INFLUENCE OF SELECTED COPING STRATEGIES ON AVAILABILITY OF FEEDS AMONG SMALLHOLDER DAIRY CATTLE FARMERS IN TRANS-NZOIA COUNTY, KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements of the Master of Science Degree in Agricultural Extension of Egerton University

EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been submitted or published for any award of a degree or diploma in this or any other University.

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Recommendation

This thesis has been submitted to Graduate School for examination with our approval as the University Supervisors.

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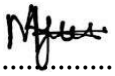

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DEDICATION

This thesis is dedicated to my wife, Anne, our children Lynn, Neon, Natasha and my parents who kept on encouraging me to finish my studies despite the many challenges I encountered during my studies and research work.

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I would like to thank Almighty Father for the care and protection throughout my studies despite the enormous challenges that I encountered. I am greatly indebted to my supervisors Dr. James Obara and Dr. Miriam Kyule for their guidance, encouragement and positive constructive criticism on my work.

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ABSTRACT

In Trans-Nzoia county smallholder dairy cattle farmers are constrained by feeds shortage despite livestock extension agents and other stakeholders disseminating various coping strategies to farmers. Due to this, it became necessary to determine the influence of selected coping strategies to overcome non availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County. The selected coping strategies that were investigated are crop stovers preparation strategies and forage conservation strategies. The study used cross sectional survey research design. The target population was all dairy cattle farmers and the accessible population was 13,971 smallholder dairy cattle farmers in the study area. Using proportionate stratified random sampling121smallholder dairy cattle farmers were sampled from Kaplamai, Kwanza and Waitaluk wards in Trans-Nzoia County. Data was collected using questionnaire. The instrument was pilot tested in Kimilili ward of Kimilili Sub-county in Bungoma County using 30 randomly selected smallholder dairy cattle farmers. The instrument validation was done by the supervisors from the department of Agricultural Education and Extension. A Cronbach alpha reliability coefficient of 0.8 was attained. Descriptive statistics and multiple regression were used for data analysis respectively. The null hypotheses was at 0.05 alpha level of significance. The study established that feeds availability to farmers is low during both rainy and dry seasons of the year but much lower during the dry season. The results from this study show that both crop stovers preparation strategy and forage conservation strategy do not significantly influence availability of feeds. Farmers used the following feeds; forage (98.3%), hay (51.2%), silage (37.2%), crop stovers (77.7%), cereal by products and legume crops (14.9%). It was noted that 26.4% of dairy farmer purchase feeds to supplement what they have from their farms both the dry and wet seasons. In addition, feeds availability was in abundance in wet season than the dry season. In reference to the findings, this study concluded that most farmers tend to conserve less forage when feeds are available. Therefore, farmers should do more feed conservation during wet season. This study recommends that the County government and other stakeholders to continue capacity building smallholder dairy cattle farmers on crop stovers preparation strategies to improve on the amounts available for usage during feeds scarcity. It also recommends the extension agents to capacity build smallholder dairy cattle farmers to conserve more forage during the rainy season when they in plenty for usage during feeds scarcity period.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASL Above Sea Level

CDLP County Director of Livestock Production

FAO Food and Agricultural Organization

IGAD Inter-Governmental Authority on Development

ILRI International Livestock Research Institute

KALRO Kenya Agricultural and Livestock Research organization

KG Kilograms

KNBS Kenya National Bureau of Statistics

MOLD Ministry of Livestock Development

SCLPO Sub County livestock Production Officer

SPSS Statistical Package for the Social Sciences

UM4 Upper Midland ecological Zone

WLEO Ward Livestock Extension Officer

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Majority of world's livestock low input systems suffers from either permanent or seasonal feeds shortage. In these systems, farmers use various coping strategies in mitigating against feeds shortage like collecting, storing, conserving forages and crop residues (Duguma & Janssens, 2021). Lack of feeds availability globally has affected livestock productivity and the profit that the smallholder dairy farmer obtains from farming. Availability of quality feeds through the year for dairy farming contributes to high livestock production in terms of milk. In addition, the health animals have a shorter calving interval since the animals have good healthy conditions that increases prolificacy (Para et al., 2020). Some of the strategies that have been developed by smallholder farmers to improve feeds conservation and livestock feeds include but not limited to introduction of improved forages, improving crop residue quality, supplementary feeding, conducting zero grazing and conserving crop residues that are abundant in rain season (Balehegn et al., 2020).

In Malaysia forage conservation in form of silage ensured feed availability during feeds shortage among smallholder dairy cattle farmers during the drought and flood periods (Ates et al., 2018).A study conducted in found that India feed shortage was addressed using conserved fodder (Shinde & Mahanta, 2020).Smallholder dairy farmers in Africa experience feeds shortages and use various coping strategies like using crop residues such as maize stovers, bean haulm and wheat straws, underfeeding their animals through feed rationing and use conserved pastures and fodder (Lukuyu et al., 2012).

In South Africa, farmers experience feeds shortage which later influences the milk production by dairy animals. However, farmers cope feeds shortage by practicing feeds conservation like making hay and silage (Maina et al., 2020).In Ethiopia, during the dry season farmers experienced feed scarcity especially during the dry season. This made farmers to conserve crop residues and hay, purchase commercial feeds, sell some livestock as a coping strategy of managing feds shortage. In addition, feeds shortage was found to cause low productivity in terms of milk and animal diseases (Duguma & Janssens, 2021). In addition, seasonality in animal feeds in the East Africa region is highly influenced by

fluctuations in rainfall patterns leading to unpredictable weather patterns (Ongadi et al., 2020).

In Nigeria, the dairy farmers used to rely on natural pasture from community land throught the year. However, they started experiencing a decline in the milk production since the number of animals feeding on community land were increasing with time. Therefore, the smallholder dairy farmers shifted to feeds conservation. For instance, it was observed that at least 75% of the farmers used cottonseed cake or bran as a concentrate during the dry season, which promoted an increase in milk production (Millogo et al., 2016).

In Ghana, livestock production has a significant contribution in meeting human nutritional needs like milk, meat and manure that is used sometimes for crop production. The dairy farmers benefit by selling milk and manure thus doubling their income (Kleemann & O'Riordan, 2015). However, in the recent decade, the smallholder dairy farmers have faced high feeds shortage especially during the dry leading something that has compromised animals' health, animals productivity, the farmers' daily returns from milk. In addition, feeds unavailability has been found to cause an increase in the cost of livestock production since animals are a susceptible to diseases. To overcome the feeds shortage, some farmers have opted to purchase animal feeds. For instance, a study conducted in Ghana revealed that at least 40% of smallholder dairy farmers purchased groundnut hailms and cereal straws like sorghum straws to supplement animas feeds. In addition, it was observed that about 50% of farmers either borrowed or bought crop residues from neighbors for livestock (Odhong, 2015). However, in the recent decade, the smallholder dairy farmers have faced high feeds shortage especially during the dry leading something that has compromised animals' health, animals productivity, the farmers' daily returns from milk. In addition, feeds unavailability has been found to cause an increase in the cost of livestock production since animals are a susceptible to diseases. To overcome the feeds shortage, some farmers have opted to purchase animal feeds. For instance, a study conducted in Ghana revealed that at least 40% of smallholder dairy farmers purchased groundnut hailms and cereal straws like sorghum straws to supplement animas feeds. In addition, it was observed that about 50% of farmers either borrowed or bought crop residues from neighbors for livestock (Odhong, 2015).

In Tanzania, dairy farms experienced feed shortage and they opted to use hay, silage and promote feeds conservation to maintain milk supply both the dry and wet seasons. The crop residues from individual farms was not sufficient even during the season and the farmers had to purchase animal feeds from other sources (Ndah et al., 2022).Kenya's dairy industry is

dynamic and plays an important economic and nutritional role in the lives of many people ranging from farmers to hawkers, processors and consumers (Ngongo, 2019). The dairy industry is the single largest sub sector in Kenya and it contributes fourteen percent of the agricultural gross domestic product (Maina et al., 2018). Feeds shortage is common in western Kenya and farmers use various coping strategies to mitigate the feeds shortage namely, purchase forages and concentrates, use of dual-purpose crops from their fields such as leaf strips, thinning, toppings, sweet potato vines and use conserved feeds (Lukuyu et al., 2019).

A study conducted in Somali by Issack (2021) on assessing feed shortage saturation in Somalia, challenges and mitigation strategies revealed that camel farmers were experiencing high feeds shortage. The study found out that the farmers used maize, sesame oil meal, yellow peas seeds, alfalfa hay and sorghum straws to supplement feeds. However, despite the farmers using various feeds to meet animal nutritional and health needs, it was observed that during the dry period farmers lacked animals feeds thus they had to walk from one place to another in search of pasture something that fatigued animals leading to a decliner in milk production (Mare et al., 2018). Farmers who are able to develop feeds conservation during the rain season were observed to spend less in livestock farming especially during the dry season. In addition, animals that are not well fed were found to be frequently attacked by diseases thus farmers experience huge costs in general livestock production since during the dry period they opted to purchase livestock feeds (Shire, 2015).

In Trans-Nzoia County smallholder dairy cattle farmers experience feeds shortage (Njogu, 2019).Despite the various coping mechanisms that have been developed by Kenya Agricultural and Livestock Research Organization (KALRO) that is found in Trans-Nzoia County. Farmers attributed the feeds shortage to small farm sizes and failure to plant improved grasses. For this study, the coping strategies that were considered are crop stovers preparation strategies and forage conservation strategies using various forms (Twinamatsiko et al., 2020).During feed shortages farmers use conserved forages in the Kenyan highlands. In Kiambu County feeds shortage was reduced by fodder conservation using cost effective

methods but the extent to which the various forms of conserved forages contribute towards the availability of feeds is not known (Ajak, 2019). In Trans-Nzoia County it was found that the ensiled materials were mainly crops such as maize and sorghum (Sakwa, 2020).

1.2 Statement of the Problem

Dairy farming is the most popular livestock enterprise in Trans-Nzoia County whereby 80% constitute smallholder dairy farmers. These farmers produce over 75% of the total milk in the county. Despite these potential farmers experience feeds shortage at farm level. Due to this, Kenya Agricultural and Livestock Research Organization (KALRO) found in the County developed various coping strategies to reduce the feeds shortages. Livestock extension agents have disseminated the coping strategies to farmers through various extension methods. The feeds shortage has led to reduced milk production, reduced income from milk for farmers and poor body conditions of the animals. This study sought to contribute towards missing information by determining the extent to which the selected coping strategies namely crop stovers preparation strategies and forage conservation promote feeds availability among smallholder dairy cattle farmers in Trans-Nzoia County.

1.3 Purpose of the Study

The purpose of the study was to determine the influence of selected coping strategies on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County, Kenya.

1.4 Specific Objectives of the Study

The objectives of the study were to determine the:

i. Availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County
ii. Influence of crop stovers preparation strategy on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County
iii. Influence of forage conservation strategy on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County.

1.5 Research Question

Objective one was changed to a research question which stated that:

What is the level of feeds availability among smallholder dairy cattle farmers in Trans-Nzoia County?

1.6 Hypotheses

Two research hypotheses were tested during the study. They were:

H01: Crop stovers preparation strategy does not significantly influence availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County.

H02: Forage conservation strategy does not significantly influence availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County.

1.7 Significance of the Study

The findings of this study are likely to assist livestock farmers in selecting appropriate coping strategies that are suitable for their conditions and likely to ensure feeds are available all the year round. The findings are also likely to inform farmers' extension agents and the government on influence of crop stovers preparation strategy on availability of feeds among smallholder dairy cattle farmers and influence of forage conservation strategy on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County. This could assist in reducing hazards of feeds shortage among smallholder dairy cattle farmers in Trans-Nzoia County and Kenya as a whole.

1.8 Scope of the Study

The study sampled smallholder dairy cattle farmers in Trans-Nzoia County who provided information on the influence of crop stovers preparation strategy and the influence of forage conservation on availability of feeds among smallholder dairy cattle farmers. The farmer's factors that were incorporated into the study were gender, age, level of education of the

farmers, source of income, dairy production system practiced, types of dairy cows owned and number of dairy cows owned by the smallholder dairy cattle farmers.

1.9 Limitations of the Study

Some farmers were reluctant to share personal details that were being sought. This was solved after the researcher explained that the information would be used only for research work which could help them solve dairy feeds shortage problems and that the data could be was be treated with respect, professionalism and handled in confidence.

