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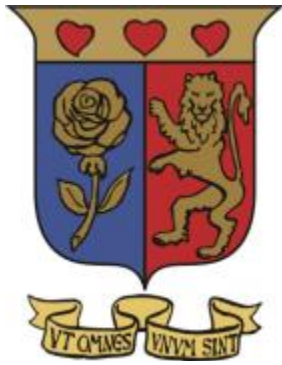
Factors influencing the productivity of hay in Lanet Division, Nakuru West Sub – County.

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Strathmore
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Factors Influencing the Productivity of Hay in Lanet Division, Nakuru West Sub- County

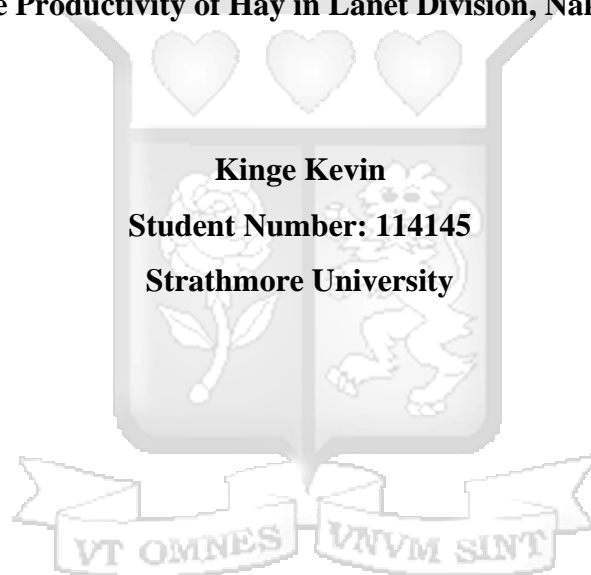


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DECLARATION

This proposal is an original work and has not presented for a degree in any other University.

Signature: _____

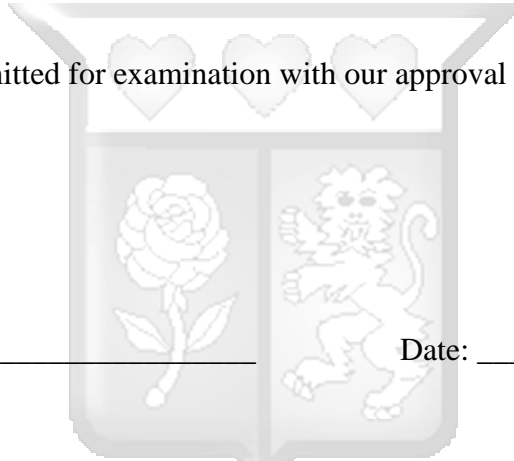


Date: 8th September 2022

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This proposal has been submitted for examination with our approval as University Supervisors.

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Date: _____

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Abstract

Kenya suffers large deficits of feed for its dairy sector and there are projections that demand will continue to surpass production due to the fast-growing population leading to an increase in demand for milk and milk products hence more livestock to feed. This has created a huge market for fodder and in Kenya, the most common is Boma Rhodes grass. There is a large potential opportunity for many small-scale fodder farmers if they manage to increase production, reduce their cost, improve quality and connect better to market or consumer.(de Zeeuw & Dubbeling, 2022). Dairy farmers are increasingly becoming more reliant on the fodder hence the need to grow more fodder, specifically Boma Rhodes grass. So, the grass is doing well in Lanet. This research sought to find the determinants of hay productivity in Lanet, Nakuru County. The study hypothesized that socioeconomic factors, farm management and farm characteristic as factors that influence the productivity of hay. The study adopted a descriptive design approach and data was collected through the use of structured questionnaire. Several findings were established, with regards to farm characteristics, farm ownership was found to have a positive effect on productivity. Similarly, loam soil was established to contribute to more productivity of Boma Rhodes grass compared to black cotton soil. When it comes to farm management practices that was measured using record keeping, post-harvest management and storage, use of technology and value addition, the findings of the study reveal that they have a positive effect on productivity. Finally on socio-economic factors, the study found out that income per acre in the immediate previous season positively affects productivity. The study also found that farmers with a higher value of farm assets are in a better position to grow with specialized tools and make more profits compared to farmers with very few. Finally, farm equipment cost results to increase in productivity.

CHAPTER ONE

Introduction

1.1 Background Information

Over the past few years, farmers in Nakuru have transitioned to growing Boma Rhodes grass (Hay) as a cash crop from a mixed farming system where they predominantly grew maize and beans (Nyoro, 2002). Lanet area located in Nakuru east division is the area of the study due to its popularity with the hay grass. Many farms in the area have in the recent past reduced to 5 acres and below. The subdivision of land attributed to the growing populations. Many factors from high costs of production, poor market prices of maize among other factors which are discussed in the study have led to the switch. Boma Rhodes grass is a perennial grass that is drought resistant because of its strong root system (Boonman, 1993). After the first harvest, the seeds drop on the ground aiding in a quick spread quick forming the good ground cover, and grows to one and a half meters. Despite Boma Rhodes grass being drought resistant, it requires heavy rainfall to produce good yields of up to 200 bales per acre (Makini et al., 2019). For many years, Maize has been the main cash crop and a staple food in Kenyan households but in the recent past, the prices and access to the market have been a problem. Maize dominates all national food security considerations. Almost every farmer produces some maize (Hassan & Karanja, 1997). Lately, farmers face many challenges in growing maize. They range from access to markets, high costs of inputs, low maize prices, pests and diseases, and unfair competition from cheap imports (Mwangi & Ely, 2001). Boma Rhodes grass is hard to establish since the seed germination is poor and has expensive inputs, but if you use the proper procedures of establishment, it becomes less stressful and yields better from the first harvest (Makini et al., 2019). Despite these factors, Boma Rhodes is preferred since once established the farmers get up to two harvests a year for six years without having to grow it again. Other costs after planting such as weeding are low over the subsequent years, unlike other crops.

The quality of Boma Rhodes hay bales is of high importance. The standard requirements for good quality hay are; the bales should have minimum stalks and be leafy green, should not be mixed with weeds, should have 16% dry matter, tightly baled, and weigh 15 kgs. Proper storage after harvesting contributes to the quality of the hay. The hay stores should be well protected from rain but also have enough aeration. The floors should be well built to keep off termites and rodents since they can damage the hay. The hay market demand has been driven by the dairy industry. A

dairy cow that weighs 400 kg will consume an equivalent of about 3% of its body weight in dry matter. This will mean 12 kg dry matter per day. Since hay contains 85% dry matter, if the cow is consuming only hay, it requires 14 kg of hay daily (Lukuyu, Gachui, Lukuyu, Lusweti, & Mwendia, 2012).

Other factors that have contributed greatly to the demand include, the grass adaptability to climate, higher revenue returns compared to other crops, low cost due to the nature of the grass planting cycle which lasts up to six years, resilience to pests and diseases saving the farmer money and proper land utilization all year long (Okomboli, 2015).

1.2 Statement of the Problem

In the last decade, farmers in Nakuru have been making a shift from maize production to hay production. However, little is known about the recent move. Thus, this study aims to investigate the hay productivity in Lanet area. The study is a pioneer in many ways and therefore, provides a novel contribution to theory regarding the adoption of Boma Rhodes grass in Nakuru County. It is worth stating that literature is scarce concerning the determinants of crop adoption move to hay adoption. Although there are a handful of studies that are exceptions to this, they have several shortcomings that prompt more investigation on this subject (World Agroforestry Centre (ICRAF) & Mwebaze, 2002).

Firstly, studies that have been conducted outside of Kenya either focused on the demand side of hay or the technological adoption of forage. For example, (Abebe et al., 2018) paid attention to the pastoralist community and dairy farmers, little is mentioned about the supply side. The main focus of the current study is on the arable farmers who cultivate crops; thus, it is more supply-centric. A study by (Bashe et al., 2018) concentrated on the adoption of forage technology in hay cultivation and did not necessarily look at the switch in production from maize to hay.

Studies conducted in Kenya have followed a similar pattern from international studies some have paid attention to the demand side of hay adoption mainly by the dairy farmers among these studies include Manyeki, Kubasu, Kiriwa, and Mnene (2013). In addition, the grass under the study was *Brachiaria* grass which is quite different from Boma Rhodes grass. Others have overlooked the

other determinants and focused on socio-economic factors. This is particularly the case for a study by (Maina et al., 2020). The current study seeks to incorporate more potential determinants to Hay productivity such as farm characteristics and crop profile.

1.3 General Research Objectives

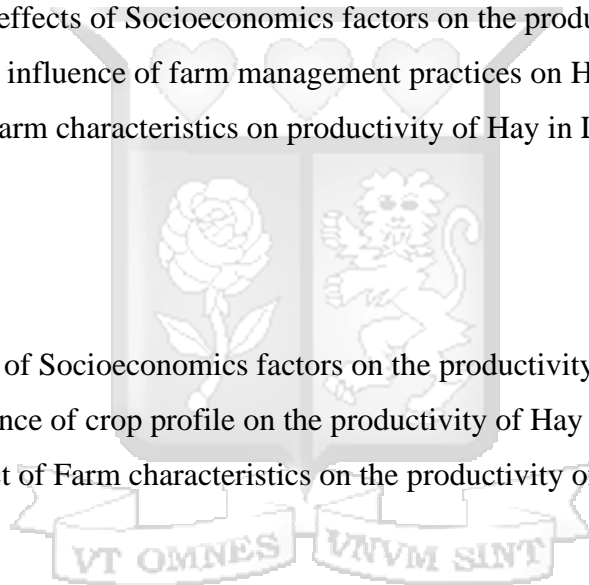
The general objective of the study is to study factors that influence hay productivity in Lanet Nakuru.

1.3.1 Research Objectives

- I. To determine the effects of Socioeconomics factors on the productivity of Hay in Lanet.
- II. To investigate the influence of farm management practices on Hay productivity in Lanet.
- III. To establish the Farm characteristics on productivity of Hay in Lanet.

