2020) who conducted a study to understand the key determinants in decision making on purchased livestock feed by households. The author noted that membership in groups led to increased probability to purchase fodder by 47%. This was because the groups provided market insights on prices, demand, supply of fodder and offered incentives such as lower prices and favorable repayment terms for the feeds.

In the same context Ng'ang'a et al. (2020) conducted a study on agro-pastoralists in Laikipia county to examine determinants influencing adaptation strategies to climate change. The authors who utilized multivariate probit model found that social capital which included membership in common interest groups such as cooperatives, had a positive and significant influence in the adoption of fodder production as an adaptation strategy. The findings were similar to Maina et al., 2020 who conducted a study on a different sector on dairy. The author noted that a significant

proportion of adopters at 87 percent belonged to a social group. Therefore, membership in groups increased the probability of households adopting bracharia grass.

Common interest groups offer avenues for diffusion of knowledge on adaptation strategies in the face of climate change as was noted by Ndiritu (2021). From the study conducted in Laikipia, Kenya, on 440 respondents using multivariate probit model, the authors noted that access to private ranching had a positive and significant influence on herd management and later the pastoralists diffused the knowledge gained to common interest groups.

In a different global context, Leyte et al. (2022) observed that in Philippines, the primary providers for forage seeds were government institutions and Non-Governmental Organizations accounting for 63 percent of the transactions while co-operative members followed at 26 percent. In contrast, Vietnam exhibited a different pattern of social relationships. The government and a combination of neighbors and family had an equal role in forage seed transactions contributing to 30 percent and 28 percent respectively. These observations suggest that the influence of groups on the adoption of livestock feeds varies between the two countries, with different social relations and structures playing a role in each case.

Njuguna-Mungai et al. (2022) conducted a study to analyze adoption of improved forages technologies in Ethiopia and Kenya finding that access to groups provided an opportunity for women to access forage seeds that were grown in homesteads leading to increased greater decision making as the improved fodder reduced their time spent harvesting fodder and increased incomes from sale of forage cuttings. However, requirements of group membership which include ownership of land is cited to limit participation by poorer households.

To build on this knowledge, the present study incorporated various common interest groups in examining their influence on optimizing the adoption of purchased livestock feed options.

2.3.3 Effect of household income on the adoption of purchased livestock feeds

Access to income has been studied in different contexts. Duguma and Janssens (2016) investigated coping strategies by smallholder dairy farmers during feed scarcity in the dry season in Ethiopia. Their analysis revealed that farmers estimated at 98.1 percent experienced feed shortages leading to reduced incomes and that priority feed options include green feeds, concentrates hay,

unconventional feeds and grazing pasture. In a different study conducted during the fodder growing season of 2014, Lugusa et al. (2016) found that increased incomes from sale of grass seeds was an incentive for fodder production.

Opiyo et al. (2016) study on dryland areas reveal that income from pastoral activities has a positive and significant influence on the likelihood of adaptation to climate change. Omollo et al. (2018), found that collective action of co-operatives positively influences access to credit and consequently the adoption of fodder production. Reduced incomes as a result of prolonged droughts in Tanzania was found to influence quality and quantity of livestock products as households were unable to purchase feeds which is necessary for increased production according to a study conducted by Maleko et al. (2018).

Kebebe (2019) supported these findings, highlighting the high costs of agricultural technologies, such as feed supplements as deterrents to household participation in markets, pushing them toward subsistence farming, particularly affecting women who lacked access to resources such as incomes. Mohamed Sala et al. (2020) found that households with access to off-farm income had a negative and significant influence on purchasing fodder by 33 percent. This was because increased off-farm income is correlated to low herd size and therefore corresponding low demand for fodder. In Northern Ghana, emergence of livestock feed markets in the face of livestock feed shortages is noted to be influenced by seasons with the prices of cereal bran remaining consistent across seasons whilst crop residues high during early to late dry seasons. Income generation was seen to influence participation in the feed markets (Konlan et al., 2018) .

Furthermore, the dependence on external resources, such as labor for technologies like silage making, hindered the adoption of livestock feed technologies, particularly for women (Balehegn et al., 2020). This reliance on family labor, coupled with a lack of collateral, resulted in tradeoffs in adopting off-farm feeding, as noted by Roe et al. (2021).In Vietnamese context, the primary market for local beef production is less demanding in terms of feed quality compared to dairy. According to Leyte et al. (2022), this market dynamic shapes the income optimization strategies of farmers. Rather focusing on utilization of high-quality feeds, farmers tend to adopt strategies that are cost-effective and require less labor and land use, such as free grazing and the use of crop residues as supplements. These strategies are geared towards enhancing labor returns and overall

income, suggesting that the decision to purchase livestock feeds is driven more by economic considerations rather than feed quality.

Rustis et al. (2023) found that during the wet season, higher incomes for the households influences ability to access fodder according to a study that was conducted in Tanzania on 210 agro-pastoral households that sought to investigate determinants influencing accessibility of fodder and conservation of rangelands. Considering the various contradictory studies existing on how access to income drives adoption of strategies, the study specifically focused on income from livestock production as a variable on how it influences adoption of purchased livestock feed options.

2.3.4 Control Variables influencing adoption of purchased livestock feeds

Rustis et al. (2023) found that education of the household head positively influences agro-pastoralists access fodder and rangeland conservation. The study also incorporated other variables on income and assess. The findings on positive significance of education was similar to the study conducted by Omollo et al. (2018) on fodder producers. In the case age of the household head, according to Sala et al. (2020), age of the household head has a positive influence on participation in fodder markets but not on the quantities purchased. However according to Omollo et al. (2018) who conducted a study on fodder producers and non-producers, age of the household head did not have any significant difference between the producers and non-producers.

In the case of bracharia grass, average age of the household head was recorded as between 54 to 58 years with the adopters being significantly older than non-adopters (Maina et al., 2020). Additionally, household size was found to be insignificant according to Sala et al. (2020) in purchase of fodder. In the study on perceptions of climate change in the dryland areas by Opiyo et al. (2016), household size is evidenced to have a positive and significant influence on the likelihood of adaptation to climate change as increased household means increased labor for production.

2.4 Research gaps

From the summary, numerous research has been conducted focusing on livestock feed practices. Most of the studies have looked at fodder production as an adaptation strategy for pastoralists Ng'ang'a et al. (2020), Rustis et al. (2023) Omollo et al. (2018). With farmers facing multiple climate related risks such as recurrent drought and limited produced feeds limited studies exist on

the interrelationship across these complementary practices such as purchased feeds in the pastoralist areas. Therefore, the study seeks to add new knowledge through assessing how access to income, membership in pastoral groups and female household head influence purchase of livestock feeds by pastoralists in Arid and Semi-Arid Lands of Kenya.

