

**PROTAGONIST (CROP FARMERS AND CATTLE HERDERS)  
PERSPECTIVES OF CROP FARMER-HERDER CONFLICT AND  
SUSTAINABLE CATTLE PRODUCTION IN GHANA**

**KNUST**

**BY**

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## DECLARATION

“I hereby declare that this project is the result of my own research and that no part of it has been presented for another degree in this university or elsewhere. I also declare that the preparation and presentation of this project were supervised in accordance with guidelines on supervision of project laid down by the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana”.

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## ABSTRACT

The protagonist (crop farmers and cattle farmers) perspectives of crop farmer-herder conflict and sustainable cattle production in Ghana was investigated in two surveys and two animal experiments.

The first survey study evaluated the root causes of farmer-herder conflict and proposed possible solutions. Sixty (60) crop farmers from six communities in Agogo traditional area and 140 cattle herders from four districts were selected using a multi-staged sampling technique to obtain a sample size of 200 respondents. Data were collected using 200 structured questionnaires consisting of both open ended and close ended questions. The selected farmers were interviewed and asked questions relating to the set objectives. Focus Group Discussion (FGD) were conducted to validate the findings from the quantitative result. Descriptive statistics, specifically, the mode, frequency counts and percentages were used to achieve research objective. Cross tabulation was also employed to establish the relationships between the variables. Results of the survey indicated that 83.6% of the respondent are very youthful and active indicating that both crop farmers and cattle herders wanted to show their strength whenever there is misunderstanding. Majority of the crop farmers (68.0%) and the cattle herders (66.6%) who had basic education preferred other method of responding to disturbances than retaliation and those with no formal education opted for similar trend than to retaliate. The results implies that educational attainment had no direct effect on the choices they made. The respondents agreed that crop damages by cattle (83.3%), land encroachment (75%), contamination of water (85%), killing of stray animals (66.7%), pasture poisoning (61.7%) and cattle rustling (63.3%) are among the possible causes of the conflict. Majority of the respondent agreed that community and religious leaders are best in resolving conflict between crop farmers

and herders. They further agreed that ‘Operation Cowleg’ is not sustainable solution to the conflict. The study concluded with the recommendation that cattle farmers should be encouraged to acquire land to establish pastures for cattle and also frequent training workshop on pasture development and conservation for dry season feeding should be organized for them.

The second survey was conducted due to the influx of cattle from the conflict areas into the urban and the peri-urban areas and inadequate pasture for the animals in some selected communities in the Ashanti Region. One hundred and five (105) respondents were selected in seven communities within two municipalities to assess their awareness and willingness to cultivate pasture using semi-structured questionnaire. Variables considered in the survey included demographic characteristics of respondents, farm operation, management system, feedstuffs availability and knowledge about improved pasture. Descriptive statistics were used to analyze the data, and frequency and percentage tables and bar charts were used to present the results. The results showed that majority (99%) of the farmers were males and are within the age bracket of 21 to 30 years. Grass, kitchen waste, cassava peels, crop residue, and agro-industrial byproducts are some of the usual feeds that farmers in the study area used in feeding cattle. The major challenge faced by the respondents was shortages of feed and lack of fodder conservation technique. Also, majority of the respondents (75.7%) were unaware of improved fodder and 92.4% never attended any training on fodder and pasture development even though 99% confirmed their readiness to go into pasture development when planting materials are made available. It was concluded that integration of pasture establishment and improved forage technology in farming system in addition to adequate training on fodder conservation and animal feeding trials can support farmers in different way.

The first animal experiment assesses the effects of concentrate supplement on dry matter and water intake, nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet. Four N'dama bull calves averagely six months of age and weighing 61.63 kg were used in a 10-week (70 days) experiment of which 14 days were used for adaptation period and 56 days for data collection. Calves were housed and cared for individually in a well-ventilated and roofed pen. The animals were randomly assigned to one of four dietary treatments in a 4×4 Latin Square Design consisting of Napier grass only for T1 (Nap0<sub>Conc</sub>), T2, Napier grass + concentrate fed at 1.5% of LW (Nap1.5<sub>Conc</sub>), T3, Napier grass + concentrate fed at 2.0% of LW (Nap2.0<sub>Conc</sub>) and T4, Napier grass + concentrate fed at 2.5% of LW (Nap2.5<sub>Conc</sub>). During the 14 days adaptation period, the animals were adapted to the experimental diets after which they were individually weighed and randomly assigned to the four dietary treatments. The Napier grass basal diet was harvested at 60 days of planting and chopped into 10 cm lengths and fed individually to the calves. The results showed a significant ( $P < 0.05$ ) difference in DM intake, DM digestibility and nitrogen balance with the exception of the average daily water intake ( $P > 0.05$ ). The total DM intake of the animals was 36.92 kg, 42.37 kg, 44.55 kg and 44.74 kg for Nap0<sub>Conc</sub>, Nap1.5<sub>Conc</sub>, Nap2.0<sub>Conc</sub> and Nap2.5<sub>Conc</sub> respectively. It was concluded that supplementation of a Napier grass basal diet with different levels of concentrates significantly improved dry matter intake, nutrient digestibility, and nitrogen balance of N'dama bull calves compared with the control. In addition, supplemental concentrate did not influence the water intake of the animals.