1.4 Research Questions

- I. What is the effect of Socioeconomics factors on the productivity of Hay in Lanet?
- II. What is the influence of crop profile on the productivity of Hay in Lanet?
- III. What is the impact of Farm characteristics on the productivity of Hay in Lanet?



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section provides a comprehensive analysis of theories and empirical works conducted on factors that influence the growth of hay. The first section will present the theories relevant to the study. The second part will provide and critique empirical studies that have been conducted in the area of study. These studies will comprise of those done globally, in the African region and Kenya. The study will go-ahead to present a conceptual framework and finally, the gaps identified based on the empirical literature review.

2.2 Theoretical Literature Review

Theoretical review entails concepts that are tied to their definitions and have relevant scholarly literature references. They demonstrate an understanding of concepts and theories related to the topic of research and at the same time considering other factors around the topic. This subsection presents the theories that underpin this study. The theories identified include the Agricultural Supply theory and allocative efficiency theory.

2.2.1 The Agricultural Supply Theory

The agricultural supply theory stems from the works of Gale Johnson (1952). The theory postulates that agricultural products face a different supply dynamic from other goods in the market. Thus, according to Gale (1952), the main factor that influences the supply of the agricultural product is the quantity factor of production employed namely land, labor, or capital employed.

A rise in the prices of the product results to an increase in production of the products by the farmers hence flooding the market in the coming seasons. This affects the product prices supply exceeding demand and the farmers get affected.

A reduction in the price of the product will lead to a lower output or production by the farmers. The farmers will demand smaller quantities. The land as a factor of adoption will be almost perfectly inelastic in the short run. The land is only affected with depreciation and depletion of its quality exceed maintenance expenditure.

A price reduction will lead to the underutilization of land when less product is produced on the same land size. With a decline in production, demand for labor would also decrease and hence unemployment problems will persist. Farm mechanization also affects the demand for labor with farm machines and equipment replacing the labor force. The supply of labor to agriculture is a function of its wage in agriculture, comparable labor wage in non-agriculture, and the level of unemployment, plus the growth of the farm labor force due to the excess factors such as many of agricultural labor force residing in the rural areas or farms areas and the new migration of the youth to the urban centers leaving the elderly in the rural areas.

If the elasticities of the quantity of labor supplied for the farm wage rate, the nonfarm wage rate, and unemployment are relatively small, the reduction in labor supplied produced by a decline in relative prices may be fairly small. These are likely to be the conditions when the price decline is assumed to be temporary. If the price decline is assumed to be permanent, the elasticities of the quantity of labor supplied concerning the relevant variables are likely to be relatively large, and the adjustment in labor supply would occur more rapidly. With the assumption that the production function remains unchanged. The production function in agriculture does change as new techniques become available. Though the availability of new techniques of production is probably unrelated to the level of farm prices, the rate of adoption of new techniques requiring significant investments.

Also, many techniques have not been adopted by the farmers due to various constraints and challenges such as, new seeds, better pest and control methods, and new irrigation techniques that are climate-smart. Thus, it may be assumed that the production function shifts at a slow rate under any circumstances and that this rate may be increased somewhat by high real output prices. If real farm prices were constant, agricultural output would gradually increase due to the autonomous shifts in the production function. The employment of farm resources in a growing economy could increase, decrease, or remain constant depending upon the annual change in demand for farm products, and the technological change in agriculture.

The supply function for agricultural products is sometimes expressed as a simple relation between the quantity of output and the price of the output. However, the use of this relation obscures the complexity of the supply process determining the supply of agricultural products. The supply of

agricultural products depends on several factors such as; (1) Production conditions which are the technological relations between inputs and outputs; (2) The supply conditions of the factors of production; (3) Price or demand conditions for output; and (4) The behavior of stakeholders, including the objective of the entrepreneurs. The explanations of the behavior of agricultural output assume that firms maximize profits and that the demand for factors of production is determined solely on this basis unless a contrary assumption is made. The assumption of profit maximization implies that output behavior will be determined by the relationship between output and factor prices. Attention must be given to the supply conditions for the factors of production. It is assumed that there is a labor supply function including all farm labor.

To do this requires a strict separation of the farm firm and the labor function of the operator and other family members. The farm operator is both an entrepreneur and a laborer. He accepts this dual role in the belief that he can thereby achieve a larger return from his energies. Otherwise, he would forego his entrepreneurial activities and hire out as a laborer. Analytically, we can divorce the supply of labor by the operator and his family to the farm firm from the farm firm itself, i.e., we need not assume that this labor is a part of the firm. The response in quantity supplied following a price decline is related to disinvestment inland and failure to provide for maintenance.

The marginal opportunity cost of labor falls rapidly as unemployment increases and rises similarly as unemployment declines. As the marginal opportunity cost approaches zero, the supply curve for agricultural labor becomes very inelastic. Farmworkers are willing to accept lower rates of pay rather than be unemployed. These conditions of supply would mean that during a major pro- longed decline in business activity that (1) farm prices, farm wage rates, and land rents would fall in about the same proportion and (2) the employment of land, labor, and machinery would not change appreciably. Condition (2) might prevail without (1) if the resources had to be used in fixed proportions or if one of the resources had a fixed coefficient of production, conditions that seem less plausible than the conditions of supply outlined above

2.2.2 Theory of Allocative Efficiency

Allocative efficiency can be described as a measure of how a farm uses the production inputs optimally in the right combination to maximize profits (Inoni, 2007). Therefore, the allocative efficient level of production is where the farm operates at the least-cost combination of inputs. Most studies have been using gains obtained by varying the input ratios based on assumptions

about the future price structure of products for example maize output and factor markets among other products. This study follows Chukwuji, et al., (2006) reviewed assumptions used by farmers to allocate resources for profit maximization. Such assumptions included, farmers choosing the best combination such as low cost of inputs to produce profit-maximizing output level; there is perfect competition in input and output markets; producers are price takers and are assumed to have perfect market information; all inputs are of the same quality from all producers in the market.

Allocative efficiency can also be defined as the ratio between total costs of producing a unit of output using actual factor proportions in a technically efficient manner, and total costs of producing a unit of output using optimal factor proportions in a technically efficient manner.(Inoni, 2007). Hence, for the farm to maximize profit, under perfectly competitive markets, which requires that the extra revenue (Marginal Value Product) generated from the employment of an extra unit of a resource must be equal to its unit cost (Marginal Cost = unit price of input) (Chukwuji et al., 2006). In summary, if the farm is to allocate resources efficiently and maximize its profits, the condition of $MVP = MC$ should be achieved.

2.3 Determinants of Hay productivity;

2.3.1 Socioeconomics factors on the productivity of Hay in Lanet.

Population growth, urbanization which have resulted in many people moving from the rural areas and affecting the consumption preferences strengthened by the fast-growing middle-income class in Kenya are redefining the agro-food systems. Population growth has been doubling the demand for milk and meat products in Kenya. These changes have led to an increase in dairy and beef cattle to feed the increasing demand for milk and milk products and the consumption of meat. Farmers are taking advantage of this responding positively to change in trends by adopting hay farming to supply the demand. The change in trend addresses the most important challenge in livestock production systems which is access to quality fodder. Research shows that the adoption of Boma Rhodes increases milk production by up to 27% translating to an average increase of about 3 liters daily per animal (Maina, Ritho, Lukuyu, & Rao, 2019). This has led to an increase in demand for the Boma Rhodes Hay bales and since the grass grows best in Nakuru, farmers have switched to it.

There have been challenges in livestock feeding especially in the dry seasons motivating the government to establish initiatives on the same such as Kenya Agricultural and Livestock Research Organization) KALRO) in collaboration with other development agencies in the field to support the establishment, production, and marketing of hay (Omollo, 2017). An example of such an initiative was the introduction of several natural fodder improvement technologies in the dry areas to increase feed availability during the dry periods and create diversify in incomes through the sale of hay and grass seed among communities living in the ASALs such as Samburu and parts on Nakuru (Mnene et al., 1999; Dolan et al., 2004; Munyeki et al., 2015; Lugusa et al., 2016 in Omollo, 2017). These initiatives plus the demand for fodder and the inability of many farmers to adopt, establish and preserve enough fodder created the emergence of a commercial fodder sector in Kenya (Auma et al., 2018). Farmers in Lanet grow hay commercially to feed this demand.

2.3.2 Farm management practices on the productivity of Hay in Lanet.

Boma Rhodes grass is cheaper compared to the growth of most crops such as maize and beans. This is because Boma Rhodes is only costly on the establishment. The grass requires proper tilling, two harrows, good quality seed, and the right amounts of fertilizers. With proper land preparation, the growth rate is enhanced from the first season. Once established, the grass is harvested twice a year; after the first long rains, and end of the year after the short rains. The first harvest has more yields compared to the second but it is still economically profitable compared to commercial grain farming in Nakuru, Lanet. The grass is then harvested for five years before they need re-establishment. The other cost during the five years will be the cost of fertilizers to boost growth and harvesting. Grain farming requires land preparation and the use of inputs every year with only one harvest per year.

Costs per acre Kenyan Shillings Land lease 7,000 Certified seeds 4,500 Fertilizer and herbicide inputs 8,600 Contracted services excl. land preparation and planting 8,500 shs totaling 28,600 shs and the establishment is for 5 years. Revenues per acre Kenyan Shillings Yields per acre number of bales) 220, the average price per bale of hay 150 shs for 2 harvests totaling 66,000 shs (Dijk, Wilkes, & Odhong, 2018) hence a farmer will recover the total establishment cost in the first harvest compared to maize cost of production and profit margin (Njagi, 2017).

2.3.3 Demand for fodder in Kenya

The extent of demand for hay feed is unknown in Kenya due to a lack of data on production and consumption of the same. However, it can be concluded that Kenya is a highly animal feed deficit country with large unmet demand for animal feed. This is seen especially in the dry season where prices fluctuate sharply and the supply gap increases dramatically. The demand is driven by several factors related to the dairy industry. These factors include dairy production, population growth pressure on land resources, urbanization, and increasing consumption of livestock products.