Table 2. 1 Summary of Literature and Research Gap(s)

Author	Study Objective	Methodology Used	Findings	Research Gap	Type of Gap	How the study has filled the gap
Opiyo et al. (2016)	Determinants influencing adoption of climate change adaptation strategies in Turkana County	Heckman Probit Model	Female headed households and incomes were determinants to adoption of climate change adaptation strategies which included access to better pasture.	Study did not investigate purchased feed options as an adaptation strategy	Conceptual	Study investigated purchased feed options as an adaptation strategy
Lugusa et al. (2016)	Investigate the challenges faced by the pastoral households in fodder value chains in Baringo.	Thematic Analysis	Groups provided avenues for collective bargaining to overcome the challenges	Study only looked at grass seeds for fodder production	Conceptual	Study investigated multiple feeds option for purchase
Duguma and Janssens (2016)	Assessment of feed strategies in coping with scarcity in Ethiopia	Thematic Analysis	Reduced incomes influenced feed shortages.	Study assessed feed options in the small holder urban dairy producers	Contextual	Study assessed the purchased feed options in the pastoral areas

Ng'ang'a et al. (2016)	Determinants influencing the adoption of agricultural practices that reduce vulnerability to climate change.	OLS Regression	Female headed households was not significant in the case of feed conservation as an adaptation practice.	Study only looked at feed conservation as an adaptation practice	Contextual	The study looked at various purchased livestock feed options in Arid and Semi-Arid Lands of Kenya
Konlan et al. (2018)	Identify the various types of livestock feed available in emerging livestock feed markets in Ghana	Thematic Analysis	There was no gender bias in participation in feed markets	The study contradicted other studies that measured the same	Contextual	Study assessed multiple adoption purchased feed options as an adaptation strategy in Arid and Semi-Arid Lands of Kenya
Maleko et al. (2018)	Adoption of feeding technologies in Tanzania:	Thematic Analysis	Shortage of livestock feed options, low incomes due to drought was a key determinant of adoption of feed practices	Study focused on the dairy sector	Contextual	Study assessed multiple adoption purchased feed options as an adaptation strategy in Arid and Semi-Arid Lands of Kenya
Omollo et al. (2018)	Determinants influencing household participation in fodder production in Kenya	Binary logistic regression	Female headed households were less likely to participate in fodder production. Group membership had a positive and significant influence	The authors did not consider purchase of the feeds	Conceptual	This study measured the factors influencing purchased feeds by pastoralist in Arid and Semi-Arid lands.

			on fodder production			
Ng'ang'a et al. (2020)	Determinants influencing adaptation strategies to climate change.	Multivariate probit model	Membership in common interest groups such as cooperatives, had a positive and significant influence in the adoption of fodder production as an adaptation strategy.	The authors did not consider purchase of the feeds as an adaptation strategy	Conceptual	The study considered purchase of the feeds as an adaptation strategy
(Maina et al. 2020)	Determinants influencing adoption of Brachiaria Grass among dairy farmers in Eastern & Western Kenya	OLS Regression	Membership in groups increased probability of adopting Brachiaria grass	Study focused on a single feed option in the dairy sector	Conceptual	Study aimed to investigate multiple feed options in the pastoral arid and semi-arid lands
Mohamed Sala et al. (2020)	Factors influencing the decision of pastoralists to purchase fodder in Kenya	Heckman two-step model	Female headed households were 16 percent less likely to purchase fodder. Membership in groups was a key determinant	The authors did not analyze adoption of multiple binary purchased feed options	Methodological	The study used Multivariate Probit Model

Ndiritu (2021)	Determinants influencing adaptation strategies to pastoralists in Laikipia, Kenya	Multivariate Probit Model	Access to private ranching had a positive and significant influence on herd management and later the pastoralists diffused the knowledge gained to common interest groups	The authors did not consider purchase of the feeds as an adaptation strategy	Conceptual	The study investigated purchase of feeds as an adaptation strategy
Njuguna-Mungai et al. (2022)	Determinants influencing adoption of improved forages in Kenya & Ethiopia	Thematic Analysis	Groups increased probability of adopting improved forages	The study focused on dairy production	Methodological	The study focused on purchased feed adoption in Arid and Semi-Arid Lands in Kenya
Nhundu et al. (2023)	Investigated factors influencing the decision to adopt improved fodder technologies in 224 respondents in Zimbabwe. Using Probit regression model	Probit regression model	The results revealed a likelihood of 19.3 percent of female-headed households implementing livestock fodder technologies compared to male-headed households.	The authors did not analyze adoption of multiple binary purchased feed options	Contextual	This study was based in Kenya