1.10 Assumptions of the Study

The study assumes that:

i. The farmers were honest, truthful and transparent when providing information sought from them.

1.11 Definition of Terms

Common Property- Property that belongs to all members of a community (Blomley, 2020).In this study refers to feeds resources and facilities that every dairy farmer in given community has access to without any restrictions.

Coping Strategies - Coping strategies are the processes of attempting to manage demands that are viewed as exceeding our resources (Turnbull et al., 2021). In this study the coping strategies refers to as crop stovers preparation strategies and forage conservation strategies on availability of feeds.

Crop residues-Are portions of harvested crop that remains after harvesting (Alghamdi & Cihacek, 2022).In this study it refers to crop materials that remains after the grain or other primary product is removed.

Influence –The capacity to have an effect on the character, development, or behavior of someone or something, or the effect itself (Purwanto et al., 2021). In this study, influence refers to as how crop stovers preparation strategy and forage conservation strategy affects availability of feeds

Mitigating Feeds Shortage - Mitigating feeds shortage is reducing feeds shortage (Zhou et al.,2020). In this study, mitigating feeds shortage refers to ensuring availability of dairy cattle feeds to the household all the year round.

Smallholder Dairy Farmer - Smallholder dairy farmer is one with less than six milking cows, with less than 3hectaresof land and has poor resource endowment relative to other dairy farmers (Jumba et al., 2020). In the study area, 62% of farmers have up to 10 cows and with land that is less than 3 hectares. Therefore, in this study it referred as a dairy farmer with up to ten milking cows, with less than 3 hectares of land and with poor resource endowment.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter summarizes literature review related to dairy cattle feeding, level of feeds shortage during the dry and rain seasons, crop stovers preparation strategy and forage conservation coping strategies on availability of feeds. It further gives the theoretical and conceptual frameworks.

2.2 Dairy Cattle Feeding

According to FAO, 2018 77% of the total number of dairy cattle in the world are in Africa and Asia and represents 33% of the world's milk production whereas Europe and North America represent 21% of the world dairy cattle population producing 51% of the world's milk production. The low milk production in Africa and Asia is associated with poor feed resources and other factors.

According to Karangiya et al. (2016)dairy animals in India and other tropical countries are feed mainly on by products of various food crops, oil seed and locally grown fodder. In some situations, these by products are not available in sufficient amounts to meet the entire demand for livestock population. Limited land available for meeting the needs of an ever-growing human population in developing countries cannot be spared for growing additional green fodder and coarse grains for feeding livestock. Even the available are not utilized judiciously as the majority of the animals in these countries are feed imbalanced rations resulting in low milk production below their genetic potential.

A study conducted on characterization of smallholder dairying farmers in Gambia countries found that 79% of the smallholder dairy farmers used natural pastures as their main feed for their dairy cows while 21% of the farmers did supplement feeding in Guniea Bissau 59% of the farmers used natural pastures as the main feed to feed their dairy cows while 41% did supplement feeding (Molina et al., 2020).

A study done on Ethiopia dairy sector revealed that the main feeds for dairy cows comprised of natural pastures, crop residues such as straws and chaffs of cereals and pulp and agro-industrial by products mostly from flour/oil industries and brewery residues (Negash, 2018). The above feed resources are usually scarce. According to Chufa et al.(2022) in their

study done in the highlands of Bale South East Ethiopia showed that dairy cows are feed on natural pastures, crop residues and weeds for milk production.

A study done in Zimbabwe shows that dairy cattle are mainly fed on natural pastures and crop residues as primary feed resources (Tawedzegwa et al., 2019). High cost and unavailability of protein rich commercial concentrates resulted in inconsistent and inadequate concentrate supplementation for increased milk yield (Timlin et al., 2021).

According to Alam et al. (2022) the bulk of dairy cattle feed in Kenya consist of natural forage, cultivated fodder and crop by products. Feeding constitute the largest portion of the cost of milk production in the market dairy farming.

Smallholder dairy farmers in the Kenya highlands are confronted with an increasing pressure on grazing land and therefore pressure to use feed resource (Migose et al., 2018). Further studies done by Tufail et al. (2020)on their study on the effects of feeding practices on milk yield and composition in Peri-urban and rural smallholder dairy cow and pastoral herds in Kenya found out that smallholder dairy farmers are producing milk under conditions of feed scarcity because the competition for land that restricts access to adequate grazing pastures. The available on farm feed is estimated to be less than five kilograms of dry matter per head per day which is an amount that cannot even support maintenance requirements of a cow producing ten litres of milk per day. This reflects feed scarcity which worsens during the dry season when feed available in abundance is crop residues but farmers underutilize this feed resources because they face challenges in improving the nutritive value.

2.3 Level of Feeds Shortage during Dry and Rain Seasons

Work done by Samad (2020) on feeding strategies for improving dairy productivity in smallholder farm in Bangladesh showed severe feeds shortage of up to80% occurring during dry seasons. According to Cárdenas et al. (2019) pastures and fodder availability drop by 40% during the dry season in Honduras. Ademe et al. (2020) in their research work in the central highlands of Ethiopia and north-eastern Ethiopia respectively found that feeds shortage is more severe during the dry season than during the rainy season. They indicated that crop residues provide approximately 50% of the feeds during the rainy season and 80% during the dry season. Teklu et al. (2011) in western Ethiopia found that feeds shortage during the dry season was more severe than during the rainy season. The problem during the

dry season is even more aggravated when farmer's burn natural pastures and the rains delay. A study by Makkhar (2018) estimated Ethiopia livestock feeds shortage at 9% as dry matter.

According Wester et al. (2019) in their study on the feed availability and accessibility in Manipur India they found out that there exists feeds scarcity both during the rainy and dry seasons but more during the dry season and India's feeds scarcity stands at an estimated deficit of 36% of green fodder and 57%t of concentrates. Kenya's annual feed deficit stands at about 53-57 million metric tonnes of dry matter (Government of Kenya [GOK], 2017). A study conducted by Waweru and Paul (2021), in their study on availability and use of dry season feed resources on smallholder dairy farms in central Kenya found out that more than 60% of the farmers experienced forage shortage during the dry season while 25% of the farmers experienced forage shortages throughout the year. In Trans-Nzoia county feeds shortage is more during the dry seasons than during the rainy season (Wanyama et al., 2005).

2.4 Utilization of Crop Stovers

The total world crop residue production is estimated at 3.8 billion tons of which 24% are from cereals, 8% from legumes, 3% from oil crops, 10% from sugar crops and 5% from tubers. The useable crop residues however are that of cereals (Searchinger et al., 2019). Kenya produces approximately 15.8 metric million tons of dry crop residue (GOK, 2017).Use of Crop stovers in mitigating feeds shortage is estimated to account for 25% of the total feed in both developed and developing countries (Ayele et al., 2021). In South East Asia smallholder dairy cattle famers use crop residues as their main feed during the dry and rain seasons to address feeds shortage (Khajavern & Khajavern, 2012). Baltenweck et al. (2020) indicated that the single important animal feed in Asia and Africa is not grass but rather stalks leaves and other residues of crops after harvesting. A study by Choudhary et al.(2019), found that crop residues like maize stovers, sorghum and pearl millet are not considered important in farms with enough feeds but in farms that are small and don't produce enough feeds they become important.

According to Kumari et al. (2020), chopped sorghum stover was the major source of dry fodder in India. However on average 50% of smallholder dairy farmers in India depend on crop residues to feed their animals and thus increasing the yield and quality of the crop stovers is the main avenue for enhancing productivity (World Bank, 2012). Further in India Balehegn et al. (2020) in her research noted that new varieties of sorghum have been bred to

improve stover production to meet the needs of India's dairy farmers for animal feed and food for the growing human population. Crop stovers can be tree leaves or pods and that maize stovers were used when green (thinning, leaf stripping and plant tops), entire green plant or dry stovers which can be used whole, chopped or treated with urea to increase their feeding value. When urea is used for treatment, the heap is left for three weeks then used for feeding with or without supplements (Gabriel et al., 2018). A study by Shackleton & Hebinck (2018) in South Africa found out that a primary strategy used by farmers during feeds shortages is feeding using crops, According to Maleko et al.(2018)maize was considered to be leading in providing crop residue as livestock feed during the wet and dry season in Tanzania. Chisowa et al. (2022) in Zimbabwe indicated that during feeds shortage, maize stovers were treated with urea solution to improve the feeding value. According to Valencia et al. (2022) in their study on smallholder farmers' perception and challenges toward the use of crop residues and agro-industrial by products in livestock feeding systems in Eastern Democratic Republic of Congo they found out that adoption and utilisation of crop stovers was influenced by several factors which included availability, quality, price, labour costs and capital investments. A study by Ongadi et al. (2020)found that smallholder dairy cattle farmers in the Kenyan highlands use crop residues and gather forages from common properties (road reserves, forests, schools) in their feed management practices by use of hired labour to reduce feeds shortage. Smallholder dairy cattle farmers in Trans-Nzoia county though they produce large quantities of crop stovers low emphasis is given to treating them either physically or chemically and also rarely store them well.

2.5 Forage Conservation

Forage conservation across the world is a key element for productive and efficient ruminant livestock operations and it permits a better supply of quality feed when forage supply is low (Wilkinson et al., 2020). Forage is conserved as either hay from pastures or silage from fodders .Forage conservation is another coping strategy that farmers used in mitigating feeds shortage. Ogunade et al. (2018) in their study on the impact of the quality of silage material on animal health and food security in Europe found out that silage comprises about 55% of the total amount of conserved forage, but Germany, Denmark and Netherlands silage constitute about 90% of the conserved forages for use during those seasons when fresh forage is not available.

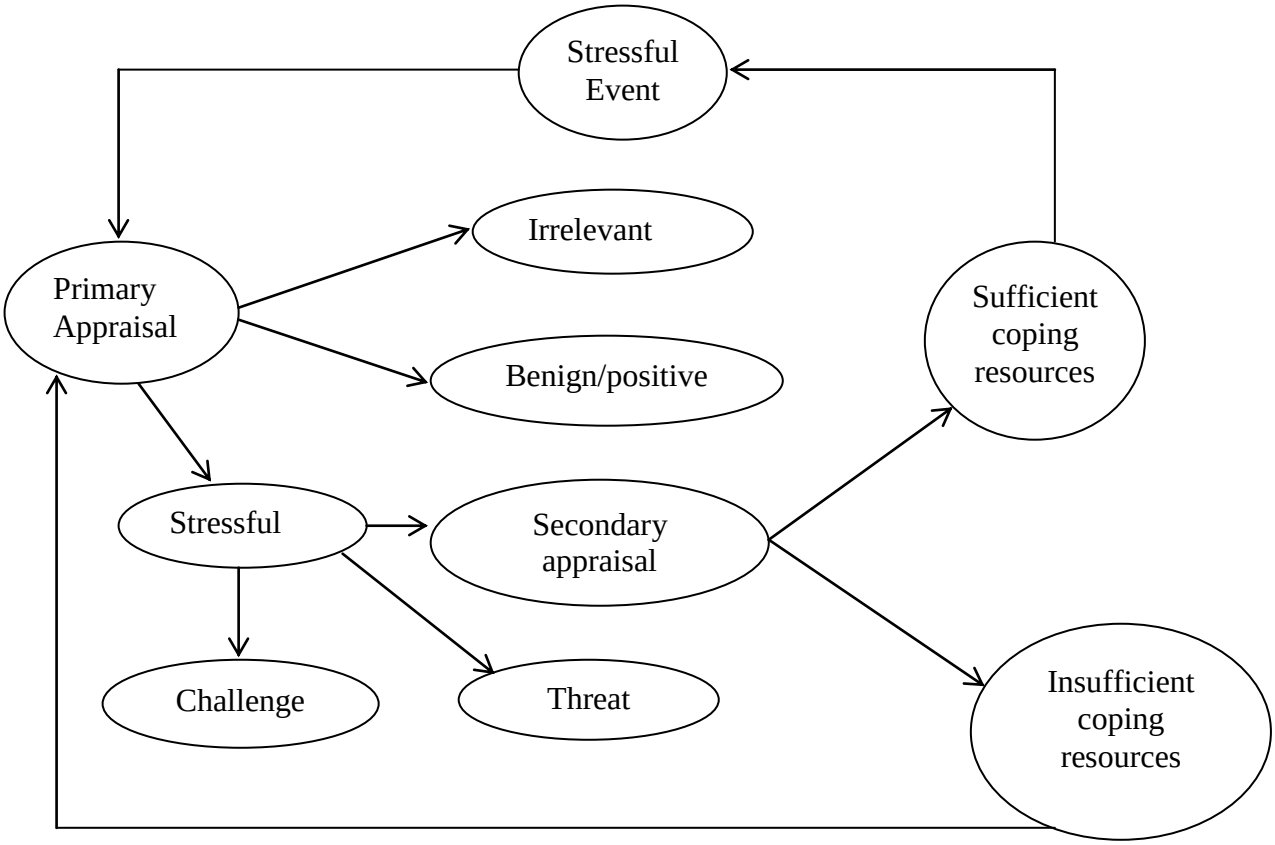
According to Harris et al. (2017) most European countries feeds availability is depended on conserved forages. Study by Tawab et al. (2020) found in Honduras that feeds availability can be maintained by using Maize silage. In Ethiopia farmers used silage and hay during feeds shortage (Mengistu et al., 2021). In a study done by Olorunnisomo and Adewumi (2015) on grass silage as conserved forage for cattle production in the humid parts of Nigeria they found that silage making as a strategy to address feeds scarcity it's poorly adopted. According to Dorcas et al.(2019) on the status of fodder conservation among smallholder dairy farmers in coastal Kenya found that only 37% conserve forage to mitigate against feeds scarcity and silage conservation was the least used (0.6%) practiced strategy despite farmers being trained. In Kenya feed shortage can be reduced by fodder conservation using cost effective methods (Ndambi et al., 2020). In addition during feed shortages farmers used conserved forage such as silage and hay. Farmers in Trans-Nzoia County have been exposed to forage conservation techniques but to what extent these technologies have contributed to address feeds shortage is not known.