The African Sustainable Livestock (ASL) 2050 country brief Kenya shows that the main livestock species in Kenya 2019 include 18 million cattle. A sample estimate of 7.2 million dairy cattle with animal feed requirements of (9-14 kg Dry Matter per day) suggests that the fodder requirement is approximately 27.5 MMT dry matter (Over 1 billion 14 kg bales) of dry grass fodder (de Souza et al., 2019). This translates to over 5 million bales for daily consumption. If commercial fodder is only required during the dry seasons which are 4 to 6 months per year, it is roughly above 500 million bales annually. Dairy cows consume the most bales due to zero-grazing. To produce these quantities of fodder would require lots of land under fodder and pasture that is why many smallholder farmers are adopting the growing of fodder despite the existing challenges of dwindling land and urbanization. Consumption of fodder is expected to increase as dairy and beef production is rapidly intensifying.

2.4 Empirical Literature Review

Several studies closely related to the topic have been conducted around the globe. However, there are significant points of departure between these existing studies and the current study that warrant more analysis and investigation of the topic. A detail presentation is contained in the subsequent subsections.

2.4.1 Socio economic factors

Maina, Ritho, Lukuyu, and Rao (2020) investigated the socio-economic determinants of the adoption of Brachiaria grass in Makueni and Siaya counties. The study adopted purposive sampling due to the presence of a large proportion of dairy farmers in the two regions. Respondents were selected by the use of a multistage sampling technique that resulted in a sample size of 237. Data analysis was conducted by the use of propensity score matching. The study established that perceived benefits of the grass, membership to an agricultural group, access to extension services, and age of household head contributed positively to the adoption of Brachiaria grass. It is worth noting that the study mainly paid attention to socio-economic determinants leaving out the critical factors. This study seeks to fill this gap by incorporating the other factors that are deemed as potential contributors to the adoption of Boma Rhodes grass in Nakuru County.

Many farmers base their decisions on investment capital and if it translates well in profits or their income, the venture is considered profitable. This is a major influence on what farmers in Lanet grow making them decide between the other crops and hay.

However, several factors affect farmers' income such as labor, availability of farm equipment, and farm inputs. Availability of cheap labor leads to increased incomes for the farmer. The farm tools and types of equipment represent the value of all tools and implements used for the agricultural production process. The farmers with a higher value of farm assets are in a better position to grow with specialized tools and make more profits compared to farmers with very few assets (Masuku, 2011; Rahman, 2003). Farm tools are essential for the production of a marketable surplus at a smallholder level. Weeding is an important practice in the cropping cycle.

Poor yield results in a failure to weed or weeding on time. It is estimated that more than 30% of yield is usually lost due to weed infestation, and farm tools come in handy in weed control (Sims & Kienzle, 2006). In line with these findings, incomes are greatly affected. The use of fertilizer and manure has the most significant effect on the profitability of farming in Lanet. Increasing fertilizer usage leads to a significant increase in the profits earned. All these factors are key, but considering that in hay farming, they are only incurred once then the farmer will enjoy between 5 to 6 years before incurring most of these costs again making hay farming a more viable option.

In the recent past, there has been a high adoption of mechanized farm equipment's. This has resulted from a drastic change of using hand tools to a more efficient mode of farming. In Kenya, the adoption of mechanized farming has allowed for more land to be cultivated efficiently increasing both the area of land under cultivation and yields. Hay can be equipment intensive but the machineries guarantee good yields from the onset as opposed if done by hand. A well-prepared land also ensures easier harvesting and re-growth of the same product with minimum weeding (Lattimore, 2008). The use of more effective equipment has tangible improvements in the farming process. Mechanization makes it possible to carry out farming operations more quickly and at the precise time calculated to maximize outputs. In Lanet, Nakuru, for example, the increasing substitution of hand plowing for tractors has greatly shortened the time; the farmer has to spend on the plowing and sowing of the crops.

Mechanization also allows the farmers to have options such as soil turning or fallow tilling depending on the soils. Proper tilling reduces the rate of weed growth, availability of weed containment farm sprays help in fighting weeds at a lower cost to. With farm harrowing and using tillers and seed planters during sowing has greatly improved on efficiency and output. With only a need for harvesting equipment after hay establishment for the next few years, many farmers view this as an important factor to consider the switch to growing hay.

The improved tools and farm machinery drastically changed the cropping patterns, cropping intensity, and crop combinations resulting in high agricultural returns. Tractors have largely transformed the agricultural landscape of Lanet in Nakuru. The biggest problem in the farming industry for Kenyan farmers is access to markets. Farmers do not know where to sell. This is because the biggest consumers are in urban areas. When we look at grains in Kenya such as maize, the prices are controlled by the *National Cereals and Produce Board* (NCPB) which consumes only 20% of produce hence distorting the forces of demand and supply (Levin & Vimefall, 2015). When it comes to Boma Rhodes hay, the supply is usually less than demand. What causes the prices to the farmer reduce is lack of storage facilities and a need to sell immediately after harvest. Hay storage structures are cheap to construct compared to the storage of other products. With the storage of hay, the farmer will have a solution to price fluctuations since they are guaranteed to sell the hay at an even high price. However, when it comes to grains such as maize, the longer they

are stored in the recent past the harder it becomes to sell at a profit due to the importation of cheaper fresh maize yearly from the neighboring countries.

Kenyan farmers either choose between selling their products to traders or brokers who collect from the farmers and delivering their produce to the market themselves. Most are discouraged by the in-accessibility and increased costs. Also, poor communication with consumers or buyers creates farmers' uncertainty about the market. Brokers and traders often take advantage of farmers' ignorance of the current market prices and exploit them offering very low prices for their products (Courtois & Subervie, 2014).

2.4.2 Farm Management practices

(Abebe et al., 2018) conducted a study to investigate the determinants of adoption of improved forages in western Ethiopia. The study explored several factors namely socio-economic and institutional factors. The study targeted 120 farmers who were divided into two clusters; one adopter and the others non-adopters. The study used a structured questionnaire to collect the data, after which logistic regression analysis was conducted. The findings of the study revealed that access to extension services, number of adult males in households, age of household head, and use of Nitrogen fertilizer positively impacted improved forage adoption. On the other hand, distance from farmer's house to development agent contributes negatively to the adoption of improved forage. This study mainly focused on the demand side of forage production. The current study seeks to understand the factor that makes the farmers cultivate hay, making it supply-oriented. (Bashe et al., 2018) conducted a study to establish the determinants of probability in improving forage technology adoption. The study sampled 121 households that were identified and selected through the use of multistage sampling, a mixed-method approach that combined quantitative and qualitative data collection methods was used. Data were analyzed using probit regression owing to the binary dependent variable. The study established that adoption of forage technology increases with the slope of the land, household size, and distance from the farmer's farm to the extension office. This study considered the adoption of forage technology and not necessarily Boma Rhodes grass which is the center of attention in the current study.

Moving to studies conducted in Kenya, Manyeki, Kubasu, Kiriwa, and Mnene (2013) investigated why dairy farmers switched from natural pastures to improved technology pastures. The study was conducted in Makindu and Mashuru Sub counties in Makueni County. These two regions are classified as Arid and Semi-Arid (ASAL) regions. The study adopted a random sampling method and carried out a household survey that consisted of 99 households. The researchers divided the sample into two strata; those that used natural pastures and those that used improved technology. Among the variables that led to the switch from natural to technologically improve pasture characteristics of the farmer, farm characteristics, and technology. The study concluded that these factors were critical in promoting the demand for technologically improved pasture. The study departs from the current study as it mainly showed the adoption of pasture technology by the pastoralist community. The current study mainly focuses on farmers that practice arable agriculture which is more of the supply side.

Good record keeping is important, for efficient farm management. Using financial records and methodology will help you understand how and where your business is going. Record keeping and sound data interpretation will help you define the weakest links of your farm business operation and enable you to start corrective action plans(Arzeno, 2018) There are a few benefits to record keeping such as; Income tax reporting where a good set of records is required for the preparation of complete and accurate tax documents. Poor records often lead to preparing income tax returns that result in either underpayment or overpayment of taxes. The second is obtaining credit which includes, if you decide to borrow money for your farm business operation, the loan officer or bank will ask to see your financial records including a balance sheet, an income statement and a cash flow statement. The creditor will require these statements in order to determine your repayment capacity. Lastly, we have a management tool. Accurate financial records, along with production data, will help the farm business operator analyze the information and make the necessary adjustments to operate more efficiently, thus increasing profitability. Such analysis will help you plan for the future, and it will pinpoint the weaknesses of your farm business and allow you to act accordingly.

The post-harvest system encompasses a sequence of activities and operations that can be divided into two groups one is technical activities and the other economic activities. Harvesting is the main part in post-harvest management. It's usually determined by seeds sprout and the stalks. Post-

harvest drying is the next stage. It ensures good preservation. The part of drying depends considerably on weather and atmospheric conditions. Baling is the next step for hay after it is lined up into rows. The bales can then be transported to the required destinations and a few make it to threshing. In threshing, the hay bales add value since they add on the price by up to 100 shs. They are then stored in clean dry storage or sold to ready a ready market. Marketing is the last phase for post-harvest management and is connected to transport since after selling they have to be transported.

Once the hay is harvested from the farms, it can be added value. There are many programs that talk of hay pellets although they are not so common in the area of Lanet, Nakuru. But threshing of the hay and packing it then selling it at a higher price is quite common. Once the hay is harvested, many farmers thrash it and package and there is an increase in price by almost 100 shs or so. The average for a one-acre land expected production is 150 bales although many farmers in Lanet, Nakuru

Aside from the advanced farm equipment's that are used today from tractors to balers (Saiz-Rubio & Rovira-Más, 2020), we now focus on farm inputs. In hay, we look at improved fertilizer and seeds. Initially, farmer used to use what was available but now with access to information, they know what is best. There has been a noticeable change of farmers purchasing the fertilizers from their registered agronomists and in Lanet, the improved seeds given have spread much to the surrounding area.