In the second animal experiment, N'dama bull calves fed a basal diet of Napier grass with concentrate supplement were evaluated for their feed intake and growth performance. In a twelve-week experiment, 16 N'dama bull calves weighing 99.06kg

on average were assigned randomly to one of four dietary treatments based on their live weight in a Completely Randomized Design (CRD) consisting of Napier grass only for T1 (Nap0<sub>Conc</sub>), T2, openly grazed + concentrate fed at 1.0% of LW (OG1.0<sub>Conc</sub>), T3, Napier grass + concentrate fed at 1.5% of LW (Nap1.5<sub>Conc</sub>) and T4, Napier grass + concentrate fed at 1.5% of LW (Nap2.0<sub>Conc</sub>). The results showed a significant ( $p < 0.0001$ ) difference in live weight gain (LWG) due to treatment effect. There were significant ( $p < 0.0001$ ) differences in average daily gain (ADG) between OG1.0<sub>Conc</sub> (272.32 g/d) and Nap0<sub>Conc</sub> (421.11 g/day) but no difference was observed in ADG between Nap1.5<sub>Conc</sub> (575.6 g/day) and Nap2.0<sub>Conc</sub> (562.8 g/day). There were significant ( $p < 0.0001$ ) differences in DM intake and average water intake between the treatment bull calves and the control group. Concentrate supplementation did not significantly affect the haematological parameters measured ( $p > 0.05$ ) except the WBC count and the total protein level ( $p < 0.05$ ). There were significant ( $p < 0.0001$ ) differences in total feed and water cost and the least cost was recorded in Nap0<sub>Conc</sub> (GHS 261.07) followed by OG1.0<sub>Conc</sub> (GHS 370), Nap1.5<sub>Conc</sub> (GHS 445.44) and the highest in Nap2.0<sub>Conc</sub> (GHS 495.12) respectively. This study recommends that smallholder Farmers and large-scale Farmers could include concentrate at 1.5% BW in the diets of bull calves for improved performance.

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## CHAPTER ONE

### 1.0 GENERAL INTRODUCTION

The free-range system is the most widely used cattle production system in Ghana. In this system, the animals are herded to scavenge for fodder on natural pastures/rangeland and communal grazing land early in the morning and returned to the 'kraal' late afternoon or at sunset with or without supplementary feed (Abdul Aziz et al., 2020). The animals are allowed in most cases access to water in the 'kraal' in plastic or metal containers. The majority of cattle herdsman are transhumance pastoralist popularly known as Fulani herdsman who herd their cattle to places where they can find grazing pastures and water for the cattle. The major problem facing the cattle herders is inadequate and shortage of forages and other feeding materials due to seasonal fluctuation of rainfall distribution. In the wet season, there is abundant and nutritious forages for grazing animals but they become unavailable to the animals due to arable crop farming. However, the quality of the natural pasture becomes very low to meet the nutrient requirement of the cattle in the lean season.

Crop residues which could serve as a cattle feed in the lean season are burnt off as crop farmers prepare their fields for the next cropping season or as result of wild bushfires. The uncontrolled burning of the crop residues also affects the grass on the field. Similarly, the scarcity of forages causes the migration of herdsman from the Sahel and northern savanna regions of Ghana to the southern part searching for water and grazing pastures for the livestock. Ofuoku and Isife (2009) observed that the burning of pasture in the lean season causes the southward movement of pastoralist to the coastal zone in the wet season in search of grassland and water. The situation compounds when alien Fulani herdsman also enter the country from other Sahel regions of West Africa such as Burkina Faso, Mali, Niger and Nigeria (Tonah, 2006)

to graze their cattle in areas like Kumawu, Agogo, Kintampo, Atebubu, Ejura and other parts of southern Ghana. The influx of the alien herders together with their uncontrolled movements of their cattle most often creates tension with the arable crop farmers.

The relationship between the crop farmers and cattle herders should be seen as mutual by beneficial because they interdepend on each other for survival (Azeez, 2015). Arable crop farmers need animal protein as well as manure for their survival and soil fertility improvement respectively while cattle herders also need the crop farmers to supply them with food and farmlands to graze their animals after harvest. However, the mutual relationship has been confronted with several problems as grazing cattle sometimes destroy farms of indigenous people leading to conflicts, family displacement, burning of farmland and properties, closure of schools and businesses, death among others. Azeez (2015) reported that, in recent times, farmer-herder conflict has become a common feature in West Africa. This phenomenon has an effect on both lives and properties as well as co-existence.

One of the major causes of these conflict is largely as a result of inadequate feed and water resources in the dry season and this result in cattle trespassing into crop farms causing destruction of farmlands and farm produce. The farm destruction mostly occurs at night due to the uncontrolled movement of the cattle by the herders. Baidoo (2014) reported that the failure of the herders to regulate cattle movement especially at night-time makes the destruction of farms inevitable. Additionally, Baidoo (2014) also stated that the larger proportion of the crop damage happens as a results of water scarcity during the dry season and the Fulani herders depends mostly on the field crops mostly fruits (plantain and water melon) as sources of water for their cattle.