2.6 Theoretical Framework

The underlying theory for the study is based on the Lazarus and Folkman (1984) Transactional theory of coping. The model describes the role of coping with stress and the process in which coping evolves. According to the model, coping is an interaction between a person and the environment, primarily that when an individual approaches a situation, a cognitive appraisal process begins to assess the level of threat and the available coping resources (Hewett et al., 2018). The theory consists of three stages namely primary appraisal, Secondary appraisal and Reappraisal as shown on the figure. The primary appraisal is a cognitive process, which decides whether you are being threatened, challenged or benefited that one is in trouble now or in future and in what way. Farmers consider feeds shortage for their dairy cattle as a threat. Once feeds shortage is appraised as threatening, challenging or harmful then the secondary appraisal is engaged. This addresses the question what if anything can be done about the threat. Here farmers look at the available resources and coping options such as using crop stovers and conserved forage to reduce the feeds shortage and assess their suitability and chances of success. Then selection of an appropriate coping strategy or strategies is done to address feeds shortage based on available resources. Finally, reappraisal occurs if the resources are not sufficient or available to implement a particular strategy or strategies from the primary appraisal stage.

Figure 1

Lazarus and Folkman (1984) Transactional Theory of Coping

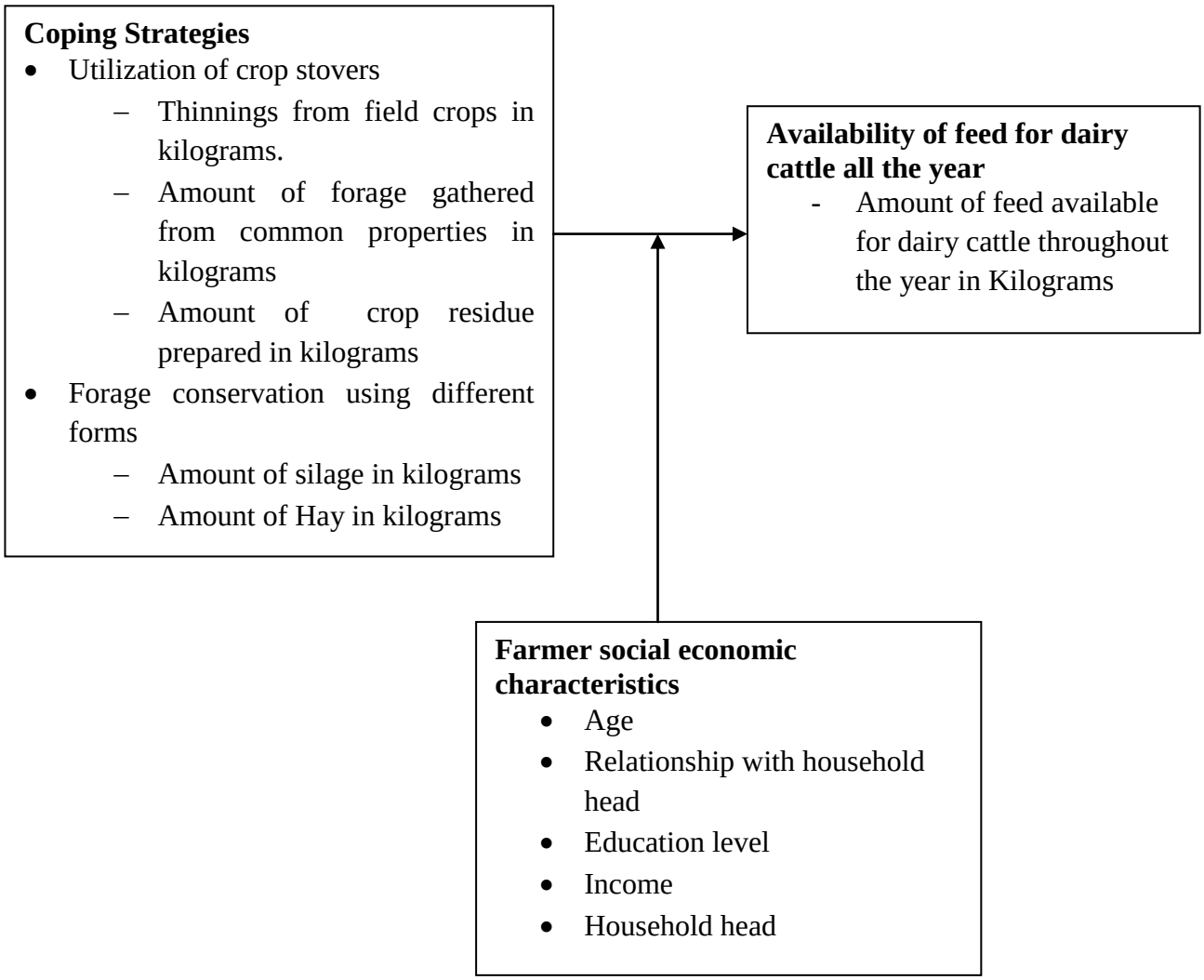


2.7 Conceptual Framework

The study conceptualises that if smallholder dairy cattle farmers take appropriate coping strategies then there could be availability of feeds for the stock all year round. The coping strategies form the independent variables for the study. The independent variables include utilization of crop stovers and forage conservation using various forms. Availability of feeds forms the dependent variable. However, farmer social economic factors are likely to integrate with the coping strategies to influence feeds availability for livestock. Social economic factors are social and economic experiences and realities that help mould one's personality attitude and lifestyle. They include age, education, income and occupation (Chand & Biradar, 2017). Farmer social economic characteristics that were considered are the age, level of education, relationship of responded to the household head and income. The influence of the moderator variable was controlled by incorporating them into the study.

Figure 2

Conceptual Framework



CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The chapter covers specific procedures that were used during the study. It contains the research design, study location, study population, sampling procedures and sample size, instrumentation, validity, reliability, data collection procedures, data analysis and summary of data analysis.

3.2 Research Design

The study used a cross-sectional survey design. The design was used because according to Frankel and Wallen (2000), it described the characteristics the population under study. The design is also economical and relatively quick in data collection. The disadvantage of this design is that respondents tend to give socially desirable responses that make them look good to the researcher, inability to make inferences at the level of cause-effect as in experimental and quasi-experimental designs (Hagan, 2000). These limitations were overcome by randomly selecting the sample size as recommended by Kathuri and Pals (1993). In addition, reactivity was dealt with by letting the responds aware why they were participating in research and the need to be honest in their responses since the findings may be used by the government in helping them solve their problems related to dairy farming.

3.3 Location of the Study

The study was done in Trans-Nzoia County. The county is located between Mount Elgon and Nzoia River and the headquarters is located at Kitale town. The County borders Uasin Gishu to the East, Uganda to the West, West-Pokot to the North and Bungoma County to the South. It's located at latitude $0^0 52`$-$1^0$ 18`S and longitude$34^0$ 38`-3523`E.

The County has an area of about 2460 $km^2$with a bimodal rainfall pattern that ranges between 950mm to 1250mm annually. The altitude ranges between 1000 meters to 1700 meters above sea level. The County has three ecological main zones which are: Upper Humid (UH), Upper Midland (UM) and Tropical Alpine (TA). The County in cosmopolitan with nearly all tribes of Kenya but the dominant community is the Luhya.

A number of companies such as Kenya seed, Western seed, Elgon tea factory, Kapsara tea factory, New Kenya Cooperative Creameries (KCC), and various government institutions provide employment to many people living in the urban areas.

The County arable land makes agriculture the top economic activity, where maize is widely practiced at commercial level. Other crops include wheat, coffee and beans. Commercial business is also very significant to the county's economy. There's dairy farming and tourism due to an array of touring sites. Dairy cattle enterprise is the second most popular enterprise to maize. Other animals found in the County include poultry, bees, pigs, sheep and goats. The soils are predominantly humic ferrasols (Mbula et al., 2019).

3.4 Target Population

Trans-Nzoia County has a population of 990,341 people (Kenya National Bureau of Statistics, 2018). According to smallholder Dairy Commercialization Programme appraisal report (International Livestock Research Institute [ILRI], 2006), the percentage of dairy farmers in relationship to the population is 3.8% in Trans-Nzoia County (which was formerly the larger Trans–Nzoia district) and smallholder dairy farmers constitute 80% of the Dairy farmers (KALRO, 2017). Based on this there are 31,113 dairy cattle farmers and 24,890 smallholder dairy cattle farmers. Therefore, the target population is 24,890-smallholder dairy cattle farmers and the accessible population is 13,971 smallholder dairy cattle farmers found in the three wards for the study as shown on the Table 1.

Table 1

Accessible Population for the Study Area

Ward	Waitaluk	Kaplamai	Kwanza	Total
Number of Dairy Farmers	7452	4501	5511	17,464
Number of Smallholder Dairy Farmers	5962	3600	4412	13,972

3.5 Sampling Procedure and Sample Size

The researcher obtained a list of the names of smallholder dairy cattle farmers from the ward Livestock Extension Officers (WLEO) from each ward. The three wards Waitaluk, Kaplamai and Kwanza were purposively selected because little research work had been done in the area. The lists obtained constituted the sampling frame from which a sample of121 smallholder dairy cattle farmers was selected. According to Kathuri and Pals (1993) and Borg and Gall (2003), the minimum sample size should be 100 respondents for major sub-groups and 20-50 respondent for each minor sub-group. The extra 21 dairy cattle farmers were added

to cushion against non-responses. Proportionate stratified random sampling was used to get a sample size of 121 smallholder dairy cattle farmers from the wards as shown in Table 2. According to Kothari (2003) this has the advantage of accurately reflecting the characteristics of a population when the population to be sampled is not homogenous in certain required characteristics and eliminates bias as it gives all individuals a chance to be chosen. This also ensured equitable and proportionate representation of the population in the sample and avoided over-representing or under-representing some strata. The proportionate stratified random sampling ensured that no sub-group is omitted from the sample and avoid overloading in certain sub-population (Borg & Gall, 2003).

Table 2

Sample Size per Location

Ward	Number of Smallholder dairy Cattle farmers	Proportion Sample	Proportion Sample per Location
Waitaluk	5962	0.4267	51
Kaplamai	3600	0.2577	31
Kwanza	4412	0.3157	39
Total	13972	1.000	121

3.6 Instrumentation

Data collection was done using a researcher administered questionnaire. The items in the questionnaire were based on the objectives of the study. The instruments were constructed by the researcher with consultations from supervisors in the department of agricultural education and extension. The variables that guided the development of the instrument were the crop stovers preparation strategies and forage conservation strategies that formed the independent variables which were investigated. The indicators for crop stovers that were investigated are amounts of thinning from field crops, amount of forages from common properties, amount of crop residues prepared. The indicators for forage conservation strategies that were investigated were amounts of hay and silage. The indicators for availability of feeds that is the dependent variable were the amount of feeds available to the stock the whole year. The instrument was appropriate in collecting information from farmers with low levels of literacy as it allowed for clarification of any ambiguity and did not discriminate against the less articulate respondents. The instrument was also used because it was easy to administer and score the responses.