2.4.3 Farm Characteristics

From observation, it is noticeable that the soils in Lanet are struggling with other crops probably due to overexploitation. This leads to low yields on other crops. Due to the excessive application of fertilizers over the years, the soils in most of the productive regions of Kenya have turned acidic including Nakuru. These results in crops not doing well on the soils and more application of NPK and Diammonium phosphate (DAP) fertilizers. PH values for acidic soils are less than 7.0 pH. Degrees of tolerance of different crops vary. Most of the horticultural crops do not tolerate acidity. Maize has a medium tolerance range but does well in very specific pH values (Kanyanjua, Ileri, Wambua, & Nandwa, 2002). However, grasses are resilient on such soils and grow well despite

the acidic conditions. Hay grass grows well in the Lanet area where many other crops have failed influencing the farmers to grow more of it.

It is not only the land tenancy and the system of ownership that influence the agricultural and cropping patterns, the size and fragmentation of farms also have a close bearing on agricultural land use patterns and yields per unit area. In Kenya, the increasing subdivision of lands is further reducing the areas available for cultivation making some very small for profitable farming.

The size of the farm contributes to the risk extent that a farmer may bear. In general, the larger the size of the farm, the greater the capacity of the farmer to take the risk and vice versa. This, in turn, would affect the extent of specialization and also the nature of technology and equipment (tractors, thrashers, harvesters, etc.) to be used. The average standard of small-scale farms may give good agricultural returns or sustenance to the farmers but cannot be maintained because of the fast-growing rural population and the prevailing inheritance customs. The succession customs in the countries like Kenya and the region results in the subdivision and fragmentation of land.

According to the inheritance customs in these countries, the property of the deceased is equally divided among the male heirs. Each son generally insists on having a share from each location and each piece of land, resulting in further fragmentation of land. It is a wasteful and uneconomic method of land utilization in which improved agricultural practices cannot be adopted. Fragmentation of land has some well-known disadvantages among them is putting a large proportion of land outside the possibility of effective cultivation or economic development. The small fields are difficult to work with modern machinery and tractors. The fragmentation of land is a great obstacle and one of the major deterrents to economically viable cultivation. It results in wastage of land, labor, and material inputs. It is responsible for increased overhead costs, including even the cost of production resulting in low returns from agriculture.

Growing of Boma Rhodes grass utilizes the land all year round for up to five years of the hay cycle. The output per acre of land under Boma Rhodes is higher than the output from the most competing cash crop in Lanet, Nakuru, maize. Other crops that are grown in the area are potatoes, horticultural products, wheat, barley, and sorghum. For horticultural products, the farmers only practice it for subsistence farming because commercially they are not viable. For the case of wheat and barley, they are only viable when done in huge parcels of land. This limits the number of

farmers who can grow them to less than 5% of farmers in Lanet, Nakuru. The same case applies to the growth of sorghum in the Lanet, Nakuru. Sorghum requires large chunks of land since over 20% of the farm produce is lost to birds so when grown in large quantities, the losses are covered from the surplus unlike when grown in smaller parcels because the whole plantation may be lost to the birds leading to extreme losses.

Sorghum performs well in semi-arid regions where other cereal crops fail. However, its production is affected by abiotic and biotic stress factors. Among the hindrances are birds. They are a serious pest and limit grain production from sorghum leading to low counts. Factors such as field sizes, fields near roosting sites for the birds, planting density, weed control measures, seed variety choice, and timing of farm operations influence the ability of the birds to damage the crop (Mofokeng & Shargie, 2016) and should be put into consideration.

Renting land is common in rural areas including Lanet and is the main approach used by smallholder farmers. The rent is considered seasonal but paid a specific amount charged annually. In light of this, it is profitable if one establishes a crop that will give returns for longer periods. Farmers who want to farm more acres but have exhausted their land or do not have any can rent the available land in the desired location. Research results show that land rentals are not fully utilized. This may be due to challenges such as access to water, distance, and an understanding of the crop that does well in that area. However, Boma Rhodes grass adapts well in any area especially Lanet as long as the proper establishment process is adhered to. For other crops such as grains and horticultural crops, they do well on owned parcels as compared to rented land which is limiting to the farmers. For this reason, most farmers who choose to add on the acreage they are farming prefer to grow Boma Rhodes grass. The research results show that land rental markets in Kenya do not maximize land use. This may be due to a lack of prior information about the land hence limiting yields resulting in low incomes (Muraoka et al., 2018) therefore land utilization is very important for the purposes mentioned.

There may be several forms on tenancy depending with the tenancy agreement. It includes the holding temporarily and uses of land for the agreed time. Both Land tenancy and land tenure affect agricultural operations and cropping patterns in many ways. Especially when land is procured at the wrong time delaying on land preparations and planting. Farmers then plan land use according to the duration of the lease agreement. Most of the crops grown especially in Lanet have one season

in the year which means the other half of the year the land is unused although paid for. But when farmers grow hay, they utilize the farm all year round for the duration of the lease agreement sometimes enjoying even two harvest seasons for hay in one year.

Land tenancy agreements vary across different regions and landowners. The most important factors that land tenants consider are the price, land fertility, and scope of use. Land fertility and location directly affect the price. Fertile lands that are relatively close to good road networks are price relatively higher per acre. Investment on land is dependent on the nature of tenancy rights but the actual landowner may put extra investments of land such as an irrigation system hence getting better yields. A farmer who has gained the right of ownership has the freedom to choose a system of production and investment which improves the quality of land and giving increasing yields.

The crops planted, cropping patterns and farm management are also dependent on the type of lease agreement on the land. The duration of time for which the land is under lease plays a huge role in this regard. In most cases, the allotment of land to the leaser is usually for one to four years, mostly on a yearly renewable basis depending on certain factors fertility of the land being the first.

In Kenya, the land rental process is fairly unstructured and farmers looking for land to lease go through a tedious process and have to deal with several brokers to get an ideal land at a preferred location. However, if land rental markets were available, the process would be more structured and efficient. Land productivity would also increase since they would transfer land from less efficient to more efficient producers and also improve access to land for households with relatively small farms. The availability of land tenancy options in Lanet is another contributing factor to the growing of Boma Rhodes hay grass in the region.

2.4.4 Hay Productivity

To measure productivity the study follows the model by Suzzane and Swindale (2015) on how to measure agricultural indicators. The model proposes five key indicators for measuring productivity of agricultural outputs. Firstly, it describes productivity as the value of all farm production irrespective of whether they are sold or not. In this view, five indicators can be interpreted as measuring what farmers could have earned net of recurrent cash costs per unit of production if they had sold their entire production. They dub the productivity as gross margin and define it as

the difference between the value of an agricultural product and the cost of producing them. The objective of this is to offer guidance about viability of different products based on net revenue. The indicators include total production, total value of sales, total quantity of sales, recurrent input costs and the unit of production.

They postulate that for each of the agriculture products in the value chain the gross margin is given by the five indicator which have different data points. The total production represents the overall quantity of products produced. The value of sales is the amount the farmer receives from selling the produced products at the farm-gate or in the market including sum paid to aggregators or middle men. Total quantity of sales is the volume of the produced products that is sold. Recurrent input costs are the total cost used in the production of product while unit of production is the total number of units engaged in production, they could be size of land in acres, number of animals among others (Suzzane & Swindale, 2015).

They provide a formula for determination of gross margin per unit of production which is given by the total value of agricultural output in relation to the cost of production. The formula is expressed as the ratio of value of sales (VS) to quantity of sales (QS), multiplied by the total production less input cost (IC) divided by the unit of production (UP). The mathematical form of the model is given by:

$$\left| \left(\frac{VS}{QS} \right) * TP \right| - IC / UP \dots\dots\dots 2.1$$

Equation 2.1 represents farm productivity as measured by gross margin per unit of production. The study adopts this approach to measure hay productivity. Quantity is measured by the bales of hay produced. The unit of production becomes the acreage so that productivity is measured per acre. Input costs represents the summation of production cost that are significant. Suzzane and Swindale (2015) avers that they should be at least 5% of the total cost, this however, excludes the estimated labor costs provided by family members.

2.5 Conceptual Framework

A conceptual framework is a diagrammatic presentation of the constructs used in the study. Figure 2.1 presents the variables of interest in the study and how they influence each other. The variables on the left-hand side are the independent variables while that on the right-hand side is the dependent variable.

