DETERMINANTS OF CATTLE NUMBERS AMONG THE MUNDARI PASTORIALISTS' HOUSEHOLDS IN SOUTH SUDAN

A CASE STUDY OF TEREKEKA VILLAGE

BY

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DECLARATION

I hereby declare that this study is original and has not been submitted for any other degree to any other university before.

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APPROVAL

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DEDICATION

This study is dedicated to my beloved parents and siblings for their endless financial contribution towards me in this journey, to DR. Yeko Mwanga for his tireless efforts towards this academic journey, and to all my colleagues for their social and academic support.

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ABBREVIATIONS

CAHW	:	Community Animal Health Workers
FAO	:	Food and Agriculture Organization
ICPALD	:	IGAD Centre for Pastoral Areas and Livestock Development
NRC	:	Norwegian Refugee Council
OLS	:	Operation Lifeline Sudan
USAID	:	United States Agency for International Development

ABSTRACT

The study aimed to analyze the determinants of cattle numbers among the Mundari households in South Sudan. A cross-sectional design was employed where a sample of 120 households participated in the study. Frequencies and percentages were used to present distribution of respondents according to different aspects of the study. A simple Poisson model and modified Poisson regression model were used to statistically analyze the count data (cattle) and help gain insights into which factors significantly affect cattle numbers among the Mundari households in South Sudan.

The results of the study indicated that gender, occupation of the household head, experience in keeping cattle, availability of pasture and household size were statistically significant with the determinants of cattle herd size among the Mundari households in South Sudan where majority of the cattle household heads were males constituting 84.2% of the population compared to their female counterparts, household heads who were engaged in full time on farm kind of work kept a larger number of cattle, household heads exceeding 20 years of experience (Coefficient = 50.08, p-value=0.011), which implies that a large positive coefficient of 50.08 indicates that the years of experience of keeping cattle strongly determines the number of cattle kept by the household heads. The availability of pasture and households with 15 members and above were more likely to have more cattle. The study findings also revealed that cattle raiding was the major challenge the Mundari households faced in their area of expertise were (74.2%) of them responded to cattle being their major challenge.

This study therefore recommends for the creation of ventures and encouragement of the females and youths to engage in cattle keeping so as to grow economically in the country. The study further recommends that emphasis on investing in pastoralists' education, awareness of new technological innovations and appropriate measures in veterinary services should be encouraged as its ideal for increasing cattle herd size.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This presents background of the study, objectives, research hypotheses, and research questions, scope of the study and significance of study.

1.1Background

Livestock production is a major component of the agricultural economy for most of the developing countries and goes well beyond direct food production, Sales of livestock and their products provide direct cash income to farmers (FAO, 2009). Almost or all the African developing countries consider agriculture as their back bond and their economies depend on agriculture for development, as livestock is a component of agriculture most of the countries rely on their products for income and food and this goes without saying that the South Sudan's economy mostly depends on cattle rearing as cattle are the main economic activities that the people of South Sudan depend on.

Given the centrality of livestock to South Sudanese economy, culture and society it is not surprising that livestock have an important role in conflicts but despite of the wars happening in the country cattle are still held more vital than people and are critically important in South Sudan leading to the country having more livestock than people: a 2014 estimate put the number of people at 13 million, with around 11.7 million cattle, 12.4 million goats and 12.1 million sheep (Doki, 2014)

Pastoral farming is appropriate for South Sudan's challenging ecology, characterised by flooding, drought, swamplands and so on: Livestock are massively important in South Sudan. The sector is the main source of income and food for the majority of the populationin South Sudan with over 70 percent of the population participating in the pastoral economy (NRC,

2016). The sector supports 950,000 livestock farmers, 350,000 herders, 4,500 animal traders, 2,000 slaughter personnel 2,000 to 4,000 butchery owners (Diana, 2015). Cattle is South Sudan's most important source of red meat, supplying 65 percent of meat needed and contributing 1.2Billion South Sudanese' pounds (409Million USD) (Diana, 2015). The production of meat and milk for domestic consumption is low in South Sudan, averaging 8.52kg of beef consumed per person in 2013. Overall, the red meat consumption per capita was 10.75 kg per person while milk consumption averaged 51.72 litres per person in 2013 (ICPALD, 2016), however, this sector is developing rapidly.

Cattle is considered as a financial asset, a kind of 'mobile bank account', most Mundari people keep cattle and sell them to pay for their essential needs like food or school fees. They are used for payment of dowries, pay compensation and settle disputes. Livestock outnumber people in South Sudan, leading to strain on natural resources exacerbated by the fact that they are so revered that people rarely kill their animals for meat, preferring to pay for imported meat. Cattle are representative of survival, wealth and a woman's ability to feed her children' (USAID, 2015: 41). South Sudanese mostly rear a breed of cattle called 'Ankole-Watusi' also known as 'the cattle kings.' Despite all the importance of cattle in the country but it's also a curse as the countrymen rear cattle for prestige (Doki, 2014) and they are one of the major tool or factors contributing to wars and conflicts among tribe-mates, other tribes but the sad part is that the government and the people in the country take the conflicts as a normal norm.

1.2Problem statement

It is difficult, if not impossible, to overstate the importance of cattle to South Sudan's economy, the cattle are massively important in South Sudan as cows are living, breathing, shitting, lactating bank accounts, an extraordinarily resilient source of wealth and power in one of the poorest countries in the world' (Allison, 2016). The Mundari pastoralists in South Sudan have

a deep-rooted tradition of cattle rearing, which not only sustains their livelihoods but also plays a significant role in their cultural identity.

However, despite the vital importance of cattle rearing, there is a luck of comprehensive understanding regarding the key determinants that influence their cattle numbers in Terekeka county (Ulimwengu, 2022) and also the cattle households are faced with many challenges (Sebit, 2017)

To address this gap in knowledge and promote sustainable development within these communities, it is imperative to investigate and identify the socio-economic, environmental and demographic factors that drive or hinder cattle rearing among the Mundari pastoralists in South Sudan. In this study a comprehensive examination of the major explainers of determinants of cattle numbers among the pastoralists, was done by using the simple Poisson model and the modified Poisson regression model for count data (S Coxe, 2009)

1.3 Objectives of the study

The main objective of the study was to assess the determinants of cattle numbers among the Mundari pastoralists living in the Terekeka village of South Sudan.