Agogo and its surrounding communities are suitable for food crop cultivation and rearing of cattle as a result of its favourable climatic condition and soil fertility. These factors attracted many farmers including Fulani herdsmen from different parts of the country for their agricultural activities (Baidoo, 2014). The crop farmers always accused the cattle herders of farm destruction by the grazing animals especially in the dry season and that has led to seasonal tension in Agogo and the surrounding township like Nyamebikyere, Bebuso, Kowireso, Mankala, Brahabebome and Abrewapong. There are several protests by the indigens of Agogo area in the Ashanti Region for authorities to expel the Fulanis' with their cattle from their community. The protest was as a result of crop destruction by the grazing cattle. As a means of expelling the herders together with their cattle from Agogo, the government of Ghana revisited an expulsion policy called "Operation Cowleg" as recommended by Dadson committee set by REGSEC in 2010 through the use of Military and Police Task Force. The 'Operation Cowleg' is been carried out to drive the animals from the conflict zone like Agogo and other areas such as Kintampo, Gushegu, Kumawu, Asante Mampong and this has led to an increase number of cattle in urban and peri-urban areas. Previously, only few individuals in the urban centres kept cattle for fattening unlike the small ruminants such as sheep and goat. The cattle population in the urban areas keeps increasing and is becoming a nuisance as they cause road traffic, polluting the environment with their faecal output and again causing damages to properties. Furthermore, most of the research works in Ghana related to crop farmer and herder conflict has focused on the causes and effects of the conflict without pointing out a sustainable and everlasting solution. In order to mitigate the recurring conflict, there is the need to explore a more scientific and modern method of cattle rearing and this can be achieved by cattle intensification, pasture establishment with paddocking system.

This can significantly solve the perennial clashes between the arable crop farmers and the cattle herders as well as trespassing arable crop farms.

### **1.1 Problem Statement and justification**

Pasture and forages are very important for the nutrition of cattle production in the World. These forages may be natural or planted pastures. In Ghana, natural pastures are more superfluous and nutritious with high carbohydrates and protein content during the early part of the wet season when the forage is fresh and young. Cattle may be allowed to go out to graze on these forages or harvested fresh and feed to the cattle in zero grazing system. However, this forage may be unavailable to the free-range animals due to continuous crop production during this time of the season. The natural pastures become fibrous and of low nutritional quality during the dry season and this affect cattle performance.

In Ghana, forage cultivation is not a common practice in cattle production as most agricultural lands are used for human settlement, road construction and expansion, cultivation of food crops and other infrastructural development. Livestock farmers usually use agricultural by-products as feed supplements but some may contain anti-nutritional factors. The Fulani herders also extensively graze their cattle especially during the lean season in search of forages and water. Their inability to control the movements of the grazing cattle leads to the cattle trespassing into the field crop to cause destruction of crops. The cattle sometimes pollute water bodies through their faecal outputs. These result in fluctuations in the growth rate, emaciation and compromised immunity as the nutrient requirements of the animals are not met. There is therefore, the need to cultivate forage that gives higher biomass yield with shorter maturity period and higher digestibility for the general improvement in animal growth

performance. Elephant grass or Napier grass (*Pennisetum purpureum*) produces a lot of fodder in areas with sufficient rainfall distribution and improved soil fertility (Wangchuk et al., 2015). It is a preferred feed for smallholder livestock producers in East Africa and accounts for up to 80% of the fodder produced (Wangchuk et al., 2015). Napier grass has been widely cultivated in East Africa according to Lowe et al. (2003) because of its rapid growth and higher biomass yield.

The herbage of forages consist mostly of leaves in their early stages of growth and the stems makes a greater percentage of the forages with age. Harvesting date may affect the herbage yield of Napier grass. Herbage yield increases with age because of the vigorous growth in the plant tissues (Minson, 1990). Ansah (2010) recorded a yield of 22489 kg/h DM with 60 days of harvesting and a higher yield of 46013 kg/h DM with 120 days of harvesting respectively. This characteristic of the Napier grass makes it suitable for pasture establishment for feeding livestock in the cut and carry system as well as conserving it into hay and silage for feeding ruminants in the lean period.

Forage digestibility is very important tool in estimating intake and general performance of cattle. Feed digestibility is the ability of the cattle to breakdown the complex feed such that it provides the necessary nutrient required for the its growth. Generally, low feed intake by the cattle is an indication of low digestibility of the feed. Younger plants are highly digestible than the older plants due to lignin content in the older plants. Ansah (2010) reported that measuring the nutritive composition and digestibility is an essential aspect of detecting beneficial forage to ruminant. The individual composition of a feed can be evaluated in the laboratory and each component related to the nutrient value of the feed, but the interaction between components and digestibility of the feed for a given animal may differ (Ansah, 2010).

In order to assess the digestibility of a given feedstuff, the productivity of an animal fed the particular feedstuff is the best measure but feeding trials are laborious, expensive and time-consuming (Terry, 2010). Research regarding intensive cattle feeding trial using Napier grass in Ghana is scanty. The objective of this research however was to assess protagonist (crop farmers and cattle farmers) perspectives of crop farmer-herder conflict and sustainable cattle production in Ghana.

### **1.2 Study questions to be answered include the following:**

- What are the causes of farmer-herder conflict and possible solution to the conflict?
- What are the awareness and willingness of urban and peri-urban cattle farmers on pasture cultivation and/or purchase of forages?
- What are the effects of concentrate supplement on nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet?
- What are the effects of concentrate supplement on feed intake, growth performance and blood parameters of N'dama bull calves fed Napier grass basal diet?

### **1.3 Objectives**

The general objective of this study was to assess the protagonist (crop farmers and cattle farmers) perspectives of crop farmer-herder conflict and sustainable cattle production in Ghana.