2.5 Conceptual framework

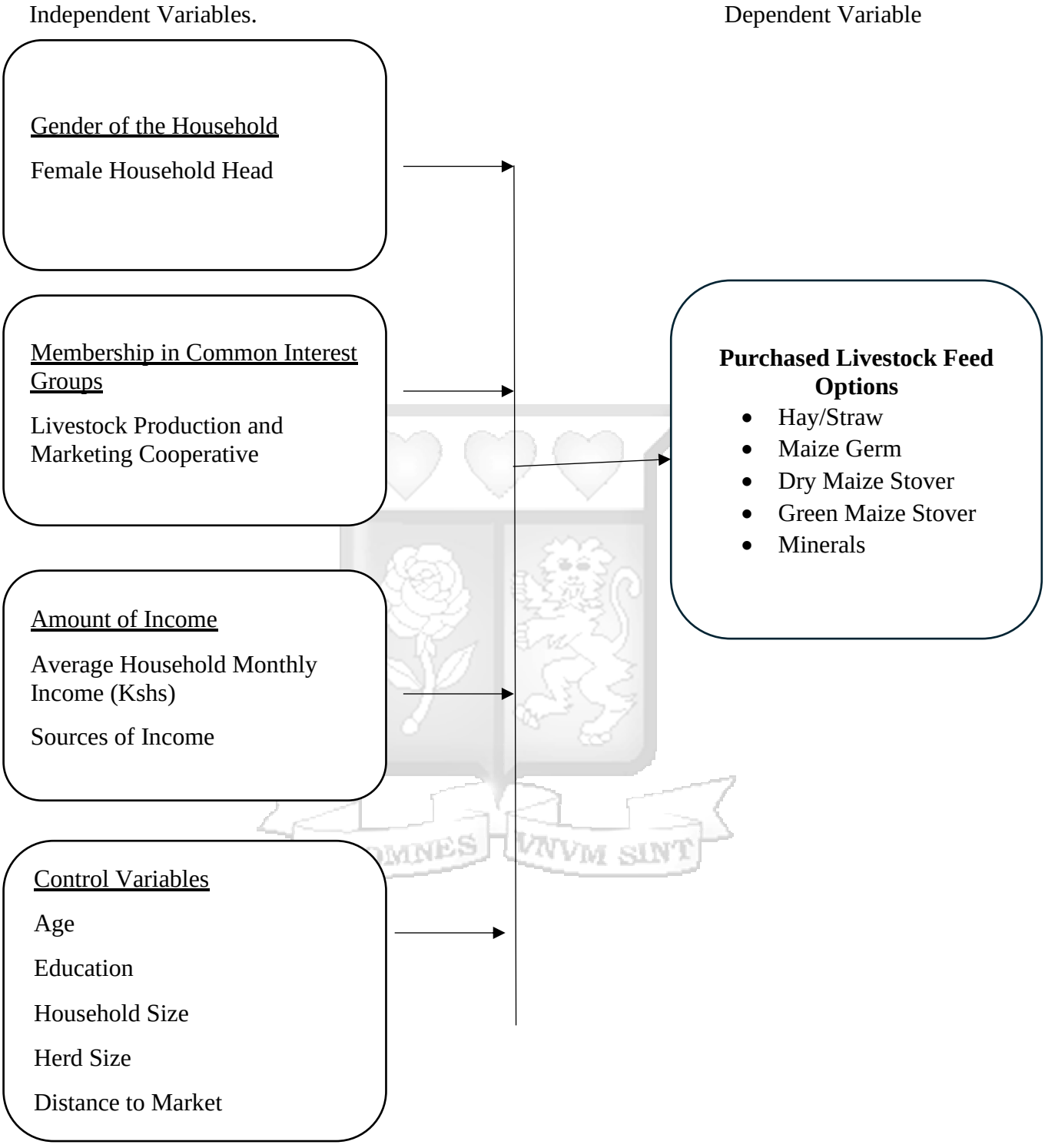

Fig 2. 1: Conceptual framework depicting linkages between dependent and independent variables Source: Author (2024)

2.5.1 Operationalization of the Variables

The measurement of the variables was depicted in table 2.2.

Table 2. 2: Measurement of the variables

VARIABLE	INDICATOR	TYPE OF VARIABLE	MEASUREMENT
Dependent variables			
Feed types Purchased	Straw hay	Binary	1 if used 0 =other wise
	Minerals	Binary	1 if used 0 =other wise
	Maize Germ	Binary	1 if used 0 =other wise
	Maize Stover	Binary	1 if used 0 =other wise
	Dry Maize Stover	Binary	1 if used 0 =other wise
Independent Variable			
Female Household Head	Gender	Binary	Male =0 Female =1
Membership in common interest groups	Membership in livestock production or marketing co-operative	Binary	1 if has membership 0 otherwise
Amount of income	Average Household Income	Continuous	In ksh
Control Variables			
Education	Years of School	Continuous	Years
Age	Years	Continuous	Years
Household Size	No. of household members	Continuous	Number
Herd Size	Tropical Livestock Unit	Continuous	Number
Distance to Market	Kilometers	Continuous	Number

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter focused on the methodology that will be used for the study. This section covered research philosophy, research design, population and sampling, data collection, data analysis, research quality and ethical considerations.

3.2 Research Philosophy

Saunders et al., (2012). identify five distinct philosophies in the realm of research which are realism, positivism, pragmatism, postmodernism and interpretivism. In alignment with the requirements of this study, the research philosophy employed is positivism. The positivist philosophy, with its roots traced back to the works of Auguste Comte, Francis Bacon, and early 20th century scientists and philosophers associated with the Vienna Circle, is known for its emphasis on providing precise and unambiguous knowledge. Epistemologically, positivists strive to uncover measurable and observable regularities and facts, concentrating on research that yields data amenable to quantification and observation (Chege & Otieno, 2020).

In this study, the positivist philosophy was deemed appropriate as it seeks to measure associations between variables by collecting and analyzing quantitative data. By focusing on observable and measurable aspects, the study aligned with the positivist approach, ensuring the generation of meaningful and credible data through quantitative methods.

3.3 Research Design

This is the methodical technique that is used to tackle the research questions (Saunders et al., 2012). For this study, a cross-sectional survey will be used as it allows the research to draw conclusions about variables under study. A quantitative approach was used for this study. Quantitative research using a structured questionnaire was used to measure factors influencing adoption of purchased livestock feeds (Saunders et al., 2012).

3.4 Population and Sampling

3.4.1 Target Population

Researchers collect data from the group to study the characteristics of the population (Manterola & Otzen, 2017). The data was collected from pastoralists households drawn from five counties, namely Kajiado, Garissa, Isiolo, Marsabit, and Wajir.

3.4.2 Sampling procedure

Multistage cluster sampling procedure was used to select the actual households to participate in the study. In the first stage sampling frame will be obtained from the Ministry of Livestock. In the second stage pastoralist households were clustered into counties and sub counties. The third stage households were systematically randomly selected to participate in the study. Further the respondents will be clustered in sub counties as illustrated in Table 1. The primary sampling units for the survey were twenty-four sub-counties. All pastoralist household heads with eighteen years and above in the sample households were eligible to participate in the study. Finally systematic random sampling was used to select individual households for study.

3.4.3 Sample size

The study utilised probabilistic methods to identify the sampled households. For the sample size a sample size formula for unidentified population size was used for the project Cochran and Ellner (1992). A sample size of 1053 was established for the study based on sampling probability calculations. The calculated sample size had a confidence level of 95 that the real value is within ±3.021% of the measured value. The Cochran formula is as below:

$$n = \left(z^2 p(\widehat{1-p})\right)/e^2$$

Where;

z is the z score associated with the desired confidence level, in this case 1.96 for a 95% confidence level

ε is the margin of error

n is the sample size

p̂ is the population proportion for a binary outcome in this case its 50 which represents the estimated population

n = (〖1.96〗 ^2 50(1 − 50))/ 〖3.02〗 ^2 =1053

The sample size was distributed as follows.