The specific objectives were to;

- Determine the influence of the demographic factors on the cattle herd size.
- Assess the socio-economic factors contributing to the cattle herd size

1.4 Hypothesis

The study was guided by the following hypotheses;

- There is no relationship between age of the household heads and the cattle herd size
- There is no relationship between gender of the household heads and the cattle herd size
- There is no relationship between marital status of the household heads and the cattle herd size.
- There is no relationship between occupation of the household heads and the cattle herd size
- There is no relationship between the household size of the household heads and the cattle herd size
- There is no relationship between the education level of the household heads and the cattle herd size

1.5 Scope of the study

The study was conducted among the Mundari pastoralists of Terekeka County, however it was restricted to only three payams out to the ten payams which includes; Tali, North Mangala, and Tombek payams in Terekeka county targeting Mundari households with cattle in their possession only.

1.6 Significance of the study

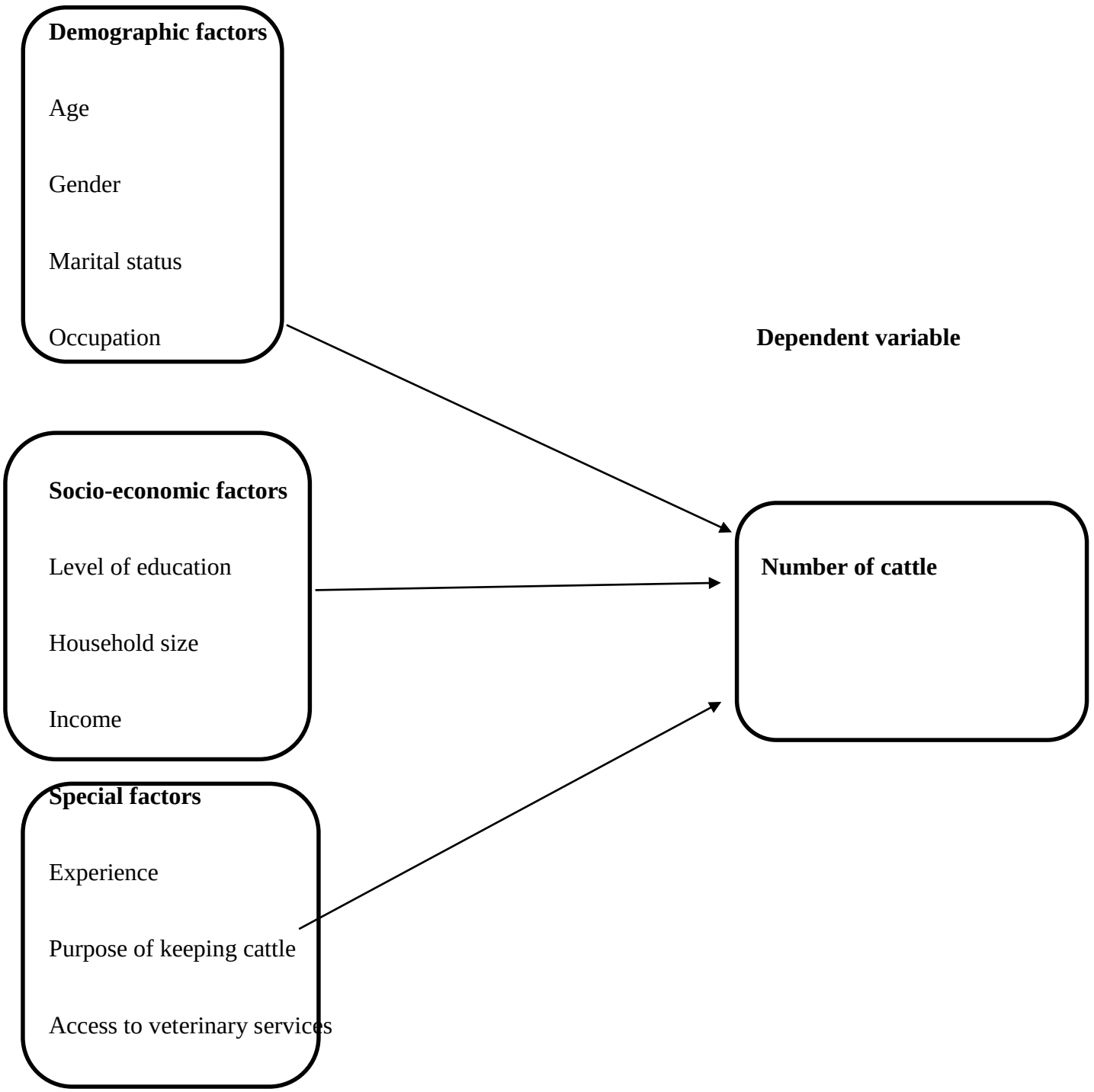
This study will be of great importance to the government, non-governmental organizations, policy makers, and other pastoralists/households in other tribes and regions in South Sudan.

The study will also contribute to the existing body of knowledge in the area of study and provide a basis for any further research in the fields.

1.7 Narrative of the conceptual framework

The conceptual framework for the study postulates that the cattle herd size among the Mundari pastoralists in South Sudan were determined by multiple factors such as the demographic factors, socio-economic factors and other special factors. The demographic factors, such as age of the household heads, gender of the household heads, marital status of the household head and occupation of the household head were theorized to have direct effects on the numbers of cattle kept. Socio-economic factors; as education level of the household head and household size are also expected to have direct impact on the cattle herd size reared. Even the special factors have direct impact on the number of cattle reared by the pastoralists/households.