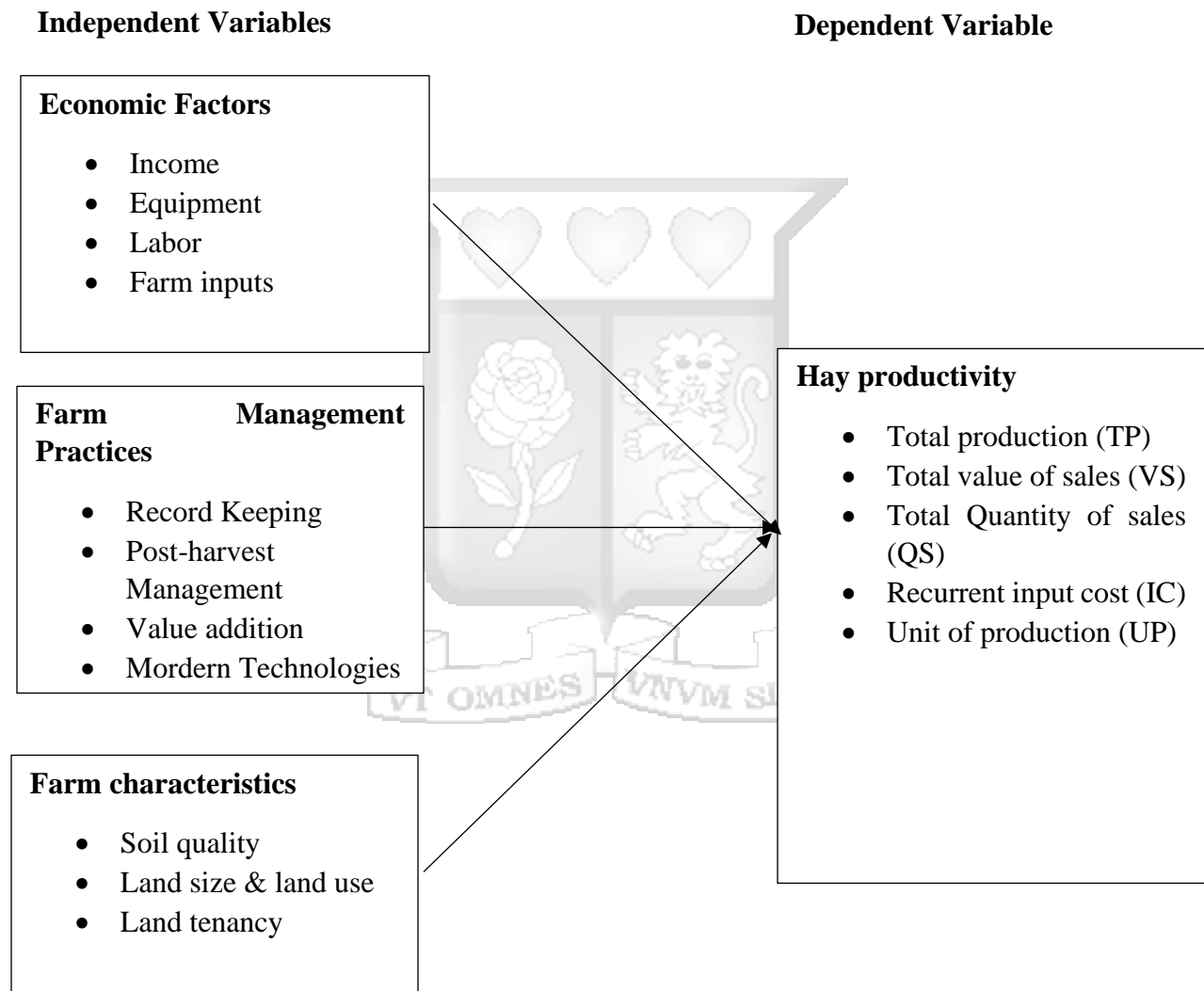


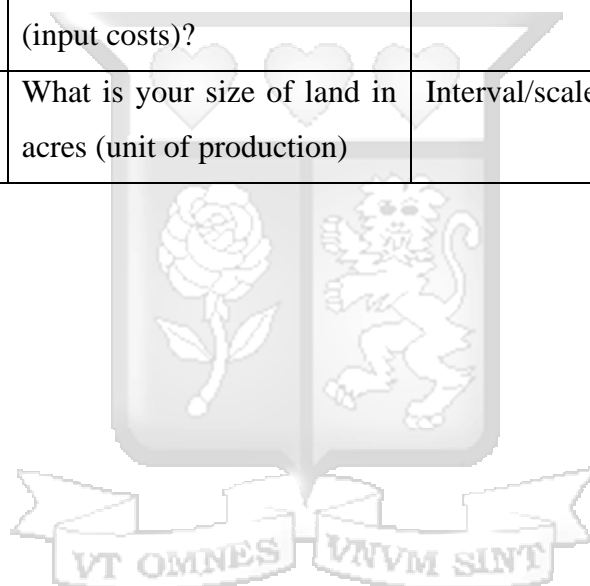
Figure 2.1: Conceptual Framework

Source: Author's Construction

2.6 Operationalization of variables

Variable	Description	Measurement	Expected sign
Socio-economic factors			
income	Income earned in the immediate previous year in Kenya shilling	Interval/scale	+
Equipment	Cost of farm equipment	Interval/scale	+
Labor	Cost of labor	Interval/scale	-
Farm inputs	Price of farm inputs	Interval/scale	+
Farm management practices			
Record Keeping	Five-point Likert scale to determine the level of record keeping practice	Ordinal	+
Post-harvest management and storage	Five-point Likert scale to determine the level of post-harvest management	Ordinal	+
Use of technology	Five-point Likert scale to determine the extent of technology use	Ordinal	+
Value addition	Five-point Likert scale to determine the extent of value addition	Ordinal	+
Farm characteristics			
Soil type	Loam or black cotton soil	nominal	+
Land size	Acreage	Interval/scale	+
Land tenancy	Leased or owned land	nominal	+
Hay Productivity (dependent variable)			

Total production (TP)	How many bales did you produce in the last season (Total production)	Interval/scale	
Total value of sales (VS)	How many bales did you sell in the last season (Total quantity of sales)	Interval/scale	
Total Quantity of sales (QS)	How much did you make from the sale (value of sales)	Interval/scale	
Recurrent input cost (IC)	How much did you spend in production in the last season (input costs)?	Interval/scale	
Unit of production (UP)	What is your size of land in acres (unit of production)	Interval/scale	



2.7 Research Gaps

As promised the literature review went through the comprehensive analysis of theories and empirical works conducted on factors that influence the growth of hay. The second part provided a critique on empirical studies that have been conducted in the area of study. These studies comprised of those done globally, in the African region and Kenya. A conceptual framework is then presented and explained carefully.

Over the years, the provision of extension services has been reducing drastically. The current ratio of extension officers to farmers in Kenya is 1:12000 as opposed to the Food and Agricultural Organization recommendation of 1:400. This has contributed greatly to the poor farm practices of farmers and by extension translating to poor yields and due to lack of basic knowledge on soils, land preparation, input utilization, and post-harvest handling. Training of more extension officers to reduce the gap of officers to farmers will be very beneficial to the entire agricultural sector translating to the growth of both economic welfare of the country and the social welfare of the farmers from the reduction of costs to profit maximization due to increased yields per acre.

From the literature review, there are several gaps such as the ever-increasing demand for Boma Rhodes grass that supersedes supply due to low production and poor distribution system. The increase in demand is due to the fast-growing urbanization with new consumption patterns such as increasing demand for beef, milk, and milk products hence a rise in livestock which is zero grazed resulting in the high demand in Boma Rhodes grass which constitutes over 70% of the livestock feeds.

The other gap is the lack of essential information to the smallholder farmers. Lack of data is a major problem in the agriculture sector in Kenya (Awuor, Raburu, Onditi, & Rambim, 2016). The lack of necessary information leads to a disconnect between farmers and consumers or market, the disconnect creates a myriad of problems such as over-supply resulting in post-harvest losses in production and low incomes and undersupplies that lead to an un-met demand for products hence price instability and room for multiple middlemen further affecting the chain from production to supply.

The last gap is poor utilization of land resources. The land is a very important input factor in production. However, most of the arable land is under-utilized. In the case of Boma Rhodes, the expected yield per acre is 200 bales but most smallholder farmers harvest around 100 bales or less (Makini et al., 2019). This leads to low incomes affecting the farmers and unmet supply to the demand requirements.

The other thing that hasn't been done and if done will improve the sector is the construction of storage facilities to store harvested produce and surpluses plus improving on the current road infrastructure. Storage allows for better planning and contributes greatly to a steady supply. Currently, when farmers harvest due to lack of storage, they sell their Boma Rhodes hay bales at throwaway prices for fear of them getting spoilt if rained on or stolen hence making losses while middlemen making profits at their expense. Proper infrastructure needs to be established to connect farmers to the market otherwise a lot of products will not reach the market and supply will be affected.



CHAPTER THREE

METHODOLOGY

3.1 Introduction

The objective of the research is to determine the most significant factors that affect the adoption of Boma Rhodes and to recommend strategies farmers can use to optimize the growing of hay. The section below describes the research designs and methodology that will be employed while conducting the research.

3.2 Research Design

The research design helps the researcher reflect on how before going on the ground. How the research questions are answered, how the researcher collects data, do data analysis, and if there are any ethical issues to address. The study uses descriptive research design. This research is considered supreme due to its versatility. It has the ability to make use of numerical data, use questionnaires as a data collection technique and employ data analysis procedures such as graphs and other statistics. In addition, descriptive research design can handle both quantitative and qualitative data (Kothari & Grag, 2014).

The research questions are answered by addressing the factors affecting the growth of Boma Rhodes and smallholder farmers alike in Lanet division, Nakuru East Sub- County. The study uses an array of techniques in data analysis combining both inferential and descriptive methods. Additionally, data is presented in various forms including tables and charts. It is for the aforementioned reason that descriptive research design fits well in this study.

3.3 Target Population

Study Population is a unit of observation with observed characteristics (Gray, 2004). The target population is the 2,410 smallholder farmers in Lanet Division, Nakuru East Subcounty who are farmers farming less than 5 acres of land. Boma Rhodes grass does well in Nakuru (Nakuru.go.ke) due to its climatic conditions. The climate is mild, mostly warm and temperate with 2 rain seasons,

heavy rains in the winter, and little rains in the summer (climate-data, 2019) which favor the growth of Boma Rhodes and research on the economic impact of climate suggests that favorable climate increases agriculture net revenues and thus per capita income (Karanja & Kabubo-Mariara, 2007). The 2,410 farmers are all the farmers farming less than 5 acres of land. Nakuru is also at a central location making accessible and distribution of Boma Rhodes hay efficient to the consumer bases. Boma Rhodes is very land-intensive, as much as maximizing yield per acre is important intensification on land is also key to meeting the increasing demand of the Boma Rhodes grass. Nakuru has enough land cover for Boma Rhodes intensification.

We however will be focusing on farmers farming 5 acres or less. The main reason is because this target group make 95% of the whole group. This is because of the division of land issue in Nakuru region.

3.4 Sample Size

Sample size is a representation of the population (2004). The study will use random sampling to establish the farmers. Random Sampling is a probability sampling where every observation has an equal chance of being selected. Yamane (1967) method is applied in sample size calculation. The method is considered to be simplified in the calculation of a sample for proportions (Israel, 1992). The formula is stated as:

$$n = \frac{N}{1+N(e)^2} \dots\dots\dots 3.1$$

Where:

N= Population size

e= level of precision (the theoretical threshold value is 0.05)

n=sample size

Applying the formula to our population of **2410** we get equation 3.2. The sample size becomes **343** smallholder farmers.

$$343 = \frac{2410}{1+2410(0.05)^2} \dots\dots\dots 3.2$$

3.5 Data Collection Tool and Procedure

Data for the study is collected by use of structured questionnaires. Data collection entails the administration of structured questionnaires through personal interviews. Personal interviews are deemed suitable for the study due to literacy levels in the country that is estimated to be 72% of adults above 15 years (Murage, 2019). The readability and understandability of the questionnaire will be simple and all participants will be able to understand. For this reason, there is no need for translation into Swahili or any other local language. Thus, the method will ensure that all the questions are understood by the farmers and the responses provided are accurate. The lead researcher of this study will recruit research assistants to assist in data collection to ensure timely collection of data.