3.6.1 Validity

Validity is the extent to which the instruments accurately measure what they intend to measure in a study (Goldsack et al., 2020). There are various types of validity, including construct, face, internal, external, content, criterion/ predictive, concurrent among others. In this study, face, content and construct validity were determined. Face, construct and content validity of the research instruments were determined by research experts drawn from the department of agricultural education and extension of Egerton University.

3.6.2 Reliability

Reliability is a measure of the degree to which a research instrument for example a questionnaire yields consistent result or data after repeated trials (Miller, 2011). In this study, reliability of the instrument was done by carrying out pilot testing in Kimilili ward of Kimilili Sub-county in Bungoma County. Kimilili is a neighbouring Sub County to the study area and shares common characteristics. Pilot testing procedures were identical to those that were used during the actual data collection as recommended by Mugenda (2008).

Kathuri and Pals (1993) recommended the sample size for pilot testing to be between 25 and 50. In this study a sample of 30 smallholder dairy cattle farmers with similar characteristics to those in the study location were used. This helped the researcher to see whether the responses fulfil the objectives of the investigations.

Reliability refers to the extent to which a research instrument consistently produces the same results if it is used in the same situation on repeated occasions (Heale & Twycross, 2015).The reliability of the research instruments was tested using the Cronbach alpha coefficient. A pilot study was carried out to ensure there are no wide variations in the manner in which the responses were given. A reliability coefficient of 0.80 was obtained. Since that was above the 0.7 reliability threshold for accepting the instruments; the instrument were then used to collect data.

3.7 Data Collection Procedure

After meeting the requirements from Egerton University graduate School to collect data the researcher got a permit from National Council of Science and Technology authorizing data collection. Thereafter the local administrators from Provincial administration and livestock offices were informed of the data collection exercise. Then the ward officers were visited from where the farmers were contacted and the researcher administered the

questionnaire in the field on an arranged schedule. In situations where farmers did not honour the appointment, a repeat visit was re-arranged.

3.8 Data Analysis

After data collection, editing, coding, classification and tabulation were done. This involved arranging data in groups or classes based on common characteristics. Statistical package for social sciences (SPSS) version 25 was used in organizing the data. Analysis was done using both descriptive statistics and inferential statistics. Descriptive statistics gave the results in frequencies, percentages and standard deviation while inferential statistics was used to test the hypotheses in order to determine the influence of independent variable on dependent variables. Regression and correlation analysis was used to test the hypotheses. The null hypotheses were tested at 0.05 significance level. This helped to show how crop stovers preparation strategies and forage conservation influenced availability of feeds among smallholder dairy farmers.

Table 3

Summary of Data Analysis

Hypothesis	Independent variable	Dependent Variables	Statistical procedures
H01: Crop Stovers preparation strategy has no statistically significant influence on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County	Preparation of crop stovers	Availability of feeds for dairy cattle all the year round. (Quantities of feeds available in kilograms)	Regression analysis
H02: Forage conservation strategy has no statistically significant influence on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County	Forage conservation forms	Availability of feeds for dairy cattle all the year round. (Quantities of feeds available in kilograms)	Regression analysis

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This study examined the influence of selected coping strategies on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County. The chapter presents results based on the objectives of the study. The issues analyzed and discussed include a summary of the characteristics of the smallholder dairy cattle farmers who participated in the study, determine the type of feeds available among smallholder dairy cattle farmers in Trans-Nzoia County, determine the influence of crop stovers preparation strategy on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County and determine the influence of forage conservation strategy on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County.

4.2 Characteristics of the Respondents

The study examined the characteristics of the smallholder dairy cattle farmers who took part. This was deemed necessary for the characteristics of respondents that were considered to have a relationship with coping strategies on availability of feeds among smallholder dairy farmers. The sets of the farmer characteristics that were examined included gender, age, level of education, types of dairy cattle, dairy production system practiced, number of dairy cows owned by smallholder dairy farmers and sources of income.

4.2.3 Gender of Smallholder Dairy Cattle Farmers

Data on gender of the smallholder dairy cattle farmers was analysed. This was important because gender has an influence in agriculture related enterprises. Table 4 contains a summary of the farmer ages.

Table 4

Gender of the Smallholder Dairy Cattle Farmers

Gender	Frequency	Percentage
Male	79	65.3
Female	42	34.7
Total	121	100.0

Results on Table 4 shows that there were 65.3 % male while 34.7 %female who were involved in smallholder dairy cattle farming. This agrees with Njuki and Sanginga (2013) on their study on women, livestock ownership and markets which shows that dairy cows are an asset for both rural men and women in East Africa and women own fewer productive exotic or hybrid breeds than men do. The finding also concurs with that of Belay and Oljira (2016), who found that men constitute 57 % while women constitute 43 %in agricultural activities in a study done in Ethiopia. There are fewer women in dairy farming than men likely because men probably are the main decision makers and women own fewer resources to invest (Bjornlund et al., 2019). This can also be attributed to gender roles in the community where men do rigorous work while women do light work. The smallholder dairy cattle farmers were asked their age and from their responses the results are tabulated be in Table 5.

4.2.4 Age of Smallholder Dairy Cattle Farmers

The smallholder dairy cattle farmers were asked their age. From their responses, the results are given in Table 5.

Table 5

Age of Smallholder Dairy Cattle Farmers

Age	Frequency	Percentage
30 years and below	7	5.8
31-40	43	35.5
41-50	35	28.9
Above 50 years	36	29.8
Total	121	100

Results on Table 5 shows that (35.5%) of the farmers were in the age category of 31-40 years 50 years and above (29.8%), between 41-50 years category were 28.9 %. while the age category of 30 years and below were (5.8%).This may mean that most active smallholder dairy cattle farmers within the community were in the age category of 31-40 years and are willing to take risks on new ideas to produce enough to feed their families. This agrees with study done by Sharma (2016) on the effect of age and educational level of dairy where farmers who were 30 years and below were 20%, between 30-40 years were 32.5% and those who were 40 years and above were 47.5%. In addition, Sharma noted that the young age farmers are not interested in performing agricultural related activities because of low

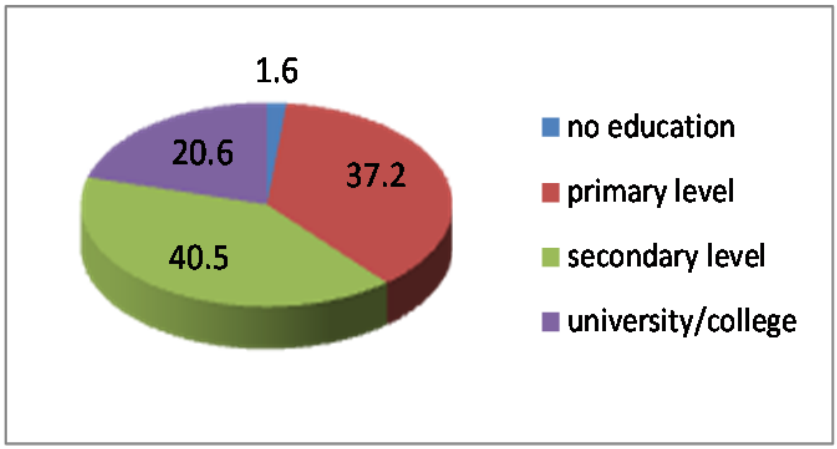
profitability, high initial investment capital and high labour-intensive tasks particularly at small level in the village.

4.2.5 Education Level of Smallholder Dairy Cattle Farmers

The smallholder dairy cattle farmers were asked their highest level of education. From their responses, the results are given in figure 3.The farmers levels of education were divided into four categories. The categories were those without any formal of education (no education), primary level, secondary level and University or college education.

Figure 3

Level of Education among Smallholder Dairy Cattle Farmers



Information on education is important because in theory education is supposed to improve productivity in all spheres of activities including agriculture (Ninh, 2021) .It's expected that a more educated farmer will be aware of the coping strategies that influences feeds availability and be able to utilize them. Education improves access to information, new ideas and may make a farmer more receptive to advice from extension agents and be able to deal with technical recommendations that require certain level of numeracy or literacy (Elemineh et al., 2020).

From Figure 3, the respondents with secondary education were (40.5%), primary level (37.2%), university or college education level (20.6%)and those without any formal education was(1.7%).This was probably because those with secondary and primary education consider dairy cattle farming as their main occupation while those with no formal education might not be aware of dairy cattle as an occupation while those with university or college level education might not be keen on dairy cattle farming as an occupation. However, a

combination of secondary and university education was 61.1%. This implies that a farmer with secondary and university education have a better knowledge and skills in relation to dairy production. The primary and secondary education holders constituted 77.7% implying that these farmers had more emphasis on dairy farming than those with both university and secondary education. The individuals with university and secondary education have other specialization that makes them earn income compared to those farmers with primary and secondary education. The results concurs with studies that were done by Kiptotet et al.(2015) on preference and adoption of livestock feed practices among farmers in dairy management groups in Kenya where those farmers with primary, secondary and university education levels, those with secondary education being the high adopters. Further Paltasingh and Goyari (2018) found out in Bangladesh that farmers with primary and secondary education levels had a significant effect on agricultural productivity than those without any formal education and university education level. Abdulai and Huffman (2014) also found a positive relationship between education level of farmers and impact of soil and water conservation technology. Studies on farm household efficiency in Bangladesh found no positive relationship with farmer level of education (Afrin et al., 2017).A study by Euler et al.(2016) found a negative relationship between farmers education level and farm efficiency on their studies on assessing the performance of nucleus estate and smallholder scheme for oil palm production west Sumatra.

4.2.6 Other sources of Income

The smallholder dairy cattle farmers were asked if they had other sources of generating income apart from dairy. Their responses are summarized in Table 6.

Table 6

Responses on whether the Farmers had other sources of Income

Have other sources of income	Frequency	Percentage
Yes	52	43
No	69	57
Total	121	100

From the results in Table 6, it shows that dairy farming was the main source of income for the smallholder dairy cattle farmers as it accounted for 57% while other sources of income accounted for 43% percent. This can probably be due to farmers taking dairy farming

as their main source of income while those with other sources of income do not have enough time to engage in farming.

The smallholder dairy cattle farmers were asked whether they had other sources of income. From their responses, the results are given in Table 7.

Table 7
Other Sources of Income

Other sources of Income	Frequency	Percentage
Employment	24	46.2
Business	28	53.8
Total		100.0

Table 7 reveals that majority (53.8%) of the farmers that had other sources of income were in business while the rest (46.2%) were employed. These results imply that engaging in business is the most popular alternative source of income besides dairy farming.

The results on in Tables 6 and 7 demonstrate that the main source of income of the smallholder farmers was dairy. This concurs with studies by Furey et al.(2016) which found out that agricultural enterprises constitute about 60% of the total income for farmers while the other sources accounted for 40%. Also a report by ILRI (2014) shows that in Senzi ward of Marani sub County, Kenya, the main income for smallholder dairy farmers was dairy farming accounting for 42%, while cash crops accounted for 40% and others12%. However work done by Nedela et al. (2009) in their study on dairy farming an alternative income generation activity in Chittagong division of Bangladesh they found out that income from dairy farming was not the highest as it came out that vegetable farming accounted for 26% of their income, dairy farming and poultry accounted for 23% each, bamboo works and handicraft accounted for 16 % and weaving 12 %.

4.2.7 Dairy Production System Practiced

Farmers were asked the type of dairy production system they practised. From the results as shown on Table 8.

Table 8

Dairy Production System Practiced

System	Frequen	Percentage
Zero grazing	18	14.9
Semi Zero grazing	84	69.4
Free range	19	15.7

The results indicate that 69.4% of farmers practiced semi zero grazing production system, followed by those who practiced free range system production system (15.7%) and lastly those with zero grazing production system (14. 9 %).

Free range production system farmers graze their animals on public or private pastures during the day and keep them within the homestead at night, in zero grazing production system the animals are confined in a limited physical space, farmers provide the animals with feeds and water while semi zero is a combination of the two (ILRI, 2014).Semi zero production system is more popular than zero grazing system perhaps because of it's low capital investment and labour requirement (Nalubwama et al., 2019). Free range is also more popular than zero grazing because it's also less costly as the animals graze freely and no structures are constructed.