Figure 1: Conceptual framework to illustrate the expected relationship between the independent and dependent variables



1.8 Structure of the dissertation

This dissertation is divided into five chapters:

Chapter one is made up of introduction, which is comprised of background of the study, problem statement, objective of the study, research question, scope of the study, significance of the study, including the structure of the dissertation. Chapter two is made up of literature review on socioeconomic factors associated with herd size and the effect of cattle raiding and conflict on herd size. Chapter three is the methodology of the study, which is further divided in sections comprised of the introduction to methodology**,** research design, study area and target population, sources of data, sample size determination, sampling technique, data collection tools and techniques, reliability and validity of research instruments, data processing and analysis, limitations of the study and ethical considerations. Chapter four is presents data analysis at three levels that is univariate, bivariate and multivariate analysis. Lastly chapter five is comprised of summary of the findings, conclusions and recommendations of the study.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter outlined the factors that determine the cattle rearing in related literature. It also presents a review of the impact of the different determinants of cattle rearing in South Sudan. The determinants presented below are categorized as demographic and socio-economic factors.

2.1 Demographic factors

Age of the household heads and cattle size

A study carried out according to Guliye (2011) argued that the younger household heads have less cattle due their lack of experience and are still in the process of accumulating their wealth in form of the cattle compared to the older household heads who have accumulated more wealth (cattle) over the years and they have larger cattle herds due to their deep-rooted culture of where large numbers of cattle represent wealth and command respect from others in the community.

Gender of the household heads and cattle size

Gender is a vital issue for the sustainable management of the livestock ownership which differs widely among the production zones (pastoralists, agro-pastoralists, small-scale and commercial) and social factors (Niamir, 1990). Men and women have different domains of activity and different knowledge and skills. In some areas, the knowledge and skills of women are considerably greater than those of men, but in general, this does not receive recognition (Njiro,1999). In many communities, large animals and cattle are mostly owned by the men whereas the poultry and small-scale goats are more of the women's domain (Hassan, 2014). Livestock plays several roles in households such as status, dowry payments as the men are the ones who pay according to the traditional cultures' ceremonial purposes, living as a form of saving (Ouma, 2003).

Marital status of the household heads and cattle size

The study carried out according to Hassan (2014), showed that married household heads have larger cattle size as opposed to the single, divorced and widowed cattle keepers. This is because married household heads use their cattle as a source of income for their families and for paying dowry for marriages and also paying for their children fees.

Occupation of the household heads and cattle size

Nthakheni (1996) argued that cattle keepers/households with access to other forms of income can meet their daily needs and production costs minus selling their cattle to make a living which in turn increases their existing herd. It may also give the household heads more buying power for purchasing additional stock of cattle (Teweldemedhin, 2013).

2.2 Socio-economic factors

Education level of the household heads and cattle size

Well educated household heads find it easier to acquire knowledge related to farming and its assumed to boost cattle rearing and they always tend to rear a limited number of cattle as opposed to the uneducated household heads who have limited knowledge related to cattle rearing and keep larger numbers of cattle as a form of wealth and income (Guliye, 2011). This is not the case for South Sudanese households as the most educated people are the ones that have larger herds of cattle since they have the resources to acquire more of the cattle than the less educated farmers.

Household size and cattle size

Traditionally, the cattle herd sizes are directly affected by a larger household size as compared to small household size. This is because large households indicate availability of abundant and

cheap family labor necessary to attend to the large herd sizes. The larger numbers of family members in a household maybe due to the head of the household marrying many wives thus having a large number of cattle to pay dowry hence having many children and their grand-children. This agrees with the suggestions of (Mariara, 2002) that wealthy husbands owned large herds of livestock as opposed to the smaller household sizes.

Income of the household heads farmer and cattle size

Income level refers to the amount of money an individual or household earns within a specified period, typically annually, and is often used as an indicator of socioeconomic status and there seems to exist a unique correlation between the number of cattle and household welfare. The number of cattle increases with income of the household heads as the households in the very rich quartile owned the largest number of cattle in South Sudan.

Purpose of keeping cattle and cattle size

Majority of the households among the Mundari tribe, rear cattle for different reasons or benefits that the cattle can offer to them in their lives such as prestige as the major purpose for them rearing cattle, dowry due their polygamous nature of marriage and source of income, those household heads tend to have a higher number of cattle.

2.3 Research gaps

The literature stresses that cattle raiding has been a traditional practice among pastoral communities in East Africa, and specifically in the South Sudan region (Idris, 2018). Traditionally, cattle rustling often involved small-scale violence and theft of the best livestock or replacement of animals lost through drought or disease. In South Sudan, a number of reports point to the prevalence of cattle raiding among the Mundari pastoralists/households. The tradition of cattle raiding stems from the central role of cattle in livelihoods, as well as in social

and cultural systems, the prestige associated with cattle ownership (Manyok, 2017). It is also perpetuated by growing cycles of violence motivated by a desire for vengeance. An attack by one community on another, leads to a reprisal attack by the latter, and so on. Cattle raiding has for years entrapped these communities in a loop of vengeance, resulting to un-measurable loss of cattle.

The outbreak of animal diseases in different locations across the country indicated that the national cattle herd has become exhausted. The deterioration in the animal health situation is even terrible when coupled with a limited capacity to address these challenges. The veterinary services remain very weak due to a lack of means and adequate human resources, resulting in an inability to respond to the deteriorating animal health situation (FAO, 2015). FAO, however, has targeted 50 percent of the national her vaccination, with over 2million livestock vaccinated in 2015.

The animal health service provision was better during Operation Lifeline Sudan (OLS). The UNICEF-led programs which trained and deployed Community Animal Health Workers (CAHW), resulting in the vaccination of many cattle against Rinderpest between 1993 and 1995, since that was the main priority at the time. This initiative decreased confirmed rinderpest outbreaks from 11 in 1993 to one in 1997 with no confirmed outbreaks since that time (Leyland, 1996).The accessibility of animal health services is still hard although more veterinary service centers are being put into place for the farmers especially in innermost villages.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter described the methods used. It consisted of Research design, target population and study Area, sample size determination and Sampling procedures, data analysis and Ethical considerations.

3.1 Research design

A cross-sectional survey of different Mundari pastoralists/households was conducted and a structured questionnaire administered to the participants from different places. Data was drawn from a quantitative survey of selected households and the survey objective; to assess the factors that determine the number of cattle among the Mundari households in Terekeka County in South Sudan.