The questionnaire contains questions sections that are thematically arranged based on the type of variable. The first section is the demographic part that captures the background of the farmers. The second section is related to the dependent variable which in this case is the adoption of hay production. This question is structured as a binary and seeks to establish whether the farmer cultivates hay or not. On the other hand, independent variables are contained in the subsequent sections. They are expressed as Likert scale questions where the respondents are expected to rate the factors that they consider vital in the choice of crops to cultivate.

3.6 Data Analysis

Data is analyzed using descriptive methods and empirical methods. Descriptive analysis will form the initial part of the analysis where data is analyzed using measures of central tendency such as mean and percentages and measures of dispersion in this case standard deviation. Descriptive analysis is vital in measuring the distribution of respondents based on their demographic characteristics. It also measures the extent to which variables of the studies are implemented.

Regression analysis is used to establish the factors that affect productivity of hay in Lanet division in Nakuru east sub-county. Ordinary Least Square (OLS) method is used in the estimation. The model is given in the form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 + \varepsilon$$

Where:

Y= Productivity of hay measured using the following formulae

$$\left| \left(\frac{VS}{QS} \right) * TP \right| - IC / UP$$

Where VS=value of sales, TP=total production, QS=Quantity of sales, IC=input cost and UP=unit of production

X is a vector of explanatory variables they include: Socio-economic factors, farm management practices and Farm characteristics.

α = a vector of coefficients for socio-economic factors, extension services, and farm characteristics respectively.

3.7 Data Quality

To ensure the quality of the data used in this study, the survey questionnaires have to be tested for validity and reliability. These two factors are considered the most important features of any measurement and data collection instrument in a good research study. There are greater transparency and reduced researcher bias by conforming to this. (Mohajan, 2017).

Validity is essentially the degree to which the survey tool measures what it claims to be measuring. It looks at what the instrument measures and how well it does.(Mohajan, 2017). To ensure the validity of data, the questionnaire uses measures that are respected in the field and widely used in the empirical literature on the same area. The questionnaire is pre-tested before it is administered. This will help in determining if the objective of the study will be adequately achieved using the data from the questionnaire and the interviews. It will also help us understand the level of complexity and time taken to fill in the questionnaire.

Reliability is the degree to which the survey tool produces consistent results. To test consistency, Cronbach's alpha is the most common measure used in the empirical literature, and the value of the alpha ranges from 0 to 1. An acceptable value in this measure is 0.70 and above.

3.8 Ethical Considerations

Ethical considerations are considered highly when conducting this research. A few factors that will be greatly observed are; ensuring the research participants are not to any kind of harm. This is possible by making smart decisions and being careful such as not agreeing to late-night interviews in isolated areas. The research participants should be respected to create a conducive environment for the research. Full consent should be obtained from participants before the study, protection of data from the research prioritized, enough confidentiality of research data anonymity of participating organizations ensured if they were asked for, legitimacy of data observed and no use false data or misleading data, for example, using primary data in a biased way.

Participants' participation is voluntary and they can either accept or reject to participate. Those who participate have a right to withdraw at any time, the respondents should participate only based on informed consent, and the research should observe the acknowledgment of other authors and references in the required format. Observation of all of the above will ensure honesty on the findings and transparency in the research.

Data collected will be purely for purposes of research hence no ethical issues will arise. The data will be kept confidential and the mode of data collection will be handled with etiquette. The research tools are appropriate since the variables have been operationalized to determine their use for data collection. Once the data is collected, it will be used for the research and stored. A published version of the same research will be published and released under the appropriate publishers. Here, they can be accessed and used as long as the work is referenced. The applicant should make any amendments suggested before approval is given.

A certificate of ethical clearance of the research will be collected from NACOSTI (National Commission for Science, Technology, and Information) and research will follow and be conducted within the limits of NACOSTI ethical standards. This will also help improve the efficiency and transparency of the research.

PRESENTATION OF RESEARCH FINDINGS
ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter begins by presenting questionnaire response rate and dependability of the tool used in the gathering of data. This section goes ahead to present analysis of data using measure of central tendency and dispersion as well as regression analysis.

4.2 Questionnaire Response Rate

The study sought to get data from hay farmers in Lanet regarding determinants of hay productivity. Based on Yamane (1967) the study had targeted a sample of 333 farmers. However, out of this only 321 farmers agreed to take part in the study. This represents a sample response rate of 96.3 percent. According to Mugenda and Mugenda (2003) response rate of above 70% is appropriate to infer from. This study has surpassed this level and thus the responses can be said to be a fair representation on the population.

4.3 Reliability of the Research Instrument

Table 4.1: Reliability test

Item	Obs	Sig	item-test correlatio n	item-rest Correlatio n	average interitem covarianc e	alpha
Record Keeping	321	+	0.7393	0.5299	0.326635	0.689
Post-harvest management and storage	321	+	0.6118	0.3958	0.420560	0.754
Use of technology	321	+	0.829	0.6609	0.255140	0.612
Value addition	321	+	0.8151	0.5897	0.254906	0.659
Test scale					0.314310	0.744

Source: Author’s computation, 2022 on reliability test in farm management

Reliability is the internal consistency of the variable constructs; this test is critical as it ascertains whether the questionnaire can be replicated in future studies and elicit the same responses. Considering this Cronbach test was applied to farm management practices whose constructs were constructed in Likert form. These were Farms management practices. The results are as below in Table 4.1 From the Cronbach alpha obtained was 0.744 which is indicative that the record keeping (0.739), postharvest management (0.6118), use of technology (0.829) and value addition (0.8151) were correlated and thus better measure for farm management practices. In addition, this indicates that the data collect tool is reliable and can be replicated for future similar studies.

4.4 Summary Statistics for demographic factors and dependent variable

This section presents results of demographic features of Hay farmers in Lanet in terms of their gender, years in farming, access to extension services and ownership of land. The chapter goes further to presents descriptive statistics of the main variables in the study in their raw form. Frequency analysis was applied to categorical variable whilst descriptive was applied to continuous variables. Results are presented in Tables 4.2 and 4.3 respectively

Table 4.2: Frequency Analysis of categorical variables

Variable	Label	Frequency	Percentage
Gender	Male	243	75.70
	Female	78	24.30
Access to extension services	Yes	6	1.90
	No	309	98.10
Nature of farm engagement	Full-time	237	73.5
	Part-time	84	26.17

Source: Author's computation, 2022 on Frequency Analysis of categorical variables

From the frequency analysis of gender majority of the farmers were male who accounted for 75.70 percent of farmers while women were 24.30 percent. The results also reveal that majority of the farmers (98.10 percent) have no access to extension services only a handful (1.90 percent) benefited from such services. On nature of farm engagement, majority of the farmers 73.5 percent are fulltime farmers and only 26.17 percent practice farming on a part time basis.

Table 4.3: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Farming years	321	8.547	7.989	1	41
Total production	321	274.365	82.914	45	300
Total quantity of sales	321	1316.753	817.11	0	2000
value of sales	321	47452.055	37842.666	0	75000
input costs	321	18177.703	17431.737	8000	21000
unit of production(land)	321	3.166	2.793	0.25	15

Source: Author's computation, 2022 on Descriptive Statistics

From the descriptive statistics presented in Table 4.3 the mean of farmers years of experience is 8 years with the least farmer having 1 year while the highest has 41 years of experience in farming. Total production of bales per acre is recorded with a maximum of 300 bales and a minimum of 45 bales of hay. The total quantity of sales out of 321 farmers is 2,000 bales and a minimum of 0 bales with a mean of 1,316.7 bales. The value of sales on the descriptive statistics table is Ksh 75,000 with a minimum of 0 because of the farmers who consume their hay bales themselves. On input costs, there is a recorded maximum of Ksh 21,000 and a minimum of Ksh 8,000 with a mean of Ksh 18,177.7. On unit of land, there is a maximum of 15 acres and a minimum of 0.25 acres.

4.5 Socioeconomics factors and productivity of Hay in Lanet

4.5.1 Descriptive Statistics

Table 4.4: Descriptive analysis of socio economic

Variable	Obs	Mean	Std. Dev.	Min	Max
Income per acre	298	15061.149	7731.336	6500	45000
Cost of farm equipment	321	17896.757	1525.244	8500	18000
Cost of labor	321	2727.451	1584.971	1000	3500
Price of farm inputs	321	7637.745	9582.421	1800	15000

Source: Author's computation, 2022 on descriptive analysis of socio-economic factors

From the descriptive statistics presented in Table 4.4, the average income per acre is Ksh 15,000, the lowest earning farmer got Ksh 6500 while the highest income got Ksh 45000 per acre. The cost of farm equipment has a maximum of Ksh 18,000 and a minimum of Ksh 8,500. It is also observed out of 321 farmers that the cost of labor per acre has a maximum of Ksh 3,500 and a minimum of Ksh 1,000. The price of farm inputs has a recorded maximum of Ksh 15,000 and a minimum of Ksh 1,800 per acre with a mean of Ksh 7,600.

4.4.2 Regression Analysis

This subsection presents regression analysis results that was mainly used to examine the objectives of the study. The first section presents the summary statistics of the model while the second part presents the estimation results. Figure 4.4 displays the results obtained using Ordinary Least Squares approach.

Table 4.5: Model Summary

Mean dependent var	10.593	SD dependent var	1.316
R-squared	0.47	Number of obs	189
F-test	14.292	Prob > F	.000
Akaike crit. (AIC)	542.994	Bayesian crit. (BIC)	581.895

Source: Author's computation, 2022 on the model summary

From Table 4.5, the coefficient of determination of the model is 0.47 an indication that 47 percent of the variation in the hay productivity is explained by the factors included in the model, while the rest is explained by other factors outside the model. The F test for the model is 14.292 with a corresponding P-value of 0.00 an indication that the overall model is statistically significant in predicting hay productivity in Lanet division. The results are thus suitable for making meaningful deduction about the population.