Table 3. 1: Distribution of sampled households by county and sub-county

County	Sample distribution	Sub county	Number of pastoralists households
Wajir	210	Griftu	35
		Eldas	35
		Khorof Harar	35
		Wajir west	35
		Wajir east	35
		Wajir south	35
Garissa	211	Ijara	42
		Balambala	42
		Daadab	42
		Garissa township	43
		Ijara	42
Kajiado	211	Kajiado North	42
		Kajiado Central	42
		Kajiado East	42
		Kajiado West	43
		Kajiado South	42
Isiolo	210	Garba Tulla	42
		Isiolo south	42
		Merti	42
		Kinna	42
		Garbatulla	42
Marsabit	211	Marsabit Central	71
		Marsabit North	70
		North Horr	70
Total	**1053**		**1053**

Source: Study data (2023)

3.5 Data collection Methods

To collect data from the pastoralist households the study employed an administered questionnaire. The questionnaire was divided into different sections based on the research topic to make it easier for the respondents to fill out (Seale, 2012). The questionnaire is in Appendix 1. Trained enumerators were contracted to administer the questionnaire to the pastoralists households aged 18 and above using the questionnaires coded on android phone (KOBO- based surveys)

3.6 Data Analysis

The questionnaire had pre-assigned codes to facilitate data input and analysis using Stata. Creswell (2014) outlines some essential steps for data analysis. The first step involved presenting the response rate for the study. This section reported the frequency of each variable

from the respondents and the descriptive statistics for each variable. The descriptive statistics were analyzed using mean, percentages, and standard deviation. To address the research objectives, Multivariate Probit model was applied.

Household decision to purchase fodder is interrelated and complementary in nature (Aryal et al., 2018). Therefore, the Multivariate Probit model simultaneously allows for correlation in the error terms of adoption choices across binary livestock feed practices (Ndiritu et al., 2014).

$$T^*_{hk} = X_h \beta_k + \varepsilon_h \quad (k=h, g,d,s,m)$$

Where

The equation is represented by first a set of equation of unobserved dependent variables which are described by a linear function of observed household (h) and characteristics (X_h) and a multivariate normally distributed stochastic term (ε_h). β_k denotes coefficients representing the influence of each characteristic on the decision to adopt a specific livestock feed practice.

T^*_{hk} denotes the dependent variable which is interpreted as the degree of anticipated benefit from adoption of purchased livestock feed options (straw hay, maize germ, dry maize stover, green maize stover and minerals) by households when perceived advantages outweigh non adoption. The second equation illustrated that household choice of adoption of livestock feeds is dichotomous in nature given by the equation,

$$T_{hk} = \begin{cases} 1, & if \ T_{hk} > 0 \\ 0, & otherwise \end{cases}$$

T_{hk} is the adoption of the k_{th} livestock feeds by the h_{th} household. In the multivariate model, the stochastic terms were assumed to be jointly distributed multivariate normal random variables (MVN).

3.7 Research Quality

3.7.1 Validity

The validity refers to how well a measures what it aims to measure (Saunders et al., 2012). The research used simple and clear questions in the questionnaire to ensure validity. Moreover, a pilot study checked the internal validity by making sure that the respondents interpret the questions as intended. External validity related to how applicable the study's findings are to other situations or groups (Saunders et al., 2012). The study achieved this by carrying out the research in a real life setting and comparing the results with previous literature.

3.7.2 Reliability

Research reliability is the degree to which research instruments produces consistent results time and again (Saunders et al., 2009). Reliability was measured using Cronbach's alpha coefficient which is a reliability coefficient that gives unbiased estimate of data generalizability. Internal consistency and reliability are deemed high when the alpha coefficient is close to 0.70 implying that the data would be generalized to mirror all responses within the target population and therefore the questionnaires was deployed after obtaining an alpha coefficient of 0.7224.

Table 3. 2:Cronbach's alpha coefficient

Average interitem covariance:	0.023167
Scale reliability coefficient:	0.7224

Source: Study data, (2023)

3.8 Ethical consideration

Ethics was observed before, during and after carrying out the study to ensure the validity of the results collected. Permission was sought from the relevant authorities including the Institutional Ethics Review Board and NACOSTI before the research was undertaken. Full disclosure of the purpose of the study was provided to the respondents by using the letter of introduction. Informed consent was sought from the respondents by describing the rights and freedom to voluntarily participate in the research. The respondents were informed of the time required to complete the interview. Additionally, confidentiality and anonymity were ensured, and personal bias and opinion eliminated to ensure objectivity and fair consideration.

CHAPTER FOUR

PRESENTATION OF RESEARCH FINDINGS

4.1 Introduction

This chapter presents the findings from the study. In the first part, descriptive statistics on female headed households, common interest groups, access to income and control variables are presented. In addition, results from correlation tests, Multivariate Probit on the factors influencing adoption of purchased livestock feeds and the likelihood test ratio are also presented.

4.2 Response rate

The aim of the study was to collect responses from 1053 households in Marsabit, Kajiado, Wajir, Isiolo and Garissa. The responses were collected from all the counties and the research garnered 100%. This high degree of participation was deemed adequate for use in a quantitative analysis. According to Kothari (2004), data analysis can be deemed representative of the entire population if the rate of response is at least 70%.

Table 4. 1 Response rate

Value	Frequency	Percentage
Yes	1053	100%

Source: Primary Field Data (2023)

4.3 Female headed households and main activity

The findings in table 4.2 reveal that 93.1% of the households are engaged in pastoralism indicating that pastoralism is the main activity in the 5 counties surveyed. The findings reveal that among the respondents engaged in pastoralism, 80.7% of the household heads are male while female headed households made up the remaining 19.3%. This suggests that pastoral production is male dominated for the most part with the reasons behind it being that they control access to productive resources such as land, water, and livestock. Female headed households may be involved in livestock feed practices probably for small ruminants.

Table 4. 2:Descriptive statistics on female headed households and main activity.

Variable	Mean	Standard Deviation
Gender of the household head (1 Male 0 otherwise)	0.807	0.395

Pastoralism households main activity (1 Yes 0 otherwise)	0.931	0.254

Source: Primary Field Data (2023)

4.4 Descriptive statistics on Incomes Characteristics

Results on income characteristics are presented in table 4.3 and table 4.4. Agropastoralism contributed to income for 30% of the pastoralist's income. Other sources of pastoralist income were Salaried employment at 16.44%, Petty trade at 19.18%, Casual labor at 10.96% and business and trade at 23.29%. The average household income earned for three-month period from livestock products was KES. 14160. Income earned from non-pastoralist activities for a three-month brought in KES. 12226. Overall, this suggests that there is a probability of reduced incomes because of prolonged drought.

Table 4. 3:Other sources of Pastoralists Income

Agropastoral	30.14%
Salaried employment	16.44%
Petty trade	19.18%
Casual labor	10.96%
Business and trade	23.29%

Source: Primary Field Data (2023)

Table 4. 4 :Other sources on Income Characteristics

Variable	Mean	Std. dev.
Household's income earned from livestock and related products (3 months period)	14160.4	22982.06
Household's income earned from other sources (3 months period)	12226.06	19969.33

Source: Primary Field Data (2023)

4.5 Descriptive Statistics on common interest groups of pastoralists

Results on common interest groups of pastoralists are presented in Table 4.5. Pastoralists have aligned themselves to various groups. Membership in livestock production or marketing co-operative had 5% of the pastoralists. These suggests a growing recognition among pastoralists of the benefits of collective action in livestock feeding practices.