Work done by Lukuyu et al. (2019) in their study on farmers' perception of dairy breeds, breeding and feeding strategies; a case study of smallholder dairy farmers in Western Kenya found out that 79.6 % preferred free range/free grazing system, 13.6 % preferred semi zero grazing system and 6.8 % practiced zero grazing system. They attributed this to free grazing being the least in terms cost than semi zero grazing and zero grazing systems.

4.2.8 Types of Dairy Cows Owned by the Farmers

The smallholder dairy cattle farmers were asked the types of cows they owned. From their responses, the results are given in Table 9.

Table 9

Types of Dairy Cows Owned by the Farmers

Type	Frequency	Percentage
Exotic	9	7.4
Dairy Crosses	112	92.6

From the results, it came out that 92.6% kept dairy crosses while 7.4% kept dairy exotic breeds. This is consistent with Koskei et al.(2020) who established that dairy crosses cows are more popular in Rift Valley which includes Trans Nzoia County. Also it concurs with studies by Kiptot et al.(2015) on preference and adoption of livestock feed practices among farmers in dairy management groups who found out that 92% of farmers kept cross breed dairy cows while 8% had exotic breeds in central Kenya, north rift and south rift regions of Kenya. However a study by Khan et al.(2013) in Mymensingh district a selective rural in Bangladesh in their study on management and production system found out that 85.4 % of smallholder dairy farmers had dairy crosses while 14.6 % had indigenous cows but there were no farmers who had exotic breeds.

4.2.9 Number of Dairy Cows Owned by Smallholder Dairy Farmers

The respondents were asked how many dairy cows they kept. Their responses are summarized in Table 10.

Table 10

Number of Dairy Cattle Owned by Smallholder Dairy Farmers

Number	Frequency	Percentage
1-3	63	52.1
4 – 6	54	44.6
7 – 10	4	3.3

The results indicate that the number of animals owned by the farmers ranged from 1 and 10. Those with 1 to 3 animals were 52.1 %, 4 to 6 animals were 44.6 % and those with 7 to10 animals were 3.3 %. The findings support those of a study by Sembada et al. (2018) in west Java, Indonesia on improved milk production performance of smallholder farms found out that smallholder farmers kept 3-4 dairy cows.

4.3 Analysis of the Objectives

The section focuses on the analysis of the results obtained in relation to the objectives

4.3.1 Objective 1: Feeds Availability among Smallholder Dairy Cattle Farmers in Trans Nzoia County

4.3.2 Sources of feed

The farmers were asked the sources of their feeds and the results are given in Table 11.

Table 11

Sources of Feeds

Source	Frequency	Percentage
Own farm	120	99.2
From community land	93	76.9
Gift (neighbor, relative)	19	15.7
Bought	62	51.2

From the results obtained in Table 11, it shows that there was a concurrence of 99.2 percent that the farmers got feeds from their own farm, a concurrence of 76.9 percent from community land, a concurrence of 51.2 percent bought their feeds and a concurrence of 15.7 percent got their feeds as gifts. From Table 11 the percentages do not add up to 100 percent because the farmers have more than one source of feeds. This agrees with Odero (2017) who found that a large percentage of smallholder dairy cattle farmers get their feeds from their own farms, followed by common sources and lastly others bought feeds for their animals. This also compares well with Njonge (2017), who on his studies on challenges faced by smallholder dairy farmers in Kirinyaga County, Kenya found out that 58 percent of dairy farmers got their animal feeds from their farms, 27% were buying,8 percent from others and 5 percent from neighbours.

4.3.3 Types of Feeds Used by Smallholder Dairy Cattle Farmers

The farmers were asked the types of feeds they use on their farms. The results obtained from the respondents are presented on Table 12.

Table 12

Types of Feeds used by the Dairy Farmers

Feed	Frequency	Percentage
Forage (pasture, fodder)	119	98.3
Hay	62	51.2
Silage	45	37.2
Crop stovers	94	77.7
Cereal by-products (maize germs, wheat and maize bran)	26	21.5
Legume crops (sweet potato, calliandra)	18	14.9
Non protein, nitrogen sources (urea, poultry litter)	14	11.6
Supplements (fishmeal, salt, vitamins, concentrates)	109	90.1
Others	5	4.1

From Table 12 it shows that there was a concurrence of 98.3%who used forage, a concurrence of 90.1% gave supplements to their cattle, a concurrence of 77.7% used crop stovers, a concurrence of 51.2 % used hay, a concurrence of 37.2% used silage, a concurrence of 21.5 percent used cereal by products, a concurrence of 14.9% used legume crops and a concurrence of 11.6% used Non protein nitrogen sources. From the above results, the percentages do not add up to 100 %because the smallholder dairy cattle farmers use more than one type of feed. This is consistent with Feyissa and Kebende (2018), who on their study on feed availability, conservation practices and utilization in selected milk shades in the central highlands of Ethiopia found that natural pastures (forages) were the dominant livestock feed. However, crop stovers in the central highlands of Ethiopia were more popular than supplement feeds as the region mainly grows crops. This concurs with Waweru and Paul (2021) who on their study on farming systems and forage cultivation in western Kenya and Ethiopia baseline survey report found out that 60 % of farmers in Kenya cultivated and feed their animals with forages while Kakamega County it stands at 50%. This suggests that forage is the main feed for dairy cattle.

4.3.4 Feeds Availability Levels during Dry and Wet Seasons

The smallholder dairy cattle farmers were asked rate feeds availability during the rainy and dry seasons. The rating was based on a three points scale (high = 3, medium =2, low =1). The results obtained are presented as percentages on Table 13.

Table 13

Feeds Availability Levels per Season

Feed	n	Rainy season			n	Dry season		
		High	Moderate	Low		High	Moderate	Low
Forage (pasture and fodder)	119	31.9	50.5	17.6	118	2.5	26.3	71.2
Hay	119	11.8	51.2	37.0	118	7.6	32.2	60.2
Silage	118	15.3	33.9	50.8	121	-	4.1	95.9
Crop stovers	121	4.1	36.4	59.5	121	5.0	48.8	46.2
Cereal by-products (maize germs, wheat, maize brans)	118	0.9	11.0	88.1	117	2.6	27.1	70.3
Legume crops (sweet potato, calliandra)	116	0	4.3	95.7	118	1.7	15.2	83.1
Non protein, nitrogen sources (urea, poultry litter)	117	-	14.5	85.5	116	5.2	19.0	75.8
Supplements (Fishmeal, vitamins, salt, concentrates)	119	25.2	45.4	29.4	115	20.0	22.6	57.4

The results show that during the rainy season 31.9 %of the respondents said forage availability was high, 50.5% said it was moderate and 17.0% said it was low. For Hay 11.8 % of the respondents said its availability was high, 51.2 % said was medium and 37 %said it was low. From Table 13 for silage 15.3% of the respondents indicated that silage availability was high, 33.9% said it was medium and 50.8 %said its availability was low. With crop stovers 4.1% of the respondents said its availability was high, 36.9 % said it was medium and 59.5 %said it was low. In the case of cereal by products 0.9 %of the respondents said their availability was high, 11%said their availability was medium and 88.1 %said their availability was low. From Table13, 4.3% of the respondents said legume crops availability was moderate and 95.7 % said they were low in availability. For Non-protein nitrogen sources 14.5% of the respondents indicated that they were of moderate availability and 85.5 % of low availability while for supplements 25.2 % of the respondents indicated that they were high in availability, 45.4% said moderate and 29.4 %low in availability.

During the dry season as shown on Table 13 2.5% of the respondents said forages availability were high, 26.3 %said they were moderate and the majority who were 71.2 %said were low in availability. It can be observed from table 13that for hay 7.6 %of the respondents indicated that its availability was high, 32.2 %said it was of medium availability and 60.2 %, who were the majority said it was low in availability. For silage 4.1%of the respondents said it was moderate in availability and 95.9 %who the majority were indicated it was low in availability. Also during the dry season 5 % of the respondents indicated that crop availability was high, 48.8 % stated that crop stovers availability was moderate and 46.2 % said availability was low while for cereals by products 2.0 % of the respondents said they were high in availability, 27.1%said they were moderate in availability and the (70.3%) said they were low in availability. In the case of legume crops 1.7% of the respondents said their availability was high, 15.0 % indicated they were medium in availability and the (83.1%) said they were low in availability. For Non-protein Nitrogen sources 5.2 % of the respondents said they were high in availability, 19%said they were moderate in availability and 75.8%said they were low in availability. In the case of supplements 20 %of the respondents indicated they were high in availability, 22.6 % said they were medium in availability and the (57.4%) said they were low in availability.

Therefore, cereal by-products, legumes and non-protein were not available during the rainy and dry season. Given that supplements and forage was available by at least 25%, farmers should do more conservation during the rainy season to ensure constant feeds availability. In addition, silage was low during the rainy and dry season. Farmers should be taught how to grow and manage crops for silage or choose alternative feeds that are available during the dry and rainy seasons. Forages availability was high during the rainy season (31.9%) than the dry season (2.5%). This is likely because during the rainy season there was enough water which encouraged forages growth than during the dry season. This concurs with Younis' (2021) study on climate change and its impact on livestock, which found out that water scarcity, reducesthe quantity and quality of forage crops as livestock feed. For hay its availability was high (11.8%) during the rainy season than the dry season was (7.6%). This could be due to more forage being available during the rainy season for conservation. However 37% of the respondents said its availability was lower during the rainy season while 60.2% said it was much lower during the dry season. This can be attributed to lower conservation for hay during the rainy season and high during dry season.

4.3.5 Feeds Availability Index

From the feeds availability raw data it was converted to feed availability index that are given below on Table 14.

Table 14

Feeds Availability Index (Maximum 3)

Feed	Rainy season		Dry season season	
	Mean	SD	Mean	SD
Forage (pasture and fodder)	2.14	0.69	1.31	0.52
Hay	1.75	0.65	1.47	0.64
Silage	1.64	0.73	1.04	0.20
Crop stovers	1.45	0.58	1.59	0.59
Cereal by-products (maize germs, wheat, maize brans)	1.13	0.36	1.22	0.48
Legume crops (sweet potato, calliandra)	1.04	0.20	1.19	0.43
Non protein, nitrogen sources (urea, poultry litter)	1.15	0.35	1.29	0.56
Supplements (Fishmeal, vitamins, salt, concentrates)	1.96	0.74	1.63	0.80
Feeds availability index	1.50	0.25	1.31	0.20

The overall feeds index (rainy and dry season combined) 1.50 (SD = 0.25). In reference to feeds availability index, forage, hay and supplements were in abundant during dry and rainy season. However, since the feeds availability during the rainy season was higher (1.5) compared to dry season (1.31). Therefore, the farmers should put focus on more feeds conservation in the rainy season.

4.3.6 Differences in Feeds Availability by Season

Table 15 shows the difference in means and standard deviation on feeds availability by season.

Table 15

Differences in Feeds Availability by Season

Season	N	Mean	SD	Df	t-value	p-value
Rainy	115	1.50	0.25	231	6.357	.000*
Dry	121	1.31	0.20			

The results in Table 15 indicate that the availability of feeds means (M = 1.50, SD =0.25) of the rainy season was higher than that (M = 1.31, SD = 0.20) of the dry season. The results further indicate that the difference between the two means is statistically significant at .05 level, t(231) = 6.357, p>.05. This means that although the feeds are available to farmers throughout the seasons they are generally low, its availability is lower during the dry seasons. This agrees with studies done by Makau et al. (2020)on availability and use of dry season feed resources on smallholder dairy farms in central Kenya, who found that most smallholder dairy cattle farmers experience feeds shortage even during the rainy season and the situation is more severe during the dry season when animals are underfed and often malnourished.

4.4 Objective 2

The second objective was to investigate the influence of crop stovers preparation strategy on availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County.

4.4.1 Sources of Crop Stovers

The smallholder dairy cattle farmers were asked to state the sources of their crop stovers. From their responses the results are shown on Table 16.

Table 16

Sources of Crop Stovers

Source	Frequency	Percentage
Own farm	115	95.0
Gift (neighbour, friend, relative)	12	9.9
Bought	32	26.4

From the results in Table16, it shows that there was a concurrence of 95.0 % of the farmers got their crop stovers from their own farms, a concurrence of 26.4% of the farmers

bought crop stovers and a concurrence of 9.9% of the farmers got from their neighbours. The percentages do not add up to 100% because the farmers had more than one source of crop stovers.

4.4.2 Types of Crop Stovers

The smallholder dairy cattle farmers were then asked the type of crop stovers that they use. From their responses the results are tabulated in Table 17.