3.2 Target population and study area

The study target population are the Mundari households/pastoralists who are a small ethnic group numbering between 70,000 and 100,000 people mostly cattle-oriented and are part of the Karo people composed of cattle-herders and agriculturalists. The pastoralists/households found/centered in the town of Terekeka in the Central Equatoria state about 75km north of Juba the capital city of South Sudan. Their lands are bounded on the east by the White Nile, an important source of water for livestock, (Africa geographic stories by Benoit Feron and Anne-Francoise). The study further focused on the Mundari households with cattle in their possession in three different Payams which includes; Tali, Muni and Tombek Payams in Terekeka county, South Sudan.

3.3 Source of data

Data was collected from primary sources through a well-designed pretested questionnaire that was designed in the kobo collect toolbox and data provided by the target respondents.

3.4 Sample size

The study used Kish's formula (1965) to determine the sample size of the study

$$Sample\ Size\ (n) = \frac{Z^2 \frac{\alpha}{2}\ p\ (1-p)}{e^2}$$

α - the level of significance z -value of the normal curve that cuts an area α at the tails

e -is the desired level of precision

p - is the estimated proportion

$$n = \frac{1.96^2 * 0.9\ (1-0.9)}{0.0537^2} = 120$$

Hence the sample size is 120

3.5 Sampling frame and sampling technique

The objective of the study is to assess the determinants of cattle numbers among the Mundari pastoralists in South Sudan who reside in Terekeka, a county in the Central Equatorial State of South Sudan. Terekeka consists of ten payams and 46 bomas. The payams are;Gameiza, Nyori, Mangala North, Munia, Reggo, Rijong, Tali, Tombek and Tindilo. The study used a two-cluster sampling technique in which the Terekeka County was first selected and within the county three Payams were used namely; North Mangala, Tali and Tombek. Then from selected Payams nine bomaswere chosen three from each payam, Muni (Gori, Yukara, Gabuta), from Tombek (Bori, naguli, bori-Aringa) and Tali (Dudu, Dari, Jobur). Lastly the households were randomly

selected from the bomas. The study thereafter used the purposive sampling method which is a non-probability sampling technique where the individuals for the study are selected based on the specific characteristics relevant to the study objective. The study utilized the community leaders, elders who possess the necessary knowledge and experience regarding cattle management thus acting as key informants within the Mundari pastoralist community to help identify potential participants/households who meet the study objective. The study further utilizes the snowball sampling technique where the initial participants recommend other households with cattle in the Mundari community until the 120 households were covered.

3.6 Data collection method

Data collection took four weeks and it was collected from the Mundari pastoralists in Terekeka town north of Juba, South Sudan. A questionnaire was used as an instrument for data collection. The researcher used an online based questionnaire which was designed in kobo collect toolbox and deployed to acquire the data. During the interviewing process, interviewer used a smartphone installed with Kobo-Collect to record all the responses during the interviews, the data was then downloaded into excel and export to STATA for analysis.

3.7 Data processing

All electronic data files for the survey were exported from the Kobo-Collect sever to Ms. Excel for data processing. The first step in data processing was data editing. This was done to detect and eliminate all errors in the questionnaire to ensure accuracy and uniformity during the interpretation of the data and it was followed by coding of the collected data. The survey used STATA version 15 in analyzing the data at three different levels; univariate, Bivariate and Multivariate.

3.8 Statistical data Analysis

Data was analyzedat three levels; univariate analysis, bivariate analysis using modified Poisson model test and multivariate level using multiple linear regression model using statistical software like STATA version 15 during data analysis.

3.8.1Univariate analysis

Descriptive statistics such as percentages and frequencies were used to summarize the data set for the determinants of cattle rearing among the Mundari pastoralists in South Sudan.

3.8.2 Bivariate analysis

At the bivariate stage, in the analysis the simple Poisson model was used to assess the relationships between the independent variables and the dependent variables in the study. The simple Poisson model is used to analyze count data, especially when dealing with events that occur randomly and independently over a fixed area.

$$\mathrm{P}(X = x) = \frac{e^{-\lambda}\,\lambda^{x_i}}{x_i!}$$

$\mathrm{P}(X = x)$ is the probability of observing x cattle nunbers

e is Euler's number

λ is the average rate or mean number of cattle influenced by various determinants studied

x_i is the number of cattle observed

$x!$ denotes the factorial of x

3.8.3 **Multivariate analysis**

At this stage, the modified Poisson was fitted to determine the relationship between the independent and dependent variables in the study. The Modified Poisson regression was used in the study since the dependent variable is a count data (number of cattle). Independent variables included age, gender, marital status, occupation, education level, household size, veterinary services. The model was used in previous studies by other authors for example in a study by (Christopher J.L. Murray, Tavenner and Crane (2018).

The modified Poisson regression model uses the maximum likelihood to estimate the parameters in the model on the assumption of the variables occur independently in the study.

$$\log(\mu) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 \ldots\ldots + \beta_p X_p$$

Where; $\beta_1, \beta_2, \beta_3, \ldots$ $\beta_p X_p$ - are the coefficients associated with the independent variables X_1, X_2,……X_p

β_0- is a constant

X -are the predictor variables

X_1-Age of the household heads

X_2 -Marital Status of the household heads

X_3-Gender of the household heads

X_4-Occupation of the household heads

X_5-Income of the household heads

X_6 -Level of Education of the household heads

X_7 -Household size of the household heads

X_8- Access to veterinary services

μ-the expected number of cattle

3.8.4 Assumption testing

Here several assumptions will be tested to ensure the validity and reliability of the results. They include; independence of observations, absence of multicollinearity and goodness of fit tests.

3.8.4.1 Test for Multicollinearity

The check for the presence of multi-collinearity helped in detecting those factors that have relationships among themselves so as to exclude them from the model. Multi-collinearity occurs when two or more independent variables are highly correlated to each other, using such variables together in a regression equation may lead to high standard errors, wide confidence intervals for coefficients and low t-statistics, and hence should be avoided. It was tested using the variation inflation factor (VIF).