Table 4.6: Regression Results

Ln_productivity	Coef.	St.Err.	t-value	p-value	Sig
Gender	0.16	0.24	0.67	0.505	
farming years	0.049	0.014	3.56	0.000	***
Nature of engagement	-0.267	0.199	1.34	-0.182	
Farm tenancy (base: leased)	0.235	0.086	2.74	0.007	***
Extension services	1.113	0.458	2.43	0.016	**
Soil type (base: cotton soil)	0.27	0.073	3.68	0.000	***
Farm management practices	0.538	0.127	4.25	0.000	***
Income per acre	0.711	0.178	3.99	0.000	***
Cost of farm equipment	0.465	0.132	3.53	0.001	***
Cost of labor	-0.043	0.155	-0.28	0.780	
Cost of farm inputs	3.193	1.454	2.2	0.029	**
Constant	4.74	2.742	1.73	0.086	*

*** $p < .01$, ** $p < .05$, * $p < .1$

From the regression results in Table 4.6 the dependent variable is log for productivity that was computed using the formulae displayed in section 3.6. In a bid to reduce the values of continuous variables a log transformation was conducted. The variables comprised of age, farming years, income per acre, cost of farm equipment, cost of labor, price of farm inputs. The implication of this is that the model becomes a mix of logs and linear and these variables will be interpreted as elasticities.

The coefficient for farming years is 0.049 and significant at 1 percent level of significant. This means that a 1 percent addition in years of farming practice would result in a 0.049 percent change in hay productivity in Lanet. In addition to their economic capital, older farmers have large stocks of social and cultural capital that contribute to their communities and the nation. They also possess the necessary experience gained through positives and negatives outcomes in the past (Henry, 2008).

The coefficient for access to extension service is 1.113 and significant at 5 percent. This indicates that farmers that benefited from extension services in the previous production had more productivity compared to their peers without by a factor of 1.113. This has contributed greatly to the poor farm practices of farmers and by extension translating to poor yields and due to lack of basic knowledge on soils, land preparation, input utilization, and post-harvest handling. Extension services is very important since it helps farmer improve on their soils and hence get better productivity, it also helps in post management since the farmers have better knowledge on how to handle after harvest practices.

From the regression results, the ones with 0.000 p-values are the most significant. In table 4.6, we see that farming years, farm tenancy, soil type, farm management practices, income per acre and cost of farm equipment's are the most significant. This means that a 1 percent change in this factor will lead to a significant change in productivity.

4.5 Farm management practices and Hay productivity in Lanet

4.5.1 Descriptive Statistics for Farm Management

Table 4.7: Descriptive Statistics for Farm Management Practices

Farm management practices	Mean	Standard Deviation
Record Keeping	2.10	1.019
Post-harvest management and storage	1.96	1.076
Use of technology	3.63	0.889
Value addition	2.78	0.823

Source: Author's computation, 2022 on descriptive statistics for farm management practices

From the descriptive statistics, presented in Table 4.7, Record Keeping had a mean of 2.10 and a standard deviation of 1.019, an indication that only a handful of farmers practice record keeping while, the low standard deviation is indicative that they speak in one voice. Post-harvest management and storage had a mean of 1.96 meaning that only few farmers practice postharvest management. It had a standard deviation of 1.076 meaning that there was no much variation in the responses of small holder farmers regarding this matter. With regards to use of technology, the mean was 3.63. This shows that adoption of technology was high among small holder farmers as indicated by the low standard deviation of 0.889. Finally, value addition has a mean of 2.78 and standard deviation of 0.823. this indicates that only a small number of small holder farmers process their hay into final products.

4.5.1 Regression Results for Farm Characteristics

From the regression results in Table 4.6, The coefficient obtained for farm management was 0.538 and significant at 1 percent. This is indicative that adoption of farm management practices would result to a 0.58-point change in hay productivity. Good record keeping is important, for efficient farm management.

4.6 Farm characteristics and productivity of Hay in Lanet

4.6.1 Descriptive Statistics for Farm Characteristics

Table 4.8: Descriptive Statistics for Farm Characteristics

Variable	Label	Frequency	Percentage
Soil type	Black cotton soil	126	39.25
	Loam soil	195	60.75
Land tenancy	Leased	78	25
	Owned	234	75

Source: Author's computation, 2022 on descriptive statistics for farm characteristics

From the descriptive statistics Table 4.8, the common soil type among many farmers is loam soil with 195 farmers with the remaining 126 falling under black cotton soil. Under land ownership, 75 percent of the farmers totaling to 234 farmers own the land they farm in with only 25 percent which accounts for 78 farmers lease the land they farm in.

4.6.2 Regression Results for Farm Characteristics

From the regression analysis presented in Table 4.6, Farm tenancy with the category owned and leased and having lease as the reference category had a coefficient of 0.235 and significant at 1 percent level of significance. This is indicative that a farmer owning land productivity is 0.267 points higher than those that have leased.

4.7 Postestimation Reports and Statistics

Table 4.9: Breusch-Pagan/Cook-Weisberg test for heteroskedasticity

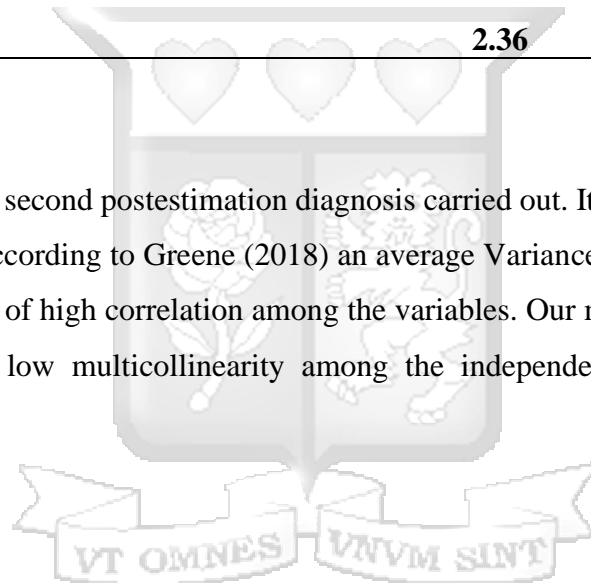
chi2(1)	1.06
Prob > chi2	0.3024

This section presents the postestimation tests after regression analysis. The first test conducted was Breusch pagan test for heteroskedasticity as displayed by Table 4.9. The null hypothesis of the test states that the residuals have a constant variance. Based on the results (Chi2=1.06, P-value=0.3024) we fail to reject the null hypothesis and conclude that there is a constant variance. The model is thus homoscedastic. And the estimates can be said to be consistent and efficient.

Table 4.10: Multicollinearity Test

Variable	VIF	1/VIF
Income per acre	6.67	0.149998
Cost of farm equipment	6.06	0.165122
Cost of labor	2.22	0.449581
Price of farm inputs	1.88	0.531618
Soil type	1.66	0.603842
farming years	1.58	0.633634
Nature of engagement	1.28	0.780151
Extension	1.25	0.79901
Farm ownership	1.15	0.867235
Farm management practices	1.14	0.877136
Gender	1.1	0.906335
Mean VIF	2.36	

Multicollinearity was the second postestimation diagnosis carried out. It shows correlation among explanatory variables. According to Greene (2018) an average Variance Inflation Factor (VIF) of above 10 is an indication of high correlation among the variables. Our mean VIF is 2.36 which is very low and indicates low multicollinearity among the independent variables. Results are displayed in Table 4.7.



CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter begins by presenting summary of the study and then goes ahead to do the interpretations of results as well as discussion by comparing the results of this study and findings obtained and conclusion made by previous studies conducted on the subject. It ends by giving conclusion based on the results and finally policy recommendation.

5.2 Discussion of Findings

This subsection contains the interpretation of the main results and discussion of results. The study used a mix of descriptive and inferential statistics. The following subsections provide details of the findings.

5.2.1 Farm Characteristics

With regards to farm characteristics, as measured by soil type with loam and black cotton soil categories, and black cotton soil as the base, the coefficient obtained was 0.27. Meaning that have thrived in a loam soil as compared to black cotton soil with a productivity point difference of 0.27.

On the other hand, Farm tenancy with the category owned and leased and having lease as the reference category had a coefficient of 0.235 and significant at 1 percent level of significance. This is indicative that a farmer owning land productivity is 0.267 points higher than those that have leased. Investment on land is dependent on the nature of tenancy rights but the actual landowner may put extra investments of land such as an irrigation system hence getting better yields. A farmer who has gained the right of ownership has the freedom to choose a system of production and investment which improves the quality of land and giving increasing yields.

5.2.2 Farm Management Practices

Farm management practices that were measured as the average of four items in a Likert scale that is, record Keeping, post-harvest management and storage, use of technology and value addition. The coefficient obtained was 0.538 and significant at 1 percent. This is indicative that adoption of farm management practices would result to a 0.58-point change in hay productivity. Good record

keeping is important, for efficient farm management. Using financial records and methodology will help you understand how and where your business is going. Record keeping and sound data interpretation will help you define the weakest links of your farm business operation and enable you to start corrective action plans (Arzeno, 2018). Hay farming is capital intensive in use of machinery to plant plough and harvest, a possible explanation for these results (Lattimore, 2008).

5.2.3 Socio economic Factors

Moving on to economic factors, the farmers with a higher value of farm assets are in a better position to grow with specialized tools and make more profits compared to farmers with very few assets (Masuku, 2011; Rahman, 2003). Farm tools are essential for the production of a marketable surplus at a smallholder level. All these factors are key, but considering that in hay farming, they are only incurred once then the farmer will enjoy between 5 to 6 years before incurring most of these costs again making hay farming a more viable option.

The cost of farm equipment had a coefficient of 0.465 and significant at 1 percent. This is indicative that a 1 percent increase in farm equipment cost results to increase in productivity by 0.465 percent. The justification for this is that hay is equipment intensive, but the machineries guarantee good yields from the onset as opposed if done by hand. A well-prepared land also ensures easier harvesting and re-growth of the same product with minimum weeding (Lattimore, 2008). Additionally, farmers with a higher value of farm assets are in a better position to grow with specialized tools and make more profits compared to farmers with very few assets (Masuku, 2011; Rahman, 2003).