Table 17

Type of Stovers

Type	Frequency	Percentage
Green maize thinning	48	39.7
Sweet potato vines	27	22.3
Banana residues (leaves, stem)	31	25.6
Maize stovers	101	83.5
Maize cobs	87	71.9
Beans straws/haulms	28	23.1
Weeds	31	25.6
Wheat straws	27	22.3
Millet	19	15.7
Sorghum	22	18.2
Forages from communal land	38	31.4
Others	7	5.8

Results in Table 17 shows that there was a concurrence of 83.5% of the farmers who used maize stovers, a concurrence of 71.9 % of the farmers who used maize cobs, a concurrence of 39.7 % of the famers who used maize thinning, a concurrence of 31.4 % of the farmers who got from forage from common properties, a concurrence of 25.6 % each of the farmers who used both banana residues (leaves, stem) and weeds, a concurrence of 23.1 % of the farmers who used bean straws/haulms, a concurrence of 22.3 % of the farmers each who used sweet potato vines and wheat straws, a concurrence of 18.2 % of the farmers who used sorghum, a concurrence of 15.7 % of the farmers who used millet and a concurrence of 5.8 % of the farmers who used other types of crop stovers. The percentages do not add up to 100 % because the farmers used more than one type of crop stover. The mostly used crop stovers was maize stovers (83.5%) while millet was the least used crop stover. This could be because

of farmers growing maize in most of their farms because it's a stable food in Kenya. Millet is less popular crop since it is perceived to have less economic value to most farmers thus making its availability for animals to be low.

This results compares well with studies by Möller (2018) on availability and use of dry season feed resources on smallholder dairy farms in central Kenya found out a concurrence of 100% of farmers used maize stovers, a concurrence of 98% of farmers used banana leaves and pseudo stems, a concurrence of 51% of the farmers used weeds and a concurrence of 22% of the farmers used sweet potato vines.

4.4.3 Quantity of Crop Stovers Prepared by Season

The farmers were asked the quantities of crop stovers they prepared during the rainy season and dry season. The computed totals are given in Table 18.

Table 18

Quantities of Crop Stovers prepared by Season

Crop stovers product	Quantity prepared in Kilogrammes	
	Rainy season	Dry season
Green maize thinning	252,180	15
Banana residue (peels, leaves, pseudo stems),	47,665	87,425
Sweet potato peels/ vines	13,522	19,625
Forage from common properties	368,125	61,880
Irish potato peels	140	250
Maize stovers	8,250	325,410
Maize cobs whole	20	1000
Wheat straw/haulm	15	150
Bean straw/haulm	2,310	15,850
Weeds	115,580	600
Crushed maize stovers	14,110	185,610
Crushed treated (with urea and molasses) maize stovers	1,200	54800
Crushed maize cobs	415	10700

The results in Table 18 shows that farmers prepared 368,125 Kilograms of crop stovers forage from common properties as the largest quantity during the rainy season, they prepared 252,180 Kilograms of green maize thinning, they collected 115,580 Kilograms of weeds,47, they prepared 665Kilogramsof banana residues, they prepared 14,110 Kilograms of crushed maize stovers ,they collected 8250 Kilograms of maize stovers whole, they prepared 1200 Kilograms of crushed maize stovers treated with urea and molasses, they prepared 2310 Kilograms of bean straws/haulms, they prepared 415 Kilograms of crushed maize cobs, prepared 140Kilograms of Irish potatoes peels, they collected 20 Kilograms of whole maize cobs and they didn't prepare any wheat straws. From the results farmers prepared more forages from common properties, maize thinning and weeds during the rainy season because probably because they were in plenty. However during the dry season the farmers prepared 325,410 Kilograms of maize stovers as the largest quantity. This is because most probably maize stovers were readily available to farmers after maize harvesting during the dry season. Then they also prepared 185,610 kilograms of crushed maize stovers, they prepared 87,425 kilograms of banana residues, they prepared 61880 kilograms forages from common properties, they prepared 54,800 kilograms of crushed maize stovers treated with urea and molasses, they prepared 19,625 kilograms forages from sweet potato vines and peels, they prepared 15,850 kilograms of forages from bean straws/haulms, prepared 10,700 kilograms of forage from crushed maize cobs,100kilogrammes from whole maize cobs, 600kilogrammes from weeds 250 kilograms from Irish potato peels and they prepared15kgwheat straws and green maize thinning. Wheat straws are not common as the smallholder dairy farmers rarely engage in wheat farming. Green maize thinning are also rare during the dry season as this is off-season for maize growing.

4.4.4 Difference in Quantities of Crop Stovers Prepared by Season

A test was conducted to find out whether there were difference in quantities of crop stovers prepared by season. Table 19 shows the difference in means and standard deviation on quantities of crop stovers prepared by season.

Table 19

Difference in Quantities of Crop Stovers Prepared by Season

Season	N	Mean	SD	Df	t-value	p-value
Rainy	121	13024.52	5061.53	240	3.308	.001
Dry	121	11028.82	4291.67			

From Table 19 it indicates that the mean (M = 13024.52, SD = 5061.53) quantity of crop stovers prepared during the rainy season was higher than that (M = 11028.82, SD = 4291.67) of the dry season. The results further indicate that the difference between the two means was statistically significant at .05 level, t (231) = 6.357, p>.05. This means that smallholder dairy cattle farmers have a tendency of preparing larger quantities of crop stovers during the rainy seasons.

4.4.5 Regression Test results between Quantity of Stovers and Availability of Feeds during the Rainy season

The influence of preparation of crop stovers on availability of feeds was established using simple linear regression. It involved regression the quantity of crop stover products prepared during the rainy and dry seasons combined and the feeds availability index. The results of the regression test are in Table 20.

Table 20

Regression Test Results between Quantity of Stovers and Availability of Feeds during the Rainy season

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
(Constant)	1.471	.042		35.247	.000
Quantitity of stover products prepared during rainy season	-5.054E-006	.000	-.153	-1.692	.093
$R = -.153$, $R^2 = .023$, $F(1, 119) = 2.861$, $p > .05$					

The result of the regression test in Table 20 reveals that the relationship between crop stovers preparation during rainy and feeds availability was negative (r = -.153, p >.05. This means that farmers prepare less crop stovers during rainy season. In addition, quantity of stovers and availability of feeds explained a small proportion of variance in production of rain season. R^2 =0.023, F (1.19) = 2.861. Hence, only 2.3% of the total feeds availability could be explained by quantity of stovers. That meant that 97.7% of feeds availability was determined by other factors a part from crop stovers. Further analysis was conduct to for the dry as shown in Table 21.

Table 21

Regression Test Results between Quantity of Stovers and Availability of Feeds during the Dry season

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
(Constant)	1.470	.042		35.248	.000
Quantity of stover products prepared during dry season	-5.868E-006	.000	-.151	-1.665	.099
$r = -.151$, $R^2 = .023$, $F(1, 119) = 2.771$, $p > .05$					

Table 21 shows that the relationship between the quantity of crop stovers prepared during the dry season and feeds availability was negative but not statistically significant at the .05 level ($r = -.151$, $p > .05$). Table 21 also show that the crop stovers explained only 2.3% ($R^2 = .023$) variation in availability of feeds. The variation was however not statistically significant, $F(1, 119) = 2.771$, $p > .05$. The results suggest that crops stovers preparation do not affect availability of feeds.

4.5 Forage Conservation Strategy on Availability of Feeds among Smallholder Dairy Cattle Farmers

The third objective was to investigate the influence of forage conservation strategy on availability of feeds among smallholder dairy cattle farmers in Trans Nzoia County.

4.5.1 Forage Conservation

The smallholder dairy cattle farmers were asked how they conserved forage. From their responses the results are shown in Table 22.

Table 22

Forage Conservation

Conservation Method	Frequency	Percentage
Hay	77	63.6
Silage	85	70.2

From Table 22 it came out that there was a concurrence of63.6 % of farmers who conserved forage as hay while a concurrence of 70.2 % of farmers who conserved forage as

silage. The percentage does not add up to 100% because the farmers conserved both hay and silage. This agrees with studies done by Martin (2005) in his studies on possibilities to improve silage conservation who found out that farmers in Sweden conserved 90 % silage and 10 %hay. However, studies done by Lewa and Muinga (2015) on the status of fodder conservation among smallholder dairy farmers in coastal Kenya found out a concurrent of 27.3 % of the farmers conserved forage as hay while a concurrent of 24.6 % of farmers conserved silage. They attributed the more hay conservation to natural pastures which were readily available. Also Amuge and Osewe (2017), in their study on socio-economic factors influencing adoption feed based dairy technologies among smallholder farmers in Ekerenyo Sub County of Kisii County, Kenya found out that about twenty four percent of farmers conserved forage for use during feeds scarcity.

4.5.2 Materials Used to Make Hay

The study sought to find out the commonly used materials in making livestock hay. The farmers were asked the materials they use in making hay. From their responses the results are given in Table 23.

Table 23

Materials used to make Hay

Material Used to Make Hay	Frequency	Percentage
Grass	63	52.1
Desmodium	19	15.7
Lucerne	46	38.0
Others	5	4.1

The results in Table 23 show that there was a concurrence of 52.1 % of the farmers used grass in making hay, a concurrence of 38.0 % of the farmers used Lucerne, a concurrence of 15.7 % of the farmers used Desmodium and a concurrence of 4.1 % of the farmers used other materials. This agrees with Phelan et al. (2015) on their studies on forage legumes for grazing and conservation in ruminant production systems who found out that grasses are more popular in making hay than legume forages as they are more persistence after being cut and easy to maintain the herbage dry matter than legumes. This also agrees with Pandey and Voskuil (2011), who in their manual for improved feeding of dairy cattle by smallholder farmers stated that leguminous fodders are difficult to ensile due to their high

protein content and low sugar content. The percentages above do not add up to 100 % because the farmers used more than one material to make hay.

4.5.3 Hay Making Methods

The smallholder dairy cattle farmers were then asked the methods they used in making hay based on a four-Likert scale of never, sometimes, often and always. Their responses on the four Likert scale were converted into percentage as shown on Table 24.

Table 24

Frequency of use of Hay Making Methods

Hay making method	Percentage			
	Never	Sometimes	Often	Always
Hay box	79.3	9.1	9.1	2.5
Tied hay	59.6	15.7	14.0	10.7
Untied hay	52.1	13.2	18.2	16.5
Standing hay	94.2	3.3	1.7	0.8

From Table 24 it shows than 79.3 % of the smallholder dairy cattle farmers have never used a hay box in making hay and those who have sometimes, often and always used a hay box were, 20.7 %. Then the smallholder dairy farmers who have never tied hay always were 59.6 %, those who sometimes tied hay were 15.7 %, those who often tied hay were 14 % and those ones who always tied hay were 10.7 %. Again, from Table 24 it shows that 52.1 of the smallholder dairy cattle farmers do not tie hay, 13.2% sometimes keep untied hay, 18.2% often keep untied hay and 16.5 % always keep untied hay. Again, from Table 24 it shows that 94.2 of the smallholder dairy cattle farmers never leave hay as standing hay, 3.3 sometimes have standing hay, 1.7% often have standing hay and 0.8 always have standing hay. From Table 24 it shows that majority of the farmers do not use any of the methods given to conserve hay. Therefore, the extension officers should lay more emphasis on training farmers to adopt various hay conservation methods.

4.5.4 Quantity of Hay Made by Season

The respondents were asked the quantities of hay they make during the rainy season and during the dry season in kilogrammes and the results are given in Table 25.

Table 25

Quantity of Hay Made by Season

Season	Quantity of hay in kilograms
Rainy	15650
Dry	41050

Table 25 shows that during the dry season farmers made 41,050 kilogrammes of hay compared to 15,650 kilogrammes of hay during the rainy season. This is consistent with Ndambi et al. (2018)who found out that more hay is prepared during the dry season than the rainy season because rain interrupts with the drying process during hay making process. The quantity prepared during the rainy season was 15,650 kilogrammes and 41,050 kilogrammes during the dry seasons are both low. According to Maleko et al.(2018), in their studies on smallholder dairy cattle feeding technologies and practices in Tanzania these low quantities are associated with land shortage, high labour demand, low awareness level among farmers and limited storage facilities.

4.5.5 Differences in Hay Made between Dry and Rainy Seasons

The t-test was used to determine difference in hay made by the farmers during the rainy and dry seasons as shown in Table 26.