3.8.4.2**Goodness of fit**

The goodness of fit of the model assumption was assessed using measures such as R-squared, adjusted R-squared and F-statistics, which indicates the proportion of variance in the dependent variable explained by the model.

3.9 Ethical concerns

It was made clear that the participation is voluntary and that the respondent is free to decline or withdraw at any time during the interview period. The participants were guaranteed that

their identifying information will not be made available to anyone who is not involved in the study and it will remain confidential for the purposes it is intended for and research participants were fully informed about the procedures involved in the research and asked to give their consent to participate.

3.10Limitations of the study

Some respondents refused to disclose some information about themselves to the researcher during the interview which left the researcher with inadequate information. Language barrier was also a problem between the interviewer and the respondent

CHAPTER FOUR: DATA PRESENTATION AND DISSEMINATION OF RESULTS

4.0 Introduction

This chapter delves into the determinants of cattle rearing among the Mundari pastoralists in South Sudan, shedding light on the factors that shape their livestock management practices. The study presents analysis at three levels that is univariate, bivariate and multivariate analysis.

4.1 Background characteristics of study participants

Demographic factors

The background character profile of cattle keepers, as depicted in Table 4.1, reveals a community primarily composed of middle-aged individuals, with (42.5%) falling within the 40-49 age bracket, and (10%) aged 50 and above while the rest of the respondents feel within age groups of 20-29(15.8%) and 30-39 age group. The gender distribution indicates a predominantly male demographic, constituting (84.2%) of the population, while females make up the remaining 15.8%. Marital status varies, with (77.5%) being married, 10.8% single, and 11.7% divorced, widowed, or separated. Occupation-wise, (51.7%) are engaged in part-time off-farm activities, while 48.3% work full-time on-farm.

Socio-economic factors

Education-wise, 38.3% have no formal education or have only completed primary schooling, and a smaller proportion, 7.5%, have tertiary education. Household sizes differ, with 20% having fewer than 10 members, 53.3% having 10-15 members.

Special factors

In terms of cattle keeping experience, 50% have less than 10 years of experience, and 11.7% have more than 20 years. The acquisition of cattle varies, with 31.7% obtaining cattle through dowry, and 35.8% through purchase. The purposes for cattle keeping include income generation (15%), prestige and dowry (42.5%). Notably, 73.3% have sold cattle in the past months. Challenges encompass cattle raids (74.2%), and disease (11.7%), while access to veterinary services is available to 79.2% of the cattle keepers. For a comprehensive overview, refer to table 4.1 below.

Table 1 Frequency and Percentage distribution of baseline characteristics of study participants

Variable	Frequency	Percentage (%)
Age		
20-29	19	15.8
30-39	38	31.7
40-49	51	42.5
50 and above	12	10
Gender		
Male	101	84.2
Female	19	15.8
Highest level of education		
No education	46	38.3
Primary	46	38.3
Secondary	19	15.8
Tertiary	9	7.5
Marital status		
Married	93	77.5
Single	13	10.8
Divorced/Widowed/Separated	14	11.7
Occupation		
Off-farm (part time)	62	51.7
On-farm (full time)	58	48.3
Household size		
<10	24	20
10-15'	64	53.3
>15	32	26.7
Is there Pasture scarcity		
Agree	31	25.8
Neutral	41	34.2
Strongly agree	48	40
Cattle keeping experience		
<10yrs	60	50
10-20'	46	38.3
>20yrs	14	11.7
How did you acquire the cattle?		
Dowry	38	31.7
Inherited	39	32.5
Purchased	43	35.8
Purpose of cattle keeping		
Source of income	18	15
Prestige	51	42.5
Dowry	51	42.5

Did you sell any cattle in the last months		
No	32	26.7
Yes	88	73.3
Challenges faced		
Cattle raids	89	74.2
Land and water shortage	17	14.2
Disease	14	11.7
Do you have access to veterinary services		
No	25	20.8
Yes	95	79.2

4.2 Factors influencing cattle numbers at bivariate analysis

The results from the simple Poisson regression analysis indicate significant relationships between certain variables and the number of cattle kept.

Demographic factors

Notably, age demonstrates a meaningful association. As the age bracket increases, there's a considerable increase in the number of cattle kept; for instance, individuals aged 50 and above have a coefficient of 1.26 ($p = 0.000$), implying a higher number of cattle compared to the reference group (those aged 20-29). Gender also showcases a noteworthy impact. Female respondents exhibit a substantial negative association (-1.31, $p = 0.000$) compared to males, indicating a lower number of cattle kept among females within the surveyed population. . Marital status demonstrates a considerable impact. Single individuals (-0.93, $p = 0.000$) and those classified as divorced/widowed/separated (-0.93, $p = 0.000$) exhibit lower counts of cattle compared to the reference group (married individuals). . Occupation, specifically being on-farm full-time, displays a negative association (-0.09, $p = 0.000$) compared to off-farm part-time, suggesting a slightly lower count of cattle for full-time on-farm occupations.

Socio-economic factors

Highest education level attained reveals significant relationships. Those with secondary education (0.34, $p = 0.000$) and tertiary education (0.28, $p = 0.000$) exhibit higher counts of cattle compared to those with no education, although the effect sizes differ. Household size also exhibits a meaningful relationship. Larger household sizes in the range of 10-15 (0.65, $p = 0.000$) and above 15 (1.42, $p = 0.000$) are associated with higher cattle counts compared to households with less than 10 members. The duration of cattle keeping experience also influences cattle counts. Those with 10-20 years (0.91, $p = 0.000$) and over 20 years (1.20, p =

0.000) of experience exhibit significantly higher counts compared to those with less than 10 years of experience. Ownership through inheritance shows a substantial negative relationship (-0.84, p = 0.000), suggesting a lower count of cattle compared to the dowry acquisition method. The sale of cattle in the last month exhibits a positive relationship (0.34, p = 0.000), indicating that those who sold cattle tend to have a higher count than those who did not. Challenges related to disease exhibit a negative impact (-0.11, p = 0.002), suggesting a slightly lower count of cattle among respondents facing disease challenges. Lastly, access to veterinary services reveals a positive relationship (0.28, p = 0.000), indicating that those with access tend to have a higher count of cattle compared to those without access.