The specific objectives of the study are:

- To assess the causes of farmer-herder conflict and possible solution to the conflict.
- To assess the awareness and willingness of urban and peri-urban cattle farmers to cultivate pasture and/or purchase forages
- To assess the effects of concentrate supplement on nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet.
- To assess the effects of concentrate supplement on feed intake, growth performance and blood parameters of N'dama bull calves fed Napier grass basal diet.

#### **1.4 Outline of the study**

To address the research objectives, four experiments were conducted. Two separate survey experiments and two animal experiments were conducted to understand the trend and perception of the cattle farmers on animal feed resources and feeding animals under zero grazing system. The first survey was carried out to assess the causes of farmer-herder conflict and possible solution to the conflict. The second survey sought to assess the awareness and willingness of urban and peri-urban cattle farmers to cultivate pasture and/or purchase forages. Two additional feeding experiments were conducted; Experiment I one was conducted to determine the effects of concentrate supplement on nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet. In experiment II, feed intake, growth performance, blood parameters and economic benefits of N'dama bull calves was determined when a basal diet of Napier grass was supplemented a concentrate diet.

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1 Trend of cattle production in Ghana

Livestock sector contribution to agricultural GDP is estimated to be 9.2% as reported by MoFA (2020). It is the lowest figure the country has recorded from 2013 as shown in Table 2.1. This figure does not include contribution of animal traction and manure to crop segment (MoFA, 2020). Farm animals are slaughtered for various reasons in Ghana. Generally, cattle, sheep and goat are often slaughtered when celebrating festivals like the Islamic Eid (Eidul-adha) and Christmas and other ceremonies (naming, marriage and funerals) as well as for sales in the various market outlets.

**Table 2.1: Contribution (%) of Livestock sector to GDP from 2013 to 2019**

Year	Contribution to GDP
2013	12.1
2014	12.6
2015	11.6
2016	10.0
2017	9.7
2018	9.6
2019	9.2

Source: MoFA, 2020

The contribution of cattle production to Ghana agricultural sector cannot be underestimated. Basically, in rural settlements, cattle are used as a measure of one's wealth and as collateral for bank loans (MoFA, 2018). Furthermore, cattle dung is used as manure or compost for improvement and maintenance of soil fertility (MoFA, 2018). According to MoFA (2011), about 75% of Ghana's cattle population comes from the northern part of Ghana. As indicated in Table 2.2, cattle population has

increased to about 32.6% between 2013 to 2020. The population of sheep and goat also increased by 33.4% and 42.2%, respectively (MoFA, 2020).

**Table 2.2: Livestock Population Trend ('000)**

Species	2013	2014	2015	2016	2017	2018	2019	2020
Cattle	1,590	1,657	1,734	1,815	1,901	1,943	2,032	2,109
Sheep	4,156	4,335	4,522	4,744	4,978	5,102	5,333	5,544
Goat	5751	6,044	6,352	6,740	7,151	7,366	7,764	8,180

Source: SRID/MoFA, 2020

The domestic production of meat has been inconsistent in recent times (Table 2.3).

The total domestic production of ruminant (cattle, sheep and goat) meat increased from 62, 995 MT in 2013 to 85, 849 MT in 2020 (Table 2.3) representing 36.3% increase over that period.

**Table 2.3: Domestic Meat Production (MT) from 2011 to 2020**

Species	2013	2014	2015	2016	2017	2018	2019	2020
Cattle	21,863	22,781	23,841	24,961	26,134	26,716	27,936	28,999
Sheep	18,703	19,507	20,347	21,349	22,399	22,959	23,999	24,948
Goats	22,429	23,573	24,774	26,285	27,889	28,727	30,278	31,902
Total	62,995	65,861	68,962	72,595	76,422	78,402	82,213	85,849

Source: SRID, 2020

Ghana mostly depends on imported livestock, meat, and milk to supply its needs for animal protein. However, it is challenging to assess the quantities of animals imported from neighboring nations because they are not well documented. In 2020, 192, 546 MT of frozen meat was imported into the country (Table 2.4). Poultry recorded the highest percentage (76.9%) and the least percentage was recorded by pork (1.8%) (MoFA, 2020).

**Table 2.4: Quantity of Frozen Meat Imported (MT) from 2016 to 2020**

<b>Meat Category</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
Poultry	100,477	151,346	204,755	153,448	148,118
Pork (Swine)	9,480	5,748	3,082	2,914	3,559
Bovine (Cattle)	24,682	28,913	30,440	18,931	37,026
Sheep and Goat	5,136	3,685	3,541	2,041	3,844
Total	139,775	189,692	241,818	177,334	192,546

Source: MoFA, 2020

Meat consumption is becoming increasingly important in the Ghanaian diets for supply of animal protein. Annual consumption of meat especially for beef, mutton and chevon has increased as a result of increasing incomes and growing urban populations with changing consumption patterns. The annual per capita consumption of meat in Ghana was about 16.2 kg (MoFA, 2018). The low level of domestic cattle meat production makes it impossible to meet the local market demands. In 2018, about 372,052 MT of meat were consumed in Ghana (Table 2.5). The same report states that local production account for only 41% of total meat consumption, with additional annual imports (59%) of meat making up the deficit. Poultry recorded the highest imported meat (84.7%) consumed in Ghana followed by beef and veal (12.6%), chevon and mutton accounted for 1.5% and pork recorded the least imported meat (1.3%).