Table 4. 5 :Common Interest Groups of Pastoralists

Variable	Mean	Std. dev.
Member of livestock production or marketing cooperative (1 Yes 0 otherwise)	0.054	0.226

Source: Primary Field Data (2023)

4.6 Descriptive on main source of purchased livestock feeds.

The household feeds used for livestock are shown in Table 4.6 below. The sampled households reveal that hay was the most popular purchased livestock feed among 43.68% of the households followed by minerals and maize germ at 37.32% and 25.35 % households respectively. Maize stover dry was purchased by 15.95 % of households and maize stover green was purchased by 10.82 % households. This insinuates that purchased feed was noted to be a growing source of alternative feed. Hay/straw may be readily available in local markets as it provides essential nutrients for livestock making them a popular choice among pastoralists. Maize germ are rich in nutrients which are crucial for livestock health and productivity and pastoralists may recognize its value and choose to purchase it. Maize germ might be consistently available in the market encouraging adoption. Minerals play a vital role in nutritional supplementation and pastoralists may understand this importance and invest in mineral supplements. In the case of maize stover green and dry, they could be seasonal affecting adoption rates.

Table 4. 6:Main types of purchased livestock feeds.

Type of feeds	**Percentage**	**Frequency**
Maize Stover Green	10.82%	114
Maize Stover Dry	15.95%	168
Hay/ Straw	43.68%	460
Maize Germ	25.35%	267
Minerals	37.32%	393

Source: Primary Field Data (2023)

4.7. Descriptive statistics on control variables influencing adoption of purchased livestock feeds

Results on control variables are shown on table 4.7. The mean age for a pastoralist household head is 47 years (SD= 14.1265). This hints that older pastoralists may have accumulated more experience and knowledge about livestock feeding practices. The average years of schooling of the household head is four years, suggesting high illiteracy levels among pastoralists. The average number of people in the household is six indicating that increased household means increased labor needed for livestock feed practices. The average distance from the household residence to the nearest market is 4.7 kilometers implying that pastoralists closer to markets have better access to a variety of purchased feeds.

Table 4. 7:Control variables influencing adoption of purchased livestock feeds

Variable	Mean	Standard Deviation
Years of schooling of the household head	4.327	5.395
Age of the household head	47.598	14.127
Number of people in the household	6.893	2.886
Distance to the nearest market from the residence in km	4.719449	12.59633

Source: Primary Field Data (2023)

4.8 Multicollinearity

Results on Multicollinearity are shown on table 4.8. Multicollinearity was checked through the Variance Inflation Factor (VIF) test. The VIF checks for correlation of independent variables and particularly the variance rises when there's correlation. The absence of correlation between independent variables is indicated by the result of VIF = 1. When 1< VIF < 5, the value of VIF indicates that there exists a moderate correlation between the variables while VIF ≥ 5 to 10 indicates that the variables are highly correlated (Shrestha, 2020). For the study, VIF =1.25, which is less than 10, thus the study concludes that the data does not suffer multicollinearity in the results as shown.

Table 4. 8 :Multicollinearity test

Variable	VIF	1/VIF
Minerals	1.68	0.596
Hay/Straw	1.57	0.639
Dry Maize Stover	1.34	0.749
Green Maize Stover	1.32	0.756
Household Age	1.28	0.78
Education	1.28	0.78

Household Size	1.2	0.834
Maize Germ	1.16	0.86
Household Income	1.15	0.873
Gender	1.08	0.925
Membership in common interest group	1.05	0.955
Mean VIF	1.25	

Source: Primary Field Data (2023)

4.9 Drivers of adoption of multiple purchased livestock feed options

Table 4. 9: Multivariate Probit

	Hay/Straw		**Maize germ**		**Dry Maize stover**		**Green Maize Stover**		**Minerals**	
	Coefficient	Std-err	Coefficient	Std-err	Coefficient	Std-err	Coefficient	Std-err	Coefficient	Std-err
Gender of the household head (1 female, 0 Male)	-0.149	0.107	0.034	0.113	0.361**	0.122	0.277*	0.136	-0.038	0.108
Years of schooling of the household head (years)	0.042***	0.008	0.001	0.009	0.007	0.010	0.030**	0.010	0.033***	0.008
Age of the household head (Years)	0.010***	0.003	0.006	0.003	0.001	0.004	0.006	0.004	0.014***	0.003
Number of people in the household	0.049*	0.015	-0.027	0.017	0.051***	0.017	0.029	0.018	0.033*	0.015
Household's income earned in Ksh	0.004	0.002	-0.002	0.023	0.009***	0.001	0.005	0.002	0.003	0.002
Distance to the nearest village market from the residence in km	0.007*	0.003	0.008**	0.003	0.008**	0.003	0.008**	0.004	0.004	0.003
Member in common interest groups (1 yes, otherwise)	1.237*	0.462	0.457	0.336	0.784*	0.358	0.270	0.371	0.854*	0.366
Tropical Livestock Units (TLU)	-0.002*	0.001	0.001*	0.001	0.001	0.001	0.004***	0.001	-580.0*	0.001
_cons	-1.246	0.187	-0.724	0.195	-1.225	0.207	-1.821	0.225	-1.375	0.189
Number of obs	1053									
Wald chi2(40)	209.41									
Prob > chi2	0.000									

Notes: ***, ** and * significant at 1%, 5% and 10% probability level, respectively Source: Primary Field Data (2023)

4.9.1 Influence of female household head on the adoption of purchased livestock feeds.

The first objective was to determine the extent to which female headed household pastoralists influence adoption of purchased livestock feeds. Influence of female-headed households was found to be positive and significant for dry maize stover at 5% and green maize stover at 10% significance levels (Table 4.9). This implies that female household heads are more likely to adopt dry maize stover and green maize stover. This suggests that women bear the burden on livestock management especially during drought therefore demanding more time and labor, female headed households may prioritize the proximity of the purchased feeds which are cheaper and available in the season which might be dry maize stover and green maize stover.

4.9.2 Effect of membership in common interest groups on the adoption of purchased livestock feeds by pastoralists in Arid and Semi-Arid lands of Kenya.