Table 2 Simple Poisson for the factors influencing the number of cattle kept at bivariate analysis

Number of cattle kept	Coefficient	Std. Err.	P-Value	[95% CI]	
Age					
20-29	0				
30-39	0.57	0.04	0.000	0.49	0.66
40-49	0.89	0.04	0.000	0.81	0.97
50 and above	1.26	0.05	0.000	1.17	1.34
Gender					
Male	0				
Female	-1.31	0.05	0.000	-1.41	-1.22
Highest level of Education					
No education	0				
Primary	-0.01	0.02	0.719	-0.06	0.04
Secondary	0.34	0.03	0.000	0.28	0.40
Tertiary	0.28	0.04	0.000	0.21	0.36
Marital status					
Married	0				
Single	-0.93	0.05	0.000	-1.03	-0.84
Divorced/Widowed/Separated	-0.93	0.05	0.000	-1.03	-0.84
Occupation					
Off-farm (part time)	0				
On-farm (full time)	-0.09	0.02	0.000	-0.13	-0.05
Average monthly income	0.00	0.00	0.000	0.00	0.00
Household Size					
<10	0				
10-15'	0.65	0.04	0.000	0.57	0.72
>15	1.42	0.04	0.000	1.34	1.49
Is there Pasture Scarcity					
Agree	0				
Neutral	0.35	0.03	0.000	0.29	0.40
Strongly agree	0.24	0.03	0.000	0.19	0.30
Cattle Keeping experience					
<10yrs	0				
10-20'	0.91	0.02	0.000	0.86	0.96
>20yrs	1.20	0.03	0.000	1.14	1.26
How did you acquire cattle					
Dowry	0				
Inherited	-0.84	0.03	0.000	-0.90	-0.79
Purchased	-0.06	0.02	0.010	-0.10	-0.01
Did you sell any cattle in the last month					
No	0				
Yes	0.34	0.03	0.000	0.29	0.39

Challenges faced					
Cattle raids	0				
Land and water shortage	0.05	0.03	0.122	-0.01	0.10
Disease	-0.11	0.03	0.002	-0.17	-0.04
Do you have access to veterinary services					
No	0				
Yes	0.28	0.03	0.000	0.23	0.34

Test for multicollinearity

The check for the presence of multi-collinearity helped in detecting those factors that have relationships among themselves to exclude them from the model. In table 4.2, the VIF values are presented for each predictor variable, quantifying how much the variance of a coefficient is increased due to collinearity. The mean VIF of 2.91 suggests a moderate average level of multicollinearity across all predictors. Consideration of VIF values aids in assessing the impact of multicollinearity on regression results and guides decisions on variable selection or transformation to ensure reliable model outcomes.

Table 3 VIF test for multicollinearity

Variable	VIF	1/VIF
Age		
30-39	7.17	0.140
40-49	8.9	0.112
50 and above	5.53	0.181
Gender		
Female	3.44	0.291
Highest level of education		
Primary	2.07	0.482
Secondary	1.78	0.560
Tertiary	1.92	0.520
Marital status		
Single	3.09	0.324
Divorced/Widowed/Separated	2.26	0.443
Occupation		
On-farm(full time)	1.85	0.542
Average Monthly Income	1.51	0.662
Household size		
10-15'	2.36	0.424
>15	4.38	0.228
Is there Pasture scarcity		
Neutral	2.07	0.483
Strongly agree	2.63	0.380
Cattle keeping experience		
10-20'	2.79	0.359
>20yrs	2.9	0.345
How did you acquire the cattle?		
Inherited	2.55	0.392
Purchased	1.77	0.564
Purpose of cattle keeping		
Prestige	3.07	0.326
Dowry	2.68	0.373
Did you sell any cattle in the last months		
Yes	1.41	0.710
Challenges faced		
Land and water shortage	1.58	0.631
Disease	1.46	0.683
Do you have access to veterinary services		
Yes	1.58	0.631
Mean VIF	**2.91**	

4.3.2 Goodness of fit test

The goodness of fit for the model was tested using the F-statistic which was presented in the table 4.3 below. The F-statistic of 6.76 with 25 and 94 degrees of freedom is used to test whether the model as a whole is statistically significant; the associated p-value (Prob > F) is 0.0000, indicating strong evidence against the null hypothesis of no relationship. The R-squared value of 0.6426 indicates that approximately 64.26% of the variability in the dependent variable is explained by the model's predictors. The Adjusted R-squared value of 0.5475 considers the number of predictors in the model and adjusts the R-squared value accordingly. The root mean squared error (RMSE) is 39.662. Overall, the significant F-statistic and the substantial proportion of variability explained by the model suggest a good fit.

Table 4 F-statistic for goodness of fit test

Number of observations	120
F(25, 94)	6.76
Prob > F	0
R-squared	0.6426
Adjusted R-squared	0.5475
Root MSE	39.662

4.3 Factors influencing cattle numbers at multivariate analysis

The Modified Poisson regression results provide insights into the various factors influencing cattle keeping. Notably, gender proves to be a significant predictor, with female cattle keepers managing fewer cattle than their male counterparts (p-value = 0.002). Occupation also emerges as a noteworthy factor, where those engaged in full-time on-farm work tend to maintain a higher number of cattle (p-value = 0.042). Experience plays a pivotal role, with cattle keeping for over 20 years associated with a substantial increase in cattle count (p-value = 0.011). The

availability of pasture significantly influences cattle numbers, as respondents in agreement or strong agreement with pasture scarcity manage more cattle (p-value = 0.042; strongly agree, p-value = 0.016). Conversely, challenges such as disease (p-value = 0.648) and limited access to veterinary services (p-value = 0.655) are associated with fewer cattle. Other variables like marital status, education, and cattle acquisition method exhibit comparatively minor impacts. These findings highlight the intricate interplay of socio-demographic attributes, experience, resource availability, and challenges in shaping cattle keeping practices. The statistically significant effects underscore the importance of tailored strategies and interventions to promote sustainable cattle management across diverse contexts.