Furthermore, despite the shortfalls, the gap in local production has been met by the import of live animals particularly ruminants (Cattle, sheep and goat) from neighbouring countries like Niger, Burkina Faso and Mali and importation of mostly frozen meat (MoFA, 2018). Production of cattle is mostly transhumance where Fulani nomads normally trek distances with the animals for grazing pastures. This calls for research-based policy intervention to identify potential strategies for revitalizing the beef industry to increase production.

**Table 2.5: Market supply of meat (MT) in 2018**

Type of meat	Consumption	Production	Imports	Self-sufficiency rate (in %)
Poultry meat	241, 538	55,784	185,747	23.1
Pork	28,553	25,757	2,796	90.2
Beef and veal	51,860	24,236	27,624	46.7
Sheep meat	50,100	20,828	3,212	93.6
Goat meat		26,061		
Total	372,052	152,671	219,422	41.0

Source: MoFA, 2018

### 2.1.1 Marketing channels for cattle and agents in Ghana

The marketing of cattle and their products (meat and milk) is an important activity all over Ghana. The cattle value chain generally involves cattle owners, herdsmen, middlemen and butchers. In the kraal or cattle market, the animal transaction is largely by visual assessment or appraisal between the parties involved. The use of weighing scale is not common in this type of market. The price of the animal often depends on the time of the season, availability of the animal and the location. The animals are expensive in the festive season and the price falls few days after the festivals. Furthermore, the exchange rate also has an influence on the price because most cattle are transported from the neighbouring countries. According to MoFA (2009), cattle are often transported from Ghana's northern regions and the Volta basin to the south. Articulated trucks or long vehicles are usually used in transporting the animals from the north or neighbouring countries to the south. Additionally, people engaged in cattle business also move to other parts of the country notably Ejura (Ashanti Region), Yeji (Bono East Region) and Bupei (Savannah Region) to buy cattle. The cattle are then transported to the local market hubs to be distributed to butchers, small-scale producers, and individual consumers. The Kumasi abattoir is the main site for the sale of cattle and other livestock in the Ashanti Region. (Figure 2.1).



**Figure 2.1: Cattle market at the Kumasi abattoir**

Source: Author (Fieldwork, 2022)

### **2.1.2 Constraint to increased cattle production**

The major constraint of cattle production in Ghana is inadequate and seasonal shortage of feeds and feeding materials due to seasonal variation of rainfall distribution pattern. In the rainy season, there is plentiful and nutritious forages for grazing animals but they become unavailable to the animals due to arable crop farming. Furthermore, in the dry season, the forage quality becomes very low to meet the nutrient requirement of the cattle. Annor and Adongo (1992) stated that the quality and quantity of natural pastures decreases to the extent that they are unable to meet the nutritional requirements of the for maintenance of body weight.

Infestation by pests and diseases is yet another issue that impacts Ghana's cattle industry. Another significant setback to national ruminant productivity is helminth. Helminthes infestation are generally associated with low production and a high calves' mortality rate (MOFA, 2018). Similarly, improper housing leads to low productivity and mortality, poor feeding, and pest and disease control. To preserve the long-term

sustainability of the livestock sector, alternative strategies in the production of cattle must be researched.

## **2.2 Breeds of Cattle in Ghana**

In Ghana, majority of cattle breeds are of the beef breed. The West African Shorthorn (WASH) is Ghana's most identifiable humpless cattle breed, with coats that are often white and black, but can also be yellowish brown and white (Aboagye, 2002). The West African Short Horn (WASH) is a short and broad indigenous breed. The trypanosomiasis-prone Zebu breeds are mostly found in the northern boundaries, particularly in the northeastern region, where tsetse fly incidents are much lower. N'dama, Sokoto Gudali, White Fulani, Muturu, and Sanga are among the various cattle breeds found in Ghana.

### **2.2.1 N'dama Breed**

The N'dama breed is the most representative "Bos Taurus" and trypanosomiasis tolerant breed in West Africa (ILCA, 1979). The breed, which originated in Guinea's Fouta Djallon regions, is now widespread throughout coastal west and central Africa especially in tsetse fly-infested areas (DAGRIS, 2005). Because N'dama cattle are trypano-tolerant, they can be reared in tsetse fly-infested areas. The N'dama is a tough breed with a small body (Figure 2.2). They are typically fawn in color, but can range from sand to black and are occasionally spotted. They have short legs and a thick, deep neck. Their back is broad, fleshy, and straight from the withers to the tail head. They have a short, broad head and a wide muzzle. Both bulls and cows commonly have horns, and these horns typically have a lyre-shaped or upward and outward curvature. Both the dewlap and the umbilical folds of N'dama cattle are

underdeveloped. Spencer and Eckert (1988) reported that the average height of a cow at shoulder level is about 100 cm, and that of a bull is about 120 cm. The beef conformation of N'dama cattle distinguishes them from other cattle breeds. The average birth weight recorded in areas with low of trypanosomiasis was 19 and 22 kg (Spencer and Eckert, 1988). The mature live body weight of cows is 250 to 330 kg, while bulls weigh between 320 and 360 kg (Mason, 1996). The meat has a great flavor and is relatively lean, with a dressing percentage of about 50% (Maule, 1990). N'dama cows produces about 2 – 3 liters of milk each day since they are not particularly efficient milk producers (Payne, 1990). The breed, however, is excellent for producing meat.