The second objective was on the effect of membership in common interest groups on the adoption of purchased livestock feeds. Membership in common interest groups was found to be positive and significant for Hay/Straw at 10%, dry Maize Stover at 10% and Minerals at 10% significance levels (Table 4.9). These findings suggest that a household head who is a member in a common interest group is more likely to adopt hay/straw, dry maize stover and minerals. This suggests that common interest groups provide knowledge sharing platforms on alternative feed options, collective decision making and market linkages that may influence bargaining power. Group members may exchange insights on feed options including the benefits of hay/straw. They may also highlight the value of dry maize stover as a feed source during scarcity and the importance of mineral supplementation.

4.9.3 Effect of income on the adoption of purchased livestock feeds by pastoralists in Arid and Semi-Arid lands of Kenya.

The third objective was on the effect of household income on the adoption of purchased feeds. Household income was found to be positive and significant for dry maize stover at 1% level (Table 4.9). These findings suggest that pastoralists with access to income are more likely to adopt dry maize stover. This suggests that with reduced incomes because of drought, pastoralists are more likely to adopt dry maize stover. The positive relationship therefore underscores the role of incomes in adoption of purchased feeds.

4.9.4 Effect of control variables on the adoption of purchased livestock feeds by pastoralists in Arid and Semi-Arid lands of Kenya.

In the case of the effect of control variables on adoption of purchased livestock feeds, years of schooling of the household head was found to be positive and significant in adoption of hay at 1%, green maize stover at 5% and mineral at 1% significance levels (Table 4.9). This suggests that households heads with basic education are more likely to adopt hay, green maize stover and minerals. The households may, understand the benefits of hay as a supplementary feed during dry seasons or when natural pasture is scarce. They may appreciate the importance of providing essential minerals to maintain animal well-being. Household size was found to be positive and significant for adoption of purchased hay at 10%, dry maize stover at 1% and minerals at 10% significance levels (Table 4.9). This signifies that bigger households are more likely to adopt hay, dry maize stover and minerals because larger households are associated with collective activities, including livestock feeding practices.

Age of the household head was found to be positive and significant for hay and minerals at 1% significant levels (Table 4.9). This indicates that older household heads are more likely to adopt hay and minerals. This alludes that older household heads may have accumulated more experience and knowledge about livestock feeding practices. They may be more aware of the benefits of hay a supplementary feed during dry seasons or when pastures are scarce leading to better decision-making regarding purchasing hay and minerals.

Distance to market in kilometers was found to be positive and significant for hay at 10%, maize germ at 5%, dry maize stover at 5% and green maize stover at 5% significance levels (Table 4.9). This implies that households closer to the market are more likely to adopt hay, maize germ, dry maize stover and green maize stover. The positive relationship underscores the importance of proximity to markets in influencing feed choices.

Herd size in Tropical Livestock Units was found to be positive and significant for maize germ at 10% and green maize stover at 1% significance level (Table 4.9). This signifies that households with larger herd size are more likely to adopt maize germ and green maize stover. This insinuates that maize germ being a byproduct of maize processing, is rich in energy and protein and larger herds require more diverse and nutrient rich feed sources to maintain productivity and thus households with substantial herds may prioritize purchase of maize germ to meet animals

nutritional needs. Green maize stover provides fresh succulent feed during seasons when natural grazing areas are limited and may supplement livestock diet. Herd size was also found to be negative and significant for minerals and hay at 10% significant levels indicating that household heads with larger heads are less likely to adopt purchase of minerals and hay may not be sustainable for larger herds reducing the need for purchased hay and concentrated mineral supplementation.

Multivariate probit model was estimated jointly for the binary dependent variables, hay, maize germ, dry maize stover, green maize stover and minerals. The Wald chi2 test (40) = 209.41, Prob > chi2 value of 0.000 indicates that the explanatory variables in the model are collectively significant at 1% level. This means that these variables, as a group, significantly affect the adoption of multiple purchased livestock feed options (Table 4.9).

4.10 Substitutability and complementarity purchased livestock feed options

Table 4. 10 Correlation coefficient of error terms obtained from MVP model estimation.

	Binary correlation coefficient	Standard errors	P-value
rho12	0.268	0.052	0.000
rho13	0.223	0.057	0.000
rho14	0.472	0.060	0.000
rho15	0.731	0.030	0.000
rho23	-0.227	0.060	0.000
rho24	0.227	0.065	0.001
rho25	-0.148	0.055	0.008
rho34	0.655	0.047	0.000
rho35	0.430	0.052	0.000
rho45	0.580	0.052	0.000
Likelihood ratio test of rho12 = rho13 = rho14 = rho15 = rho23 = rho24 = rho25 = rho34 = rho35 = rho45 = 0: chi2(80) = 219.51 Prob > chi2 = 0.0000			

Source: Primary Field Data (2023)

The numbers in rho refer to 1=Hay/Straw; 2=Maize germ; 3=Dry Maize Stover; 4=Green Maize and 5= Minerals. The ρ values are jointly equal to zero.

Positive correlation coefficients for rho12, rho14, rho15, rho24, rho34, rho35, rho45 suggest complementary relationship between the corresponding purchased feed options. Negative correlation coefficients for rho23, rho25 indicate a substitute relationship. The MVP results show that the likelihood ratio test for overall error terms correlation (q) rejected the null hypothesis that the error terms are not correlated (chi2(80) = 219.51 Prob > chi2 = 0.00000). This implies correlated binary responses between different purchased feeds and supports the choice of MVP model for this data. This shows the interdependence of different purchased feed options in the probability of adopting one purchased feed is conditioned by whether another purchased feed option in the subset has been adopted or not. These results suggest that pastoralists consider both substitutability and complementarity when making livestock decisions about purchased feeds in Arid and Semi-Arid Lands. This is supported by the significance of some of the pairwise correlation coefficients between error terms of the adoption equations reported in Table 4.10. The high correlation coefficient 73% for hay/straw and minerals confirm that the two purchased feed options have a complementary relationship. This is consistent with the efforts of the common interest groups in promoting the two options jointly.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This is the last chapter of the study, discussed in accordance with the specific objectives. The chapter collates the findings into one summary for purposes of discussion. Conclusions drawn from the findings have informed the recommendations for policy and practice thereafter, and limitations have provided direction for future research.

5.2 Summary of findings

This study set out to assess the factors influencing adoption of purchased livestock feeds by pastoralists in arid and semi-arid lands in Kenya. Specifically, the study sought to determine the extent to which female headed households, effect of membership in common interest groups and the effect of household income on the adoption of purchased livestock feeds which were hay/straw, maize germ, dry maize stover, green maize stover and minerals.