Table 5 Multivariate Poisson regression for the factors influencing cattle keeping

Number of cattle kept	**Coefficient**	**P-value**
Age		
20-29	0	
30-39	13.98 (20.83)	0.504
40-49	25.67 (21.85)	0.243
50 and above	2.91 (28.38)	0.919
Gender		
Male	0	
Female	-59.99 (18.4)	0.002
Highest level of education		
No education	0	
Primary	-10.14 (10.72)	0.347
Secondary	-3.1 (13.25)	0.815
Tertiary	-16.04 (19.07)	0.402
Marital status		
Married	0	
Single	0.93 (20.48)	0.964
Divorced/Widowed/Separated	1.27 (16.95)	0.941
Occupation		
Off-farm(part time)	0	
On-farm(full time)	20.25 (9.84)	0.042
Average monthly income	0 (0)	0.011
Household size		
<10	0	
10-15'	11.04 (11.15)	0.325
>15	41.23 (17.14)	0.018
Is there Pasture scarcity		
Agree	0	
Neutral	22.68 (10.99)	0.042
Strongly agree	29.42	0.016

	(11.98)	
Cattle keeping experience		
<10yrs	0	
10-20'	13.07 (12.43)	0.296
>20yrs	50.08 (19.21)	0.011
How did you acquire the cattle?		
Dowry	0	
Inherited	-10.14 (12.35)	0.414
Purchased	-9.78 (10.06)	0.333
Purpose of cattle keeping		
Source of income	0	
Prestige	14.63 (12.83)	0.257
Dowry	3.66 (11.99)	0.761
Did you sell any cattle in the last months		
No	0	
Yes	5.98 (9.72)	0.54
Challenges faced		
Cattle raids	0	
Land and water shortage	0.62 (13.07)	0.962
Disease	-6.25 (13.65)	0.648
Do you have access to veterinary services		
No	0	
Yes	5.02 (11.22)	0.655

Standard errors in brackets

4.4 Discussion and findings

The results of the multiple modified Poisson regression analysis indicated that gender, occupation, household size, cattle keeping experience, income of the household head were the determinants of cattle numbers among the Mundari households in Terekeka County. This was because they had a positive and statistically significant influence on the numbers of cattle owned by the households.

Demographic factors

The first significant predictor, gender, highlights an interesting gender disparity in cattle keeping. Female cattle keepers manage fewer cattle compared to their male counterparts. This observation aligns with broader gender-related roles in agriculture, where women might have different responsibilities and access to resources. This finding is consistent with a study conducted by Tavenner and Crane (2018), which reported similar gender-based differences in cattle management, emphasizing the need for gender-sensitive interventions.

Occupation emerges as another crucial factor influencing cattle keeping. This indicates that individuals engaged in full-time on-farm work tend to maintain a higher number of cattle. This could be attributed to their increased availability and commitment to cattle management. A study by Huffman (1993) found comparable results, linking occupation with cattle herd size, thereby reinforcing the notion that occupation has a substantial impact on cattle management practices.

Socio-economic factors

Household's size with members exceeding 15; is found to have a relationship with the number of cattle kept by the farmer. This suggests that households with more members are inclined to keeping larger number of cattle due to the free and adequate labour provided as compared to

households with fewer members. Education was significant factor in determining the number of cattle kept by the Mundari pastoralists' in South Sudan. That is education level of the farmer does not affect the number of cattle kept

Special factors

Experience in cattle keeping, exceeding 20 years, is also found to be significantly associated with a higher cattle count. This implies that seasoned cattle keepers have developed expertise and strategies that contribute to efficient cattle management. This finding echoes the work of

Boogaard et al. (2011), who noted that experience plays a pivotal role in livestock management decisions, leading to enhanced productivity over time.

The availability of pasture emerges as a significant factor influencing cattle numbers. Respondents who agreed or strongly agreed with pasture scarcity managed more cattle, suggesting that scarcity might prompt more intensive use of available grazing resources. This result is in line with studies by Boogaard et al. (2011) and (Mahmud et al., 2021), which underscored the influence of pasture availability on herd size and grazing practices.

Conversely, challenges such as disease and limited access to veterinary services were found to be associated with fewer cattle. This suggest that they might not be major drivers of cattle numbers in this context. However, these findings should be interpreted cautiously, as disease outbreaks can have substantial impacts that might not be fully captured in the regression model alone. A study by Mahmud et al. (2021) highlighted the complex relationship between disease, veterinary services, and livestock management.

Variables such as marital status, education, and cattle acquisition method exhibited minor impacts on cattle numbers. These findings suggest that while these factors might contribute to

variations in cattle keeping practices, their influence is overshadowed by other more significant predictors identified in the study.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMANDATIONS

5.0 Introduction

In this concluding chapter, a comprehensive summary of the findings, conclusions, and recommendations will be presented.

5.1 Summary of findings

Household heads with cattle keeping experience for over 20 years was significantly associated with large cattle count among them as compared to the household heads with less experience in keeping cattle. Household size consisting of 15 members and above tends to keep large numbers of cattle among the Mundari household pastoralists. The availability of pasture significantly determines cattle numbers among the Mundari households in Terekeka County.

Education was not a significant factor in determining the cattle herd size among the Mundari household heads that level of education of the household heads does not determine the number of cattle kept by the Mundari household heads. Majority of the household heads were male and were aged 40-49, and most of them who reared large numbers of cattle were the male-headed households compared to the females who reared fewer number of cattle among the Mundari households.

Household heads that were fully involved in on-farm full-time type of occupation owned larger number of cattle compared to those of off-farm part-time hence occupation was a significant factor in determining the cattle herd size among the Mundari households in Terekeka County. Cattle raiding was the major challenge faced by the pastoralists and their main purposes of keeping cattle were prestige and for dowry since they were mostly involved in polygamous marriages in South Sudan.

5.2 Conclusions

The study findings rejected the hypothesis that gender had no relationship with the number of cattle kept by the farmer since the p-values were less than 0.05, meaning that gender of the farmer determines the number of cattle reared among the Mundari pastoralists in South Sudan.