Finally, the cost of inputs has a coefficient of 3.193 and significant at 1 percent. These results indicate that a 1 percent increase productivity by 3.193 percent. The higher cost of input could imply that farmers have put in all the necessary inputs to ensure survival and boost growth of hay such as all fertilizers such as DAP, CAN and folia that are needed in various stages of hay growth (Inoni, 2007).

5.3 Summary of study

This research sought to find out the productivity of hay production in Lanet area. The study had three main objectives: to determine the effects of Socioeconomics factors on the production of Hay in Lanet; to investigate the influence of farm management practices on the production of Hay in

Lanet; and to establish the impact of Farm characteristics on the production of Hay in Lanet. Several variables were used to measure productivity. Such as equipment's, hay is seen as machinery intensive but yields better productivity as compared to when done by hand. Market availability is another variable and hay is seen to have a higher market demand compared to other crops. Under farm management practices, record keeping is seen as to propel production since one can always compare and improve, and in farm characteristics, land size and soil quality are seen as good determinants of productivity. An acre of hay is said to have a maximum production of 300 bales so, the more the land one has access to, means more productivity. A formula is used under hay productivity variable which determines the gross margin per unit of production which is given by the total value of agricultural output in relation to the cost of production.

The justification of the study showed the clear gap between the cost implications of growing hay versus that of growing other crops, and the difference in both economic and social welfare visible. Under the agricultural supply theory, it shows that a rise in the prices of products results to an increase in production of the products by the farmers hence flooding the market in the next seasons which affect the product price supply exceeding demand and the farmers get affected while the theory of allocative efficiency shows that for a farm to maximize its profits, under perfectly competitive markets requires that extra revenue generated from the employment of an extra unit of resource must be equal to its unit cost.

In Nakuru, Boma Rhodes grass is the most common hay grass grown. There are other hay types that have been entering the market such as brachiaria grass. However, this grass is capital intensive since it requires an irrigated field to grow. Many farmers cannot manage to irrigate their farms hence do not opt for the grass. The brachiaria grass is more potent, with more leafy stalks and more nutritious. Mostly grown in Naivasha farms. There are other hay types but they have not entered the Kenyan market such as tall fescue grass, timothy hay which is the most recommended in the states, alfalfa and soft orchard grass. Maybe in the near future they will make it into Kenya.

The objective of the research is to determine the most significant factors that affect the adoption of Boma Rhodes and to recommend strategies farmers can use to optimize the growing of hay. The study used descriptive research design. This research design is considered supreme due to its versatility. Data collection was done using questionnaires, and the data showed farmers who use machinery extensively on hay farming and harvesting get better yields. It also showed that most

of the farmers owned the land they farmed in and a small percentage kept some hay for their own consumption. In addition, inferential statistic on this case was used to carry out an analysis between independent and dependent variable.

5.4 Conclusions

Based on the research findings the study has made several conclusions that are presented in the following subsections.

5.4.1 Socioeconomics Factors

In Lanet, only age of the household head, education level, land ownership and adoption of machinery were the main factors that influence the growth of hay. Majority of the respondents in Lanet were male headed household being between the 30 to 50 years of age and high level of illiteracy. However, a positive effect was reported in Lanet with a lower marginal effect. This is because Lanet is predominately occupied by farmers with very low level of education implying that a slight increase in the numbers of years spent in school would result to a positive influence in adoption of hay farming in this area.

5.4.2 Farm Management Practices

Building a commercial hay value chain could provide significant economic benefits for both hay growers and dairy farmers. The answers from the questionnaire demonstrates that commercial hay production is financially viable. To build a strong commercial hay value chain, suitable credit products are needed to enable investments in machinery and storage facilities. Financial institutions could benefit from technical assistance in understanding the hay sub-sector and designing suitable products. Yields per acre and hay quality can be improved. The product could also be processed and easily stored in bags, provide extra income as well as create employment opportunities. Questions still exist on soil fertility management, the use and production of specific grass varieties (seeds) and fertilizer to ensure stable yields as well as high quality hay.

5.4.3 Farm characteristics

Good hay retains as many leaves as possible since the leaves contain two-thirds of the protein. Harvest the crop at the best stage for maximum nutritive value and yield, so good hay must be

harvested to balance the best quantity with quality. Cut the hay so that drying and baling the hay can be done efficiently while maintaining the quality.

5.5 Study Contributions

The study is going to be useful to many different stakeholders including the government in having better statistics on the patterns of a smallholder farmer in the regions with recommendations on how to step in, in case of a needed intervention that might come from the research. The farmers will be of the greatest benefit from the findings and recommendations from the research done in their area. With the potential for streamlining their farming processes and attaining better yields and profits due to value chain proposed improvements.

5.6 Recommendations

Based on the findings the study recommends that there is a need for extension services as it is an important contributor to hay productivity. Majority of Hay farmers in Lanet lack these services, which go hand in hand with other farm characteristics. For instance, extension officers are able to help the farmers know the composition of their soil in terms of fertility and acidity levels. They can offer an array of remedies and recommendations that can help farmers alleviate some of these problems and ultimately improve on their production. Land ownership has been established as a critical factor, the government should look at the land tenure issues and enable smallholder farmers own land or empower them to hold long-term leases. This will be critical as it will enable farmers choose a system of production and investment options that can improve the quality of land.

Secondly, the study established that farm management practices had a positive effect in hay productivity. However, the vast majority of small holder farmers in Lanet do not practice various management methods, particularly record keeping, post-harvest management and value addition. The study recommends that Nakuru county government and development partners should organize for a seminar to sensitize farmers about the importance of farm management practice and build their capacities through trainings.

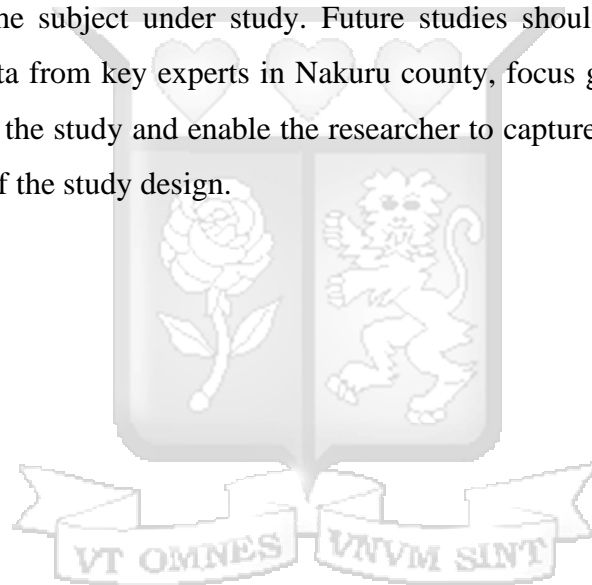
Finally, socio-economic factors are vital for the productivity of hay in Lanet. Hay is capital intensive product that require heavy machineries in every stage of production. Many farmers are however finding it difficult to hire these machines due to the high prices. The county government of Nakuru through the ministry of agriculture can buy some of these machines and lease them to

hay farmers to cushion them from the exorbitant prices charged by oligopolies operating in the market.

5.7 Study limitations

The first limitation of the study emanates from the selection of Lanet region as a case study whilst there exist other regions in Nakuru that Hay farming is prominent. This limitation was mainly influenced by limited resources and time. Future well-funded research should concentrate on the entire region this will increase the data points and statistical power and enable the study to gain better insights

Secondly, the study only focused on quantitative data, this type of data is not sufficient to offer full information about the subject under study. Future studies should employ a triangulation approach by sourcing data from key experts in Nakuru county, focus group discussion and Hay farmers. This will enrich the study and enable the researcher to capture information that was not pre-empted at the point of the study design.



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Appendices

Appendix I: Questionnaire

SECTION A: DEMOGRAPHIC CHARACTERISTICS

This section is to be filled by the farmer only

Kindly tick the appropriate box.

DC_1. What is your gender?

1. Male []

2. Female []

DC_2. What is your age

DC_3. How many years have you practiced farming.....?

DC_4. How many members are in your nuclear family

DC_5. Do you have access to extension services?

DC_6. What is the gender of the farm manager

DC_7. How many years of schooling did you attain?

DC_8. What is your nature of farm engagement?

1. Full-time []

2. Part-time []

DC_9. How much do you make on a monthly basis from your farming activity?

DC_10. Do you grow Hay?

1. Yes []

2. No []

SECTION B: ECONOMIC FACTORS

This section contains questions about the economic factors that would influence your choice to cultivate a crop.

Economic factors		
How much income do you get from one acre of hay in Ksh in the season just before the immediate previous season		
How much does it cost to hire or buy farm equipment per production of hay (in Ksh)		
What is the cost of labour per acre (Ksh)		
How much is the price of seeds and other inputs per acre in (Ksh)		
How much do you earn from other sources of income		
Do you get extension services on hay and how often do they visit in a year	Yes	If yes, how many times a year?
	No	

SECTION C: FARM MANAGEMENT PRSCTICES

This section contains questions about the farm management practices that you adopt. Kindly fill in the appropriate box with the level of implementation where 1 stands for not at all, 2 to a small extent, 3 to a medium extent, 4 to a high extent and 5 to a very high extent.

Farm management practices	
Record Keeping	
Post-harvest management and storage	
Use of technology	
Value addition	

SECTION D: FARM CHARACTERISTIC

This section contains questions about the farm characteristic that would influence your choice to cultivate a crop.

Farm characteristics		
What is the type of soil in your farm in		
Is the land you farm in yours or leased	Yes	No

SECTION E: HAY PRODUCTIVITY

Hay Productivity	
How many bales did you produce in the last season (Total production)	
How many bales did you sell in the last season (Total quantity of sales)	
How much did you make from the sale (value of sales)	
How much did you spend in production in the last season (input costs)?	
What is your size of land in acres (unit of production)	
What amount of land is under hay production	