The research utilized Multivariate probit model to analyze adoption of the purchased livestock feeds. The first objective sought to determine the extent to which female household headed pastoralists influence the adoption of purchased livestock feeds in the arid and semi-arid lands of Kenya. Influence of female-headed households was found to be positive and significant for dry maize stover at 5% and green maize stover at 10% significance levels. This implies that female household heads are more likely to adopt dry maize stover and green maize stover. The second objective sought to investigate the effect of membership in common interest groups on the adoption of purchased livestock feeds by pastoralists in arid and semi-arid lands of Kenya. The groups included livestock production/marketing co-operative. Membership in common interest groups was found to be positive and significant for Hay/Straw at 10%, dry Maize Stover at 10% and Minerals at 10% significance level. These findings suggest that a household head who is a member in a common interest group is more likely to adopt hay/straw, dry maize stover and minerals. Household income was found to be positive and significance for dry maize stover at 1% level. These findings suggest that pastoralists with access to income are more likely to adopt dry maize stover.

In the case of the effect of control variables on adoption of purchased livestock feeds years of schooling of the household head was found to be positive and significant in adoption of hay at 1%, green maize stover at 5% and mineral at 1% significance levels. This suggests that households heads with basic education are more likely to adopt hay, green maize stover and minerals. Household size was found to be positive and significant for adoption of purchased hay at 10%, dry maize stover at 1% and minerals at 10% significance levels. This signifies that bigger households are more likely to adopt hay, dry maize stover and minerals. Age of the household head was found to be positive and significant for hay and minerals at 1% significant levels. This indicates that older household heads are more likely to adopt hay and minerals. Distance to market in kilometers was found to be positive and significant for hay at 10%, maize germ at 5%, dry maize stover at 5% and green maize stover at 5% significance levels. This implies that households closer to the market are more likely to adopt hay, maize germ, dry maize stover and green maize stover. Herd size in Tropical Livestock Units was found to be positive and significant for maize germ at 10% and green maize stover at 1% significance level. Herd size was also found to be negative and significant for minerals and hay at 10% significant levels indicating that household heads with larger heads are less likely to adopt purchase of minerals and hay.

5.3 Discussion of Findings

5.3.1 Female household headed pastoralists influence the adoption of purchased livestock feeds.

The first objective of the study was to determine the extent to which female household headed pastoralists influence the adoption of purchased livestock feeds in the arid and semi-arid lands of Kenya. The findings from this study revealed that influence of female headed households was found to be positive and significant for dry maize stover and green maize stover implying that female household heads are more likely to adopt dry maize stover and green maize stover. This study contradicts the findings of Mohamed Sala et al. (2020) who found that female headed households were less likely to purchase fodder. However, it provides insights on female headed households in decision making on livestock production as was noted by Opiyo et al. (2016). The rationale behind their involvement is that interventions on livestock feeding practices, increases

the likelihood of increased decisions and empowerment in implementing feed options as was noted by Nhundu et al. (2023).

5.3.2 Membership in common interest groups on the adoption of purchased livestock feeds by pastoralists.

The second objectives of this study were to investigate the effect of membership in common interest groups on the adoption of purchased livestock feeds by pastoralists in arid and semi-arid lands of Kenya. These groups included livestock production/marketing co-operatives, women association groups and church/mosque/associations/congregations. Membership in common interest groups was found to be positive and significant for Hay/Straw, Dry Maize Stover, and Minerals. These findings suggest that a household head who is a member in a common interest group is more likely to adopt hay/straw, dry maize stover and minerals. The positive relationship underscores the importance of common interest groups in providing insights on adoption options. This is because membership in the groups facilitates adoption of sustainable and efficient feed practices Omollo et al. (2018). Therefore, this leads to diffusion of knowledge as was noted by Ndiritu (2021). Additionally, considering the drought experience of the household heads, they were more likely to join groups providing information on livestock feeds as was also noted by Lugusa et al. (2016).

5.3.3 Household income on the adoption of purchased livestock feeds by pastoralists in arid and semi-arid lands of Kenya.

The third objective was to analyze the effect of household income on the adoption of purchased livestock feeds by pastoralists in arid and semi-arid lands of Kenya. Household income was found to be positive and significant for dry maize stover. The findings revealed a possibility of the case that scarcity of livestock feed during the period of drought led to low incomes from sale livestock and related products as was noted by Duguma and Janssens (2016). This therefore influenced the feed options for the households purchased. These findings also corroborated with Leyte et al. (2022), who found that households tend to adopt strategies that are cost effective and therefore the decision to purchase fodder may be an economic consideration.

5.4 Conclusion

The results of this study confirm that pastoralists are embracing purchased feed options which brought out the relevance of Theory of Planned Behavior in the study. These results suggest that pastoralists consider the purchased feeds as either complementary or substitutes when making livestock decisions about purchased feeds in Arid and Semi-Arid Lands. Variables under investigation have significant influence on adoption of purchased livestock feeds. With regards to female headed households, influence on adoption was significant for dry maize stover and green maize stover. The second objective measured the influence of common interest groups and found that influence on adoption was significant for hay, dry maize stover and minerals. The third objective measured the influence of income and found that influence on adoption was significant for dry maize stover. Factors that encourage adoption of purchased feeds such as formalizing of the common interest groups through which services such as extension and better payment terms for the feeds may be encouraged.

5.5 Recommendations

Recommendations for Policy and Practice are as below.

5.5.1 Recommendation for Policy

The recommendations are based on the National Livestock policy which acknowledges livestock feed deficit of 30 million metric tons for produced feed and 700,000 metric tons for purchased feeds, and the need for gender-disaggregated data. (GOK, 2020). The research covering the five counties, provided granular data needed for the attainment of government Pillar 8 of Agricultural Sector Growth Transformation Strategy for strengthening research and innovations.

This research revealed pastoralists willingness to purchase livestock feeds despite their previous reliance on natural pasture as they are noted to be embracing the variety of purchased livestock feeds available to them which is a positive development in the livestock value chain in the arid and semi-arid lands of Kenya. The research revealed that female-headed households participate in purchasing a variety of livestock feeds and therefore more interventions that promote female headed households interaction in the feed value chain are needed. Agropastoralism is seen to be practiced by approximately 30 percent of the households therefore interventions that promote remote sensing technology to identify migration of pastoralists and promote public private partnerships for fodder production along riverbanks and enclosures for fodder banks would complement household incomes, food security and pastoralism in general.

County led public private partnerships initiatives in offering infrastructure such as baling equipment and ploughing would provide support in improved feed options especially for hay. Importance of technical support to pastoral and agro-pastoral households towards starting and joining existing common interest groups through which extension and training services can be offered would go a long way in enhancing purchase of livestock feeds as a mitigation strategy during drought.