The study rejected the hypothesis that age of the farmer had no relationship with the number of the cattle kept by the Mundari farmers in South Sudan since the p-values were less than 0.05, this implies that age determines the number of cattle reared.

The study failed to reject the hypothesis that marital status of the farmer had no relationship with the number of cattle kept since the p values were more than 0.05. This implies that marital status does not determine the number of cattle kept by the Mundari households in South Sudan.

The study rejected the hypothesis that the household size of the farmer had no relationship with the number of cattle kept by the Mundari pastoralists/households in South Sudan since the p values were less than 0.05 for households exceeding 15 members.

The study rejected the hypothesis that the occupation of the farmer had no relationship with the number of cattle kept since the p values are less than 0.05 implying that the occupation of the Mundari pastoralists/households determines the number of cattle reared in South Sudan.

5.3 Recommendations

Based on the study findings the following recommendations were made;

The study findings revealed that female-headed households were less involved in cattle keeping practices; therefore, it recommends that the Mundari community and the South Sudan's government to create ventures for the females and also encourage them to participate in cattle keeping such that they can also develop economically through cattle keeping.

The government of South Sudan should enforce a tight security system in Terekeka County so as to cub the challenge and reduce/prevent loss of cattle as the findings showed that cattle raiding was the major challenge faced by the Mundari pastoralists/households in South Sudan

The study recommends for Community-based organizations to be developed and well-coordinated to help farmers share and solve their problems such as buying and selling cattle as a group for better bargaining power.

5.4 Areas of further research

The study did not assess the different types of diseases that affect the cattle and the various types of breeds by the Mundari pastoralists. Therefore, the study encourages further study on the breeds of cattle kept by the farmers and associated factors with the choice of the breed kept.

Factors affecting small-scale intensive cattle production among the Mundari farmers. This area of study will help to explain the limitations to large scale intensive cattle production, this can furthermore help to employ the innovative behaviours among cattle farmers in South.

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APPENDIX

Dear Sir/Madam,

My name is **DENYA STELLA PETER**, a third-year student from Makerere University pursuing a bachelor's degree in Statistics. As a requirement for an academic award, l am carrying out a research study titled **thedeterminants of cattle numbers among the Mundari pastoralists inSouth Sudan** and your household has been randomly selected to participate in the survey and your opinion would be of great value to my education. Be assured that the information collected from you will be treated confidential and this will few minutes of your time.

SECTION A: HOUSEHOLD CHARACTERISTICS

Code	**Question**	**Circle the right option/ write your response**
V01	Gender of the farmer	1- Male 2- Female
V02	Age	……years
V03	Highest education level attained by the farmer	1- None 2- Primary 3- Secondary 4- Tertiary
V04	Marital status of the household head	1- Single 2- Married 3- Divorced/Separated 4- Widowed

V05	Occupation status of the family head	1-On-farm(full-time) 2-Off-farm(parttime) 3-businessman 4- politician 5. others (specify)-------
V06	How many people live in your household?	1.1-5 2.6-10 3.11-15 4.16 and above

Code	**Question**	**Circle the right option/ write your response**
V07	How long have you been keeping cattle?	1.1-10 2.11-20 3.21-30 4.30 and above
V08	How many family members in your householdare involved in cattle keeping?	1.1-5 2.6-10 3.11-15 4.16 and above

V09	What is the price of cattle? (one)	…….
V10	What is your approximate monthly income	…….
V11	Have you sold any cattle in the last 12 months	1.Yes 2.No

SECTION B: SOCIO-ECONOMIC FACTORS

Code	**Question**	**Circle the right option/ write your response**
V07	How long have you been keeping cattle?	1.1-10 2.11-20 3.21-30 4.30 and above
V08	How many family members in your householdare involved in	1.1-5 2.6-10 3.11-15 4.16 and above

	cattle keeping?	
V09	What is the price of cattle? (one)	…….
V10	What is your approximate monthly income	…….
V11	Have you sold any cattle in the last 12 months	1.Yes 2.No
V12	For reason did you sell your cattle	1.Old animals 2.school fees 3.cash

V13	How did you acquire your cattle?	1-Inherited 3-Buy from market 2- Gift 4 - Dowry 5-Others (specify)….
V14	How doyou acquire replacement of your stock?	1-Rearm own 2-Exchange/butter 3-Buy from market 4-others (specify)….
V15	How many cattle did you inherit, buy or received as gifts?	

	Less than 50	More than 50	
Inherited			
Purchased			
Gifts			
Dowry			

V16	What is your purpose of keeping cattle?		**Strongly disagree**	**disagree**	**Neutral**	**Agree**	**Strongly agree**	
		Prestige						
		Source ofincome						
		Store of wealth						

SECTION C: CHALLENGES

CODE	Question	
V17	Do you face any challenges with cattle rearing	Yes No
V18	What challenges do you face in your area?	

	Strongly agree	Agree	Neutral	Strongly disagree	Disagree
Cattle raiding					
Diseases					
Water problems					
Pasture scarcity					
Land problems					

<table>
<tr><td>V19</td><td>What is the major challenge that you face in cattle keeping</td><td>----------</td></tr>
<tr><td>V20</td><td>Any other challenge that you face</td><td>----------</td></tr>
<tr><td>V21</td><td>How do you think these challenges can be managed?</td><td>
<table>
<tr><td></td><td>Strongly agree</td><td>Agree</td><td>Neutral</td><td>Strongly disagree</td><td>Disagree</td></tr>
<tr><td>Ensure security</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Provisions of water reservoirs</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Veterinary services provision</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Provision of more</td><td></td><td></td><td></td><td></td><td></td></tr>
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		land to cattle keepers					
		Animal feeds provisions					
		Others					
V22	Do you have veterinary services in your community	Yes No					
V23	How easy do you access veterinary services?	1.Very easy 2.Easy 3.hard 4.Very hard					

SECTION D OUTCOME VARIABLE

V24	How many cattle do you have?	…….

THANK YOU FOR YOUR RESPONSE