Table 26

Differences in Hay Made by Season

Season	n	Mean	SD	Df	t-value	p-value
Rainy	121	129.34	20.34	240	5.625	.000
Dry	121	339.26	35.29			

The results in Table 26 indicate that the mean (M = 339.26, SD = 35.29) quantity of hay made during the dry season was higher than the mean (M = 129.34, SD = 20.34) quantity of hay made during rainy season. The results further indicate that the difference between the two means was statistically different at the .05 level in favour of the dry season, t (240) = 5.625, p<.05.

4.5.6 Materials Used for Making Silage

The study sought to find out the commonly used materials in making livestock hay and the findings were tabulated as sown in Table 27.

Table 27

Materials Used to Make Silage

Material used to make Silage	Frequency	Percentage
Napier	94	77.7
Maize	55	45.5
Desmodium	12	9.9

The result in Table 27 shows a concurrence of 77.7 % of the farmers use Napier grass to make silage, a concurrence of 45.5 % of farmers use maize to make silage and a concurrence of 9.9 % of farmers use desmodium to make silage. The percentage does not add up to 100 % as the farmers use more than one material to make silage. This is agrees with work done by Tuei et al.(2021) on the Preference and adoption of livestock feed resources among farmers in dairy groups in Kenya who found out that farmers used napier grass more followed by maize and lastly fodder legumes like desmodium. More Napier grass was used to make silage than maize probably because maize is the main cash crop so it's spared to mature and harvested for food security and also sold as a source of income. Desmodium is also not popular probably because its silage is of poor quality because as legume it contains less sugar that are needs for fermentation during silage making.

4.5.7 Methods of Making Silage

The smallholder dairy cattle farmers were then asked the methods they used in making silage and give their views on each method based on four likert scale of never, sometimes, often and always. Their responses on the four-likert scale were converted into percentage as shown on Table 28.

Table 28

Frequency of Use of Methods of Making Silage

Method of making silage	Never	Sometimes	Often	Always
Using silage bag	16.5	36.4	19.8	27.3
Using a pit	0.8	0	8.3	90.9
Above the ground covered with polythene paper	5.8	2.5	10.7	81.0

From Table 28, 16.5 % of the farmers indicated that they have never used silage bag in making hay, 36.4% of the farmers sometimes uses the silage bag in making silage, 19.8 % of the farmers often uses the silage bag in making silage and 27.3% of the farmers always use the silage bag in making silage. In the case of making silage using a pit 0.8% of the farmers indicated that they have never used a pit in making silage, farmers who sometimes uses a pit were 0%, those who often uses a pit in making silage were 8.3%and those always uses a pit in making silage were 90.9%.The farmers who have never made silage above the ground covering with polythene were 5.8%, those who sometimes made silage on top of the ground covering with polythene paper were 2.5%, those who often made silage on top of the ground covering with polythene paper were 10.7% and those who always make silage on top of the ground covered with polythene paper were 81%. The method of making silage using a silage bag was the least used as 83.5% of the farmers used it, this was followed by making silage above the ground covering with polythene paper method as 94.2%of farmers used it and silage making using a pit was the most popular as 99.2% of the farmers used it. The pit method was most popular since it is underground where it makes the use of minimal space to accommodate a lot of silage making materials. In addition, purchasing of polythene was not popular given that it is expensive to purchase by some farmers.

4.5.8 Quantity of Silage Made by Season.

The smallholder dairy cattle farmers were asked the approximate amount of silage they make during the rainy season and during the dry season in kilogrammes. From their responses the results are given on Table 29.

Table 29

Quantity of Silage Made by Season

Season	Quantity of Silage (Kilogrammes)
Rainy	83,800
Dry	125,700

From the results in Table 29, it shows that farmers made 125,700 kilogrammes of silage during the dry season, while they made 83,800 kilogrammes of silage during the rainy season. This is likely that the farmers used maize planted during the short rains. Farmers should be encouraged to make more silage during the rainy season when materials for making hay are in plenty.

4.5.9 Differences in Silage made by Season

Silage made during the rainy season was compared with that made during the dry season. Table 30 shows the difference in means and standard deviation on silage made by season by smallholder dairy cattle farmers.

Table 30

Differences in Silage Made by Season

Season	N	Mean	SD	Df	t-value	p-value
Rainy	121	692.56	449.81	239	4.609	.000
Dry	120	1032.50	673.91			

From the results in Table 30 the t-test shows that the mean for the quantity of silage made during dry season (M=1032, SD=673.91) is higher than the mean for the quantity of silage made during the rainy season (M=692, SD=449.81). This can be attributed to good forage growth during the short rains in October to December that were ensiled during the dry season. The results also indicate that the difference between the two means was statistically different at .05 level in favour of the dry season 4,609 $p<.05$.

4.5.10 Quantity of Conserved Forage (Hay and Silage combined)

The combined quantity of hay and silage or forage made by season is given in Table 31.

Table 31

Quantity of Conserved Forage (Hay and Silage combined) by Season

Season	Quantity of forage conserved (Kilogrammes)
Rainy	99,450
Dry	166,750

From the results in Table 31, it shows that the farmers conserved 166,750 Kilograms of forage during the dry season and 99,450 Kilograms of forage during the rainy season. From these results extension agents should capacity build farmers to conserve more forages during the rainy season when they are in plenty.

The influence of forage conservation strategies on availability of feeds was established using regression. Three regression tests were conducted, the first one established the influence of conservation of forage strategies on availability of feeds during rainy season, the second regression test established the influence of conservation of forage strategies on availability of feeds during dry season while the third test established the influence of conservation of forage strategies (rainy and dry season combined) on availability of feeds.

4.5.11 Conservation of Forage and Availability of Feeds during Rainy Season

The influence of conservation of forage strategies on availability of feeds during the rainy season was established by regressing the quantity of conserved forage (hay and silage combined) in kilograms on the feeds availability index. The results of the procedure are given in Table 32.

Table 32

Regression Test Results on Conservation of Forage and Availability of Feeds during Rainy Season

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
(Constant)	1.412	.029		47.926	.000
Quantity of conserved forage during rainy season	-9.122E-006	.000	-.027	-.297	.767
$R = -.027$, $R^2 = .001$, $F(1, 119) = .088$, $p > .05$					

The regression test results in Table 32 shows that the relationship between the quantity of conserved forage and availability of feeds was negative and very weak (r = -.027). The negative relationship means that farmers tend to conserve less forage when feeds are available. The results also show that forage conservation accounts for a very small variation of 0.1% ($R^{2=}$.001) in availability of feeds. This variation is however not statistically significant, F (1,119) = .088, p >.05. This implies that forage conservation does not influence feeds availability during rainy season.

4.5.12 Conservation of Forage and Availability of Feeds during Dry season

The influence of conservation of forage strategies on availability of feeds during the dry season was also established by regressing the quantity of conserved forage on the feeds availability index. The results of regression are given in Table 33.

Table 33

Regression Test results on Conservation of Forage and Availability of Feeds during Dry season

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
(Constant)	1.407	.031		46.090	.000
Quantity of conserved forage during dry season	-1.417E-006	.000	-.007	-.074	.941
$R = -.007$, $R^2 = .000$, $F(1, 119) = .005$, $p > .05$					

The result of the regression test in Table 33 reveal that the relationship between the quantity of conserved forage and availability of feeds was negative and very weak (r = -.007). This is an indication that farmers conserve less forage during the dry season when feeds availability is low. The results also show that forage conservation does not explain any variation ($R^2 = .000$) in feeds availability. The results further show that forage conservation does not significantly influence availability of feeds, $F(1,119) = .005$, $p > .05$.

4.6 Test of Hypotheses

The research study had two hypotheses, which were derived from objectives ii and iii.

4. 6.1 Test of Hypothesis One

4. 6.2 Quantity of Crop Stovers Prepared and Availability of Dairy Cattle Feeds

Hypothesis one: "Crop stovers preparation strategy does not significantly influence availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County."

The hypothesis was tested using regression analysis so as to get the total quantities of crop stovers prepared during the rainy season and dry season. Then establish if there was any significant difference between the quantities of crop stovers prepared and availability of feeds among smallholder dairy farmers. Table 34 shows the summary of the analysis.

Table 34

Regression of Test Results between Quantity of Crop Stovers and Availability of Feeds during the Rainy and Dry Seasons Combined

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
(Constant)	1.471	.042		35.115	.000
Quantity of stover products prepared during the two seasons combined	-2.743E-006	.000	-.153	-1.688	.094
R =-153, R^2 = .023, F(1, 119) = 2.848, p >.05					

The results in Table 34 indicate that the relationship between the quantity of crop stovers prepared during the rainy and dry seasons combined and feeds availability was negative but not statistically significant at the .05 level (r = -.153, p >.05). The negatively relationship implies that farmers prepare less stovers when the level of feeds availability is high. The results further indicate that the crop stovers explained 2.3% (R^2 = .023) variation in feeds availability. The variation was however not statistically significant, F (1, 119) = 2.848, p >.05. i.e the computed P-value was 0.094 which is more than the level of significance set at 0.05. This is an indication that crops stovers do not influence availability of feeds. Based on these results the first null hypothesis, which states that crop stovers do not significantly influence availability of feeds, was accepted. Thus it was concluded that crop stovers preparation do not statistically influence availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County. The result conforms with the findings of Haule (2017), who found a similar relationship. In his study on the assessment of the extent of utilizing crop residue as ruminant feed in crop livestock farming systems in Babati district Tanzania he found out that the level of contribution of crop residue as animal feed was low.

4.7 Test of Hypothesis Two

Hypothesis 2 was derived from objective iii and was tested to see if forage conservation strategy had any significant influence on availability of feed.

Hypothesis 2 "Forage conservation strategy does not significantly influence availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County".

4.7.1 Forage Conservation Strategy on Availability of Dairy cattle feeds

The hypothesis was tested to see if forage conservation strategy significantly influenced availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County. The influence of forage conservation strategies on availability of feeds was also established using simple linear regression. It was determined establishing by regressing the forage conserved during the rainy and dry seasons combined on the feeds availability index. The results of the regression analysis are in Table 35.

Table 35

Regression of Test Results on Conservation of Forage and Availability of Feeds

Model	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	Std. Error	Beta		
(Constant)	1.409	.031		45.875	.000
Quantity of conserved forage	-1.988E-006	.000	0-.015	-.164	.870
$r = -.015$, $R^2 = .000$, $F(1, 119) = .027$, $p > .05$					

Table 35 reveals that the relationship between quantity of conserved forage and availability of feeds was very weak and negative (r = -.015). This means that the amount of forage conserved increases as availability of feeds declines. Table 35also reveals that forage conservation do not account for any variation (R^2 = .000) in feeds availability. The results further reveal that forage conservation is not a significant predictor of feeds availability, F (1, 119) = .027, p >.05as the computed p-value of 0.870 is more than the set significance level of .05. Therefore, the results support the second hypothesis of the study which states that forage conservation strategies do not significantly influence availability of feeds. It was thus accepted.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONDS

5.1 Introduction

The chapter gives the summary of the research work, major findings, conclusions and recommendations based on the results. Suggestions for further research are also given.

5.2 Summary of the Findings

In Trans Nzoia County dairy farming is the most popular livestock enterprise and second to maize. Smallholder dairy farmers constitute eighty percent of the total farmers. Smallholder farmers produce seventy five percent of the total milk produced in the county. Despite the huge contribution the smallholder farmers make to the county's economic growth they experience many problems of which one of them is feeds shortage at farm level. Due to this the Kenya government through Kenya Agricultural and Livestock Research Organization (KALRO) in Trans Nzoia County came up with various coping strategies to address the feeds shortage. Despite these coping strategies to address the feeds shortage being disseminated to farmers by government extension agents and other stakeholders through various methods the problem persists. Due to this, the animal's body condition is poor, there is low milk production and there is reduced farmer's income and food security is not guaranteed.

The study used a cross sectional survey design and was intended to investigate the availability of feeds among smallholder dairy farmers in Trans Nzoia county, influence of crop stovers preparation strategy on feeds availability among smallholder dairy cattle farmers in Trans Nzoia county and the influence of forage conservation strategy on feeds availability among smallholder dairy farmers in Trans Nzoia county. A total of one hundred and twenty (120) smallholder dairy farmers were involved in the study.