**Figure 2.2: N'dama cattle**

Source: Author (Fieldwork, 2019)

### **2.2.2 Sokoto Gudali Breed**

The Sokoto Gudali (Figure 2.3) is one of the five Gudali breeds found in northern Ghana, Nigeria, Mali, and Benin (Tawah and Rege, 1996). The additional strains include Yola Gudali, Ngaundere Gudali, Adamawa Gudali, and Banyo Gudali. Ghana

has a small Gudali population in comparison to Nigeria, Cameroon, and the Central African Republic. Gudali, a Hausa word, is a description of "short-horned and short-legged creatures." The humped cattle are known as Sokoto Gudali. The male has dark with bluish grey shadings, while the female has medium thick, loose, and pigmented skin that is pale creamy in color (Tawah and Rege 1996). Pendulous ears and small horns are features of the animal, with the female's horns being slightly longer. Because the females' udders are well developed and have good teats, they are considered an indigenous dairy breed. They are also well-known for producing meat. At maturity, the female weighs approximately 330 kg, while the male weighs approximately 450 kg. Under direct hand and machine milking on station, the female produces an average of 1101.3 liters of milk over the course of a lactation that lasts 244.8 days. The average height of the bull at the withers ranges from 130 to 138 cm, while heifer have average height of 116 to 132 cm (Tawah and Rege, 1996). Because of their slow and sluggish character, they can be used for draft, such as ploughing and carting farm produce.



**Figure 2.3: Sokoto Gudali**

Source: Author (Fieldwork, 2019)

### 2.2.3 White Fulani

The White Fulani cattle breed, also known as Bunaji, is a Fulani-related breed that originated in Northern and Southern Nigeria, the Northeastern region of Cameroon, and western Sudan. There, they are referred to as Fellata and red Fulani, respectively. They later spread to the south of Chad and western Sudan (Glowatzki-Mullis et al., 1995). Approximately 95% of the Nigerian nation's herds are White Fulani breeds, which makes up nearly half of the total (Franklin, 1997).

The white coat color on black skin is a distinguishing feature of White Fulani (Fig. 2.4). Generally, they have black muzzles, tail tips, hooves, ears, and horn tips. Dewlap and thoracic or occasionally intermediate hump are well developed on them. Generally speaking, they have bodies that are narrower and taller, and while their rump is long, it does have a distinct slope from hook to pin bones. They have a long, robust neck, which supports their wide-foreheaded heads that appear straight or concave and carry them upward. They have thin, medium-to-long (80-105 cm) lyre-shaped horns that are bent upward and outward (Santoze and Gicheha, 2019). Their udder is well-developed and has teats that are well-positioned (Tawah and Rege, 1996). White Fulani cattle are adapted to long distance walking due to their long legs and shallow body (Kubkomawa, 2017).

They make excellent beef cattle and fatten well in feedlots and on rangeland. The average birth weight ranges from 18.2 to 24.2 kg. Mature body weights for the bull and cow of White Fulani reach approximately 500 and 325 Kg, respectively (Ou'edraogo et al., 2021). Well-finished steers had slaughter and carcass weights of 325 and 166 kg, respectively. The dressing percentage is 50-60% and the average age at first calving is 40-49 months with calving interval of 403 days on the average

(Tawah and Rege, 1996). The cows are excellent milk producers, producing an average of 627 to 1034 liters of milk per lactation. Osman et al. (2019) reported a daily milk yield of 4.50 liters. Their average lactation period lasts about 286 days (Ayantunde et al., 2005).



**Figure 2.4: White Fulani**

Source: Author (Fieldwork, 2019)

### **2.3 Vegetation in Ghana ecological zones**

The diverse West African vegetation which runs from the Sahara to the Gulf of Guinea includes the vegetation of Ghana which allows natural grazing. The principal plant ecosystems in this area include the coastal mangrove, coastal savanna, woodland, derived savanna, and inner savanna (Benneh et al., 1990). Ghana's natural pasture is influenced by these ecological zones (Figure 2.5).

The forest zone spans around 135,670 km<sup>2</sup> of land. It is separated into semi-deciduous woodland and rain forest. The forest zone is distinguished by having a higher average annual temperature than the coastal zone and well-distributed yearly rainfall of between 1500 and 2200 mm. The forest zone has an even tree cover that is 30 to 40 meters high and encourages very quick plant development (Barnes and Addo-Kwafo, 1996). Compared to the Savanna zones, pasture resources in the woodland are not as considerable (Benneh et al., 1990). However, there are areas of the forest floor that have an herbaceous layer with a few grasses. According to Oppong-Anane (2010), the significant infestation of tsetse flies and other parasites makes ruminant production difficult in this forest zone. Thus, food and tree crop production are the main priorities of this region's agriculture.

The savanna zone covers approximately 129,000 km<sup>2</sup>. The inner savanna has a continuous grass cover and scattered trees that can withstand fire and are found in Guinea and Sudan savanna (Oppong-Anane, 2013). Approximately 7,200 km<sup>2</sup> in area, the Sudan Savanna is a patch of degraded grassland vegetation on Ghana's northern border that is distinguished by its short grasses (Benneh et al., 1990). The grasses are not homogeneous and vary depending on soil type and moisture regime. *Andropogon gayanus* and *Pennisetum sp.* are major grass species, with *Hyparrhenia* and *Schizachyrium* co-dominant in some locations (Benneh et al., 1990).