5.5.2 Recommendation for Practice

Private sector led investments in provision of livestock feeds can enable pastoralists to actively participate in the export market through a commercial arrangement involving providing livestock feeds to pastoralists through organized common interest groups, with costs being offset by livestock off takers. Coordination and monitoring and evaluation can be undertaken by a research institution.

5.6 Suggestion for further research

Further research is needed to explore gender dynamics in more depth and to identify strategies that can effectively address these gender related challenges in adopting varieties of purchased livestock feed options. Considering the study period was during the drought period, a closer examination of the effect of early warning systems and extension services in the adoption of purchased livestock feeds is also relevant. Additionally, an examination of the challenges associated with adoption of the multiple feed options is relevant.

5.7 Limitations of the study

The study was limited in scope. Pastoralism is practiced in Narok, Samburu, Turkana, Baringo, Laikipia, Marsabit, Isiolo, Mandera, Wajir, Garissa, Tanariver, Pokot, and Kajiado. Among the counties where pastoralism is practiced, only 5 counties were surveyed namely Kajiado, Garissa, Isiolo, Marsabit and Wajir as they were logistically accessible.

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APPENDICES

APPENDIX 1 Introduction Letter

Household identification number (Enumerators)		

Household identification number (Supervisor code)
…….

Hello,
Thank you for agreeing to speak with me. I am a post graduate student at Strathmore University Business School conducting a survey for academic research purposes and the project is part of the Market Transformation for Pastoralist project (MTP)
This interview is not mandatory but your answers to these questions are what will make our study successful. Your views are important and will help us to generate research findings and learn lessons about the adoption of livestock feeds in the pastoralist areas. This information would help inform the investments and policies in the livestock sector.
We selected your household randomly for the survey and would like to talk to you for about one and a half hours to collect information that is set out in this questionnaire. We will be conducting the same survey in other counties within the pastoralists regions.
We value confidentiality and we will ensure that all the answers you provide will be kept confidential.
STARTING TIME…… **END TIME**
……

APPENDIX 2. Research Questionnaire

SECTION A. RESPONDENT IDENTIFICATION AND HOUSEHOLD CHARACTERISTICS

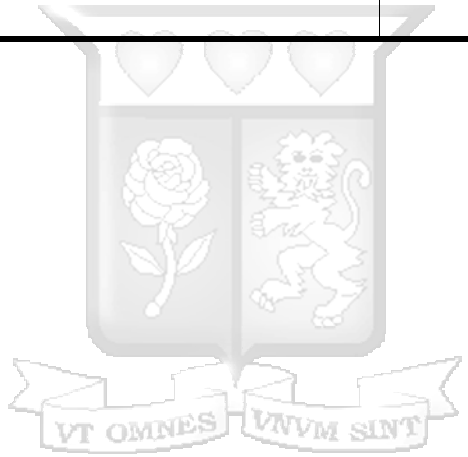
PLEASE RESPOND TO THE QUESTION BY REPORTING THE RELEVANT CODE/NUMBER IN THE MIDDLE COLUMN.

A01. Are you the head of this household?		*1 = Yes* *2 = No* *0 = Do not know*

*I will now ask questions about the **head of your household**, so about you if you have replied yes to the previous question [A01]. If you don't please respond for the person who is considering as the head of household [refer to the status mentioned in A02].*

A02. What is the gender of household head?		*0 = Female* *1 = Male*
A03. What is the highest level of education of the household head (years of schooling)?		*0 = None/Illiterate* *1 = Adult education or 1 year of education* ** Give other education in years*
A04. What is the marital status of household head?		*1 = Married living with spouse* *4 = Widow/widower* *2 = Married but spouse away* *5 = Never married* *3 = Divorced/separated* *6 = Other, specify*
A05. How old is the household head?		*Enter number, in years*

A06. How much income did your household earn in the last 3 months from Livestock?		*Enter number, in Kshs*
A07. How much income did your household earn in the last 3 months from other activities?		*Enter number, in Kshs*
A08. Has anyone in this home belong to a livestock production or marketing cooperative?		*1 = Yes* *0 = Do not know* *2 = No*



B: INFORMATION ON BOUGHT FEEDS

Specific Feeds types	Information on bought feeds	
	How many times in a month do you feed your live stock with bought {feed type}?	What quantity of bought {feed type} do you give mostly each time?
Straw/Hay		
Dry Maize Stover		
Maize Germ		
Green Maize Stover		
Minerals		

APPENDIX 3 Institutional Ethical Review Letter

Strathmore UNIVERSITY

2nd May 2024

Ann Mukami Gachuki Waimiri
Student Number: MPPM/146700
ann.waimiri@strathmore.edu
MPPM

Dear Ann,

RE: Factors Influencing Purchase of Livestock Feeds by Pastoralists in Arid and Semi-Arid Lands of Kenya

This is to inform you that the Office of Graduate Studies received your request for exemption from ethical clearance. This is based on the fact that your study cannot be reviewed by the Strathmore University Institutional Scientific Ethics Review Committee (SU-ISERC) since you have already proceeded to collect data. The ethics approval process is ONLY done before any collection of primary or secondary data. Additionally, ethical clearance is mandatory for all studies including desktop research.

The office notes that: On the grounds of your study is utilizing data collected under Strathmore Agri-Food Innovation Center, under a study titled 'An Evaluation of the Performance of Selected Climate Smart Ventures Value Chains in Kenya' which was already approved by the Strathmore University Institutional Scientific Ethics Review Committee (SU-ISERC) under reference number SU-ISERC1507/22 and further approved by NACOSTI under Ref No: 954758. This is a letter for you to proceed with the next steps of your academic requirements.

Disclaimer: *1) This is not in any way an ethical approval letter. 2) Should there be any legal implications/actions emanating from the research in terms of any ethical violations, you will be personally liable.*

Yours sincerely,

Dr. Bernard Shibwabo
Director of Graduate Studies

Ole Sangale Rd, Madaraka Estate. PO Box 59857-00200, Nairobi, Kenya. Tel +254 (0)703 034000
Email admissions@strathmore.edu www.strathmore.edu

APPENDIX 4 NACOSTI Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 851276

Date of Issue: 06/May/2024

RESEARCH LICENSE

This is to Certify that Ms.. Ann Mukami Gachuki Waimiri of Strathmore University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Garissa, Isiolo, Kajiado, Marsabit, Wajir on the topic: FACTORS INFLUENCING PURCHASE OF LIVESTOCK FEEDS BY PASTORALISTS IN ARID AND SEMI ARID LANDS OF KENYA for the period ending : 06/May/2025.

License No: NACOSTI/P/24/34990

851276

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Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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See overleaf for conditions