5.2.1 Characteristics of Respondents

From the study, it was found that there were more men (65.3%) involved in smallholder dairy farming than women (34.7%) did. (35.5%) of the farmers were in the age category of 31-40 years and the least were less than 30 years (5.8%). Most of the farmers had acquired secondary education (40.5%) and those who had not acquired any formal education were the minority (1.7%). It also came out that those farmers who did have any other source of income were the majority (57%) and those with other sources of income were the least (43%).

5.2.2 Availability of Feeds among Smallholder Dairy Farmers

From the study it came out that (99.2 %) of farmers got their feeds from their own farms and 15.7% got their feeds from their neighbours or relatives. The percent does not add up to100% as the farmers had more than one source of feeds. This concurs with studies done by Wanjala and Njehia (2014) on herd characteristics on smallholder dairy farms in western Kenya who found out that 90.1% of farmers got their feed from their own farms, 0.3 % of the smallholder farmers got their feeds from roadside, 7.6% of the smallholder farmers purchased their feeds while 2.5% got their feeds from rented land. It was also established that forages constituted their main feeds (98.3 %) for their animals and minority (11.6 %) used Non-protein sources.

It came out that availability of feeds during the rainy season was higher than the dry season. However, it also came out that feeds availability to farmers during the rainy season and dry season were both low but much lower during the dry season.

5.2.3 Influence of Crop Stover Preparation strategy on Availability of Feeds

From the study, it was established that 95 % of the farmers got their crop stovers from their own farms and 9.9 % got theirs from neighbours or relatives. The main crop stover is maize stovers (83.5 %) and millet stover contributed 15.7%. It was also established that farmers prepared large quantities of crop stovers from common properties like roads during the rainy season and they did not prepare any crop stovers from wheat straws. The results also showed that during the dry season farmers prepared large quantities from maize stovers. Again, it came out that farmers prepared less crop stovers during the rainy season when they were in plenty and crop stovers preparation strategy does not affect availability of feeds.

5.2.4 Influence of Forage conservation strategy on availability of feeds

The results show that most farmers conserved forage as silage (70.2 %) than hay (52.1 %). Farmers used more grass (52.1%) to make hay while desmodium accounted for 15.7%.It was also established that farmers prepared more hay during the dry season than the rainy season based on their means M=339.26, and M=129.34 respectively.

For silage it was found that, the major material for its preparation was Napier grass (77.7 %) while Desmodium was least used (9.9%). Again, more silage was prepared during the rainy season (125,700 kilograms) than the dry season (83,800 kilograms).

This study established that farmers were conserving less forage during the rainy season when they are in plenty and conservation does not contribute to availability of feeds. This concurs with studies done by Hidosa and Tesfaye (2008) on assessment study of Livestock resources, feed availability and production constraints in Maale Woreda in South Omo zone in Ethiopia who found out that farmer did not conserve any feeds when they were in surplus during the rainy season due to lack of awareness and shortage of land to produce sufficient feeds to conserve.

5.3 Conclusions

The following are the general conclusions of the study:

i. Availability of feeds among smallholder dairy cattle farmers in Trans-Nzoia County', the feeds used by smallholder dairy cattle farmers to feed their dairy cows include; forage, hay, silage, crop stovers, cereal by products and legume crops. It was noted that dairy farmer purchase feeds to supplement what they didn't have on their farms both during the dry and wet seasons. In addition, feeds availability was higher during the rainy season than the dry season.

ii. In determination of the influence of crop stovers preparation strategy on availability of feeds, results reveal that the crop stovers explained only 2.3% (R^2 = .023) variation in availability of feeds. The variation was however not statistically significant, F (1, 119) = 2.861, p >.05.

iii. In determination of the influence of forage conservation strategy on availability of feeds, the regression test results indicated that the relationship between the quantity of conserved forage and availability of feeds was negative and very weak (r = -.027). The negative relationship means that farmers tend to conserve less forage when feeds are available. The results also show that forage conservation accounts for a very small variation of 0.1% (R2 = .001) in availability of feeds. This variation is however not statistically significant, F (1,119) = .088, p >.05. This implies that forage conservation does not influence feeds availability during rainy season.

5.4 Recommendations

Based on the study findings and conclusions, the following recommendations can be suggested.

i. The government in collaboration with livestock extension agents should ensure feeds availability both during the rainy and dry season by increasing the farmer training sessions on feeds collection, preparation and utilization.

ii. To improve on crop stovers preparation strategy on availability of feeds the government and extension officers should capacity build smallholder dairy cattle farmers when, how to prepare and store the crop stovers for usage during the period of feeds scarcity.

iii. The extension agents should capacity build smallholder dairy cattle farmers to conserve more forage during the rainy season when they are in plenty for usage during feeds scarcity period than during the dry season, so it's recommended that farmers should be capacity build by government livestock extension agents and other service providers to conserve forages when they are in plenty during the rainy season using cost effective strategies for usage to improve feeds availability throughout the year.

5.5 Suggestions for Further Research

The following recommendations are suggested for further research.

i. Carry out a study to determine whether the coping strategies focus on addressing farmer needs in relation to feeds availability.
ii. Conduct a study to investigate the effectiveness of extension services on dissemination of coping strategies to farmers on availability of feeds.

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APPENDICES

Appendix A: Questionnaire for Smallholder Dairy Cattle Farmers

Instructions

The purpose of this interview schedule is to elicit information on the influence of selected coping strategies on availability of feeds among smallholder dairy farmers in Trans-Nzoia County, Kenya. Your honest answers are very vital to this study, will be treated with utmost confidentiality and will not be used for any purpose other than this study.

Part I: Profile of Respondents

1. Gender. Male ☐ Female ☐
2. Location ----------
3. Ward ----------
4. Sub-County ----------
5. Age in years. Under 20 years ☐ 21-30 years ☐ 41-50 years ☐
   51 years and above ☐
6. Highest level of education None ☐ Primary school ☐ Secondary school ☐
   College/University ☐ Others (Specify) ……..
7. Dairy production system Zero grazing ☐ Semi-Zero grazing ☐
   Free range ☐ Others (Specify).....
8. Type of dairy cows do you have? Exotic ☐ Crosses ☐ Zebus ☐
9. How many dairy animals do you have? .....
10. Apart from farming do you have any other source of income? Yes ☐ No ☐
11. If yes, from what is it? Employment ☐ Business ☐ Others specify.....

Part II: Feeds availability

What are you sources of feeds for your animals On-farm [ ] Common resources [ ] Gift [ ] Bought [ ]

1. Indicate the feeds used for your dairy animals by placing a tick in the appropriate cell

Feed	**Tick**
Hay	
Silage	
Crop stovers	
Forage (pasture and fodder)	
Cereal by-products (maize germs, rice polishing, wheat, maize and rice bran)	
Legume crops (sweet potato, calliandra)	
Plant by-products (cotton seed, sunflower, soya bean, copra, ground nut cakes) (supplement)	
Non protein, nitrogen sources (urea, poultry litter)	
Fish meal (supplement)	
Vitamins (supplement)	
Salt (supplement)	
Concentrates (supplement)	
Supplements	
Others (specify)	

2. Using the given scale, rate the availability of feeds listed in the table below during the rain and dry seasons.

   Scale: Not Available (NA), Moderately Available (MA), Available (AV)

Feed	**Rainy season**			**Dry season**		
	AV	**MA**	**NA**	**AV**	**MA**	**NA**
Grass (free range pasture, napier, Lucerne etc)						
Hay						
Silage						
Stovers						
Forage						
Cereal by-products (maize germs, rice polishing, wheat, maize and rice bran)						
Root crops (cassava chips)						
Legume crops (sweet potato, calliandra)						

Plant by-products (cotton seed, sunflower, soya bean, copra, ground nut cakes)						
Non protein, nitrogen sources (urea, poultry litter)						
Fish meal						
Vitamins						
Salt						
Concentrates						
Supplements						
Others (specify						

Section II: Crop Stovers production

1. Sources of crop stovers Own farm [ ] Gift [ ] Common Resources [ ]
   Bought [ ]
2. Types of crop stovers
   a. Green maize thinings - [ ]
   b. Sweet potato vines - [ ]
   c. Banana residues (leaves/stem) - [ ]
   d. Maize stovers - [ ]
   e. Maize cobs - [ ]
   f. Beans straws/haulms - [ ]
   g. Weeds - [ ]
   h. Wheat straws - [ ]
   i. Millet - [ ]
   j. Sorghum - [ ]
   k. Forages from common properties [ ]
   l. Others (specify) .....

3. Approximately how many Kilograms of the items listed in the table below do you produce/posses during the rainy and dry seasons

Crop Stover	**Quantity in Kilogram during the rainy season**	**Quantity in kilogram during the dry season**
Green maize thinning		
True beans		
Banana pseudo stems		
Banana leaves		
Sweet potato vines		
Forages from common properties(road reserves forests and schools)		
Banana Peels		
Sweet Potato Peels		
Irish potato peels		
Maize stovers		
Wheat straws		
Bean straws/haulm		
Weeds		
Processed		
Crushed maize cobs		
Crushed maize stovers		
Crushed maize stovers treated with urea and molasses		

Section III: Conserved forage

1. Do you conserve forage in your farm Yes [ ] No [ ]
2. Which forage conservation method do you practice Hay [ ] Silage [ ]
3. Indicate the materials that you use to make hay
   - Grass [ ]
   - Desmodium [ ]
   - Lucerne [ ]
   - Others (specify) .....

How often do you use the methods below in making hay?

Hay making method	**Never**	**Sometimes**	**Often**	**Always**
Hay box				
Tying the hay				
Hay made without tying				

How many Kilograms of hay do you make during the rain and dry seasons

Hay making method	**Quantity in kilograms during the rain season**	**Quantity in Kilograms during the dry season**
Hay box		
Tied the hay		
Untied Hay		

Indicate the materials that you use to make silage

- Napier grass [ ]
- Maize [ ]
- Others (specify) .....

How often do you use the methods below in making silage?

Method of making silage	Never	Sometimes	Often	Always
Using silage bag				
Using a pit				
Above the ground covered with polythene paper				

How many Kilograms of silage do you make during the rain and dry seasons

Method of making silage	**Rainy season**	**Dry season**
Using silage bag		
Using a pit		
Above the ground covered with polythene paper		

Appendix B: Research Permit

THIS IS TO CERTIFY THAT:
MR. PATRICK OSORO OKONGO
of EGERTON UNIVERSITY, 0-3546
30200,has been permitted to conduct
research in *Transnzoia County*
on the topic: *THE INFLUENCE OF SELECTED COPING STRATEGIES ON AVAILABILITY OF FEEDS AMONG DAIRY CATTLE FARMERS IN TRANS NZOIA COUNTY,KENYA.*
for the period ending:
31st December,2013

Permit No : NACOSTI/P/13/7929/251
Date Of Issue : 1st November,2013
Fee Recieved : Kshs khs1000.00

.....
Applicant's Signature

.....
Secretary
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

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Appendix C: Publication

Influence of Crop Stovers Preparation Strategy on Availability of Feeds Among Smallholder Dairy Cattle Farmers in Trans-Nzoia County, Kenya

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With the increasing scarcity of dairy cattle feeds farmers are turning to crop stovers in order to compliment the feed available for dairy cattle. Crop Stovers preparation involves making the crop stovers ready for use as dairy cattle feed. This involved cutting the stovers for feeding dairy cattle, crushing the stovers and crushing and mixing with urea for feeding dairy cattle. Therefore, this study examined the influence of crop stovers preparation strategy to overcome non availability of feeds among smallholder dairy cattle farmers in Cherangany, Kwanza and Kiminini Sub counties of Trans-Nzoia County. A multi stage proportionate stratified random sampling was used to select 121 smallholder dairy cattle farmers. Data was collected using a questionnaire and analyzed using percentages, mean standard deviation and regression analysis. The crop stovers preparation strategies considered were whole stovers, crushed stovers crushed and mixed with urea and molasses and crushed stovers mixed with urea only. From the study it came out that during the rainy season 3.5 % of the crop stovers were either crushed, crushed and mixed with urea and molasses or crushed and mixed with urea only and 96.5% were not processed for feeding dairy cattle. However, during the dry season 53.4% of crop stovers were processed, while 46.6 were used as dairy cattle feeds without any processing. The results also showed that during the dry season farmers prepared large quantities from maize stovers. At the same time, it also came out that farmers prepare less crop stovers during the rainy season and more during the dry season. The study also revealed that there were 65.3 % men and 34.7 % women who were engaged in smallholder dairy farming. Lastly, the study established that crop stovers preparation strategy does not influence availability of feeds.

Key words: Crop stovers, dairy cattle feeds, smallholder