The mangrove vegetation is found along the coastline, estuaries and lagoons. This zone's overall size is tiny, it has a high pest population, and pastures there are consequently only marginally significant. The growing season for annual vegetation in the coastal savanna zones unlike the northern savanna persists for seven months with five months fallow periods (Benneh et al., 1990).

The guinea savanna zone is found in the northern part of Ghana. The vegetation in these zones is characterized by a degraded woods with tall grasses including Napier grass (*Pennisetum purpureum*) and Guinea grass (*Megathyrsus maximus*) (Fianu *et al.*, 2001). In these agro-ecological zones, vegetation grows according to the pattern of rainfall (Fianu *et al.*, 2001).

Ghana's savanna zone, which is separated into the coastal and interior savanna zones, is characterized by grassland vegetation (Duku *et al.*, 2010). On lighter soils with regular grazing or crop cultivation, *Chrysopogon fulvibarbis* and *Imperata spp.* dominate the grass cover of the coastal savanna while *Ctenium newtonii*, *Brachiaria falcifera* and *Andropogon canaliculatus* are found in gravel-dominated soils (Timpong-Jones *et al.*, 2013). *Megathyrsus maximus*, *Hyperthelia dissolute*, and sometimes *Andropogon gayanus* are markers of the superior pastures in the more humid regions towards the northwestern edge of the Accra plains (Fianu *et al.*, 2001).

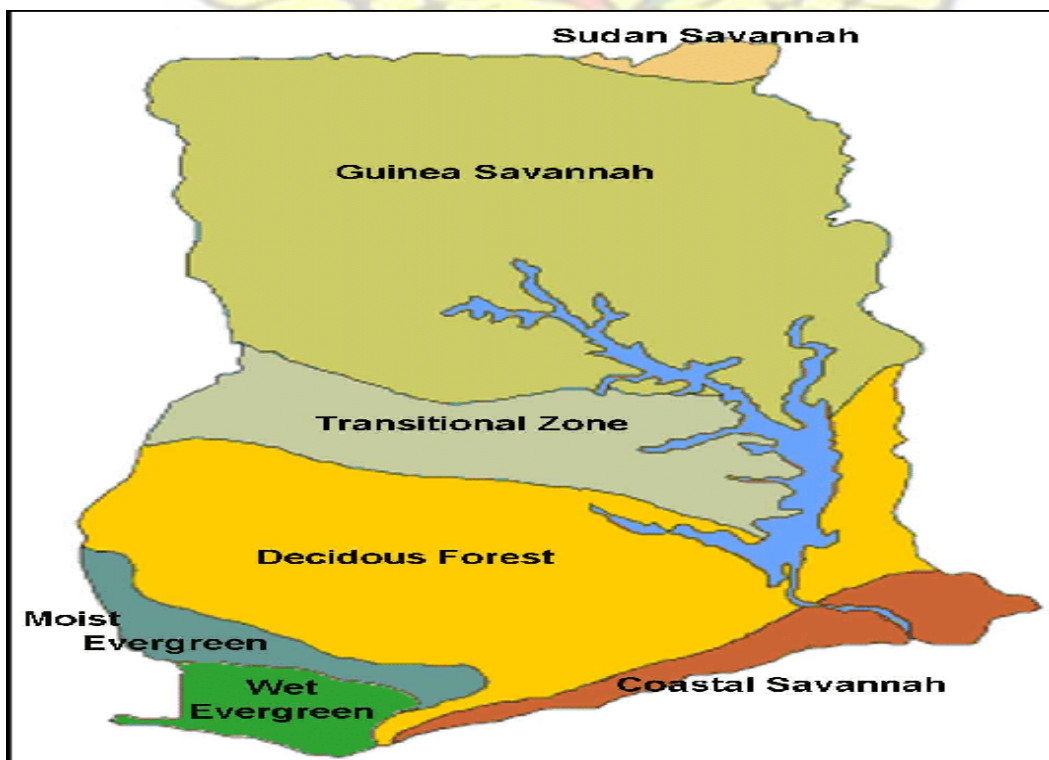


Figure 2.5: Map of Ghana showing the various ecological zones

### 2.3.1 Rangeland/Natural Pastures

A pasture is any plant resource such as grasses, legumes or herbaceous plants that serves as food for livestock, either directly in grazing or as fodder and can be natural or artificially established on an area of land. Unlike the artificial or cultivated pasture, the farmer intentionally establishes or cultivate the forage crop on an expanse of land for grazing livestock with or without paddocks, pastures on the rangeland occurs naturally for grazing animals on a large expanse of land. Rangelands are made primarily of native forage plants and are frequently grazed. This occurs in pastures utilized for long-term grazing, as well as in cultivated and uncultivated terrain. The grazing animals always prioritize the species that are the palatable (Solomon and Alemu, 2009). Natural pasture accessibility and nutritional value vary according to height, rainfall, soil type, and crop intensity. In the highlands, grass production averages around 4 tonnes per hectare (Alemayahu, 2002). Oppong-Anane (2001) estimates that Ghana has 360 000 km<sup>2</sup> or 15% of its total land area as permanent natural pastures. The majority of natural pastures have low nutritional value in terms of crude protein (CP), vitamins, and minerals, in addition to having relatively high concentrations of weeds and invasive species that are harmful to grazing animals (Oppong-Anane, 2001). At the beginning of the rainy season, the CP content is estimated to be around 8–12% DM, but falls to 2–4% DM during the dry season (Oppong-Anane, 2001). The concentrations of phosphorus range from 0.16 to 0.06% DM. Forages from bushes and fodder trees are extremely high in protein (12%) as well as other nutrients (Oppong-Anane, 2001). Annual burning and overgrazing are also a common feature on rangelands but produces good quality herbage under proper managements (Oppong-Anane, 2001).

### 2.3.2 Artificial/Cultivated Pastures

Artificial or cultivated pastures are intentionally and consciously cultivated by the farmer using seeds, stem cuttings or stolon on a well-prepared land for grazing livestock to increase production. The pasture may be of short duration as part of the rotational system or may be of long duration as permanent pasture (Eric, 2017). Cultivated pastures give higher biomass yield and superior nutritional value than the natural pastures under good management practices. Within different ecological zones in Ghana, many different fodder plants have been tested for adaptation, and some viable species have been recommended for various zones (Cudjoe, 2017). The use of enhanced forages at institutions including government ranches, state farms, universities, colleges, farmers' demonstration plots, as well as dairy and fattening areas in certain African nations, has been reported by a number of researchers (Dzimale, 2000; Alemayehu, 2002; Ansah, et al., 2010).

Some of the grasses used to establish artificial pastures in Ghana include Guinea grass (*Megathyrsus maximus*), elephant grass (*Pennisetum purpureum*), Brachiaria grass (*Brachiaria decumbens*), giant star grass (*Cynodon plectostachyus*), and carpet grass (*Axonopus compressus*). Centrosema (*Centrosema pubescens*), stylo (*Stylosanthes graccilis*), tropical Kudzu (*Pueraria phaseoloides*), and pigeon pea (*Cajanus cajan*) are the important legumes used for pastures establishment (Eric, 2017). Well-managed pastures are vital for good animal performance (Arseneau, 2010).

### 2.3.3 Establishment of Napier Grass Pasture

Elephant grass (*Pennisetum purpureum*) is another name for Napier grass. It was named after Colonel Napier of Bulawayo, Zimbabwe, who urged Rhodesia's (now Zimbabwe's) Department of Agriculture to study the possibility of using it for

commercial cattle production early in the twentieth century (Boonman, 1993). Napier grass is a hardy perennial fodder with a deep root system, stolons and creeping stems, and roots and shoots that form at the nodes and tip. The grass was originally found in eastern and central Africa, and it has since been spread throughout the majority of tropical and subtropical countries. Elephant grass is a vigorous perennial grass that may grow up to 5 meters tall and forms dense clumps or colonies from basal offshoots or short rhizomes (Langeland, 2008). Due to its tall nature, it is not suitable for grazing but can be used in cut-and-carry system for livestock feeding or conserved into hay or silage for dry season feeding. Ansah *et al.*, (2010) reported a yield of 22,489 kg/h DM and at 46,013 kg/h DM at 60 and 120 days of harvesting respectively. Ansah *et al.*, (2010) also reported a CP content of 10.99% DM, 8.63% DM and 7.99% DM for 60, 90 and 120 days at harvesting respectively. The NDF values recorded were 68.6%, 72.03% and 76.5% while the ADF values were 48.7%, 50.6% and 51.2% for 60, 90 and 120 days of harvesting respectively (Ansah, *et al.*, 2010). This, among other characteristics, make Napier grass suitable for pasture establishment.

Establishment of Napier grass pasture depends on several factors such as land availability, species adaptation, soil condition, location, time of maturity, availability and the cost of the planting material, cost of fencing, rainfall pattern of the area and ease of establishment among others.

The first important steps in Napier grass pasture establishment are the land preparation. The land is prepared by cutting down the trees and stump removal which is then followed by ploughing and harrowing to losing the soil particles. Cook *et al.* (2005) observed that land preparation and controlling of weeds are very crucial in

ensuring good establishment of grasses which can last long in the soil for several years. Sandy soil is not suitable for Napier grass establishment and it does best in deep, fertile and a well-drained loamy soil. Cook *et al.* (2005) reported that Napier grass can grow on a variety of soil types, but it thrives in deep, rich soils like friable loams. It can also grow on sandy soils with a pH range of 4.5 to 8.2 and poorly drained clays with a texture that is quite heavy. Soil fertility testing is necessary to determine whether fertilization is required or otherwise. The prepared field is then fenced to prevent encroachment of strayed animals from disturbing and destroying stake stems on the field. Time of the establishment of the grass should correspond to the rainy season which is key climatic factor that affects the general productivity of pasture crops. Ansah *et al.* (2010) reported a higher biomass yields in areas with an annual average rainfall of 843 mm. If irrigation is to be used, the sprinklers must be well connected on the field for best functioning. After field preparation, the planting material generally the stem cutting is well prepared and cut to three nodes. Two-third of the node at a slanting position at an angle of 30 – 45° is then buried in the soil 15 – 20 cm deep in a straight line, ensuring that the two nodes are covered by the soil with 50 cm between plants and 100 cm between rows.

According to Mannetje (1992), the plant produces relatively few seeds and is often propagated vegetatively by stem cuttings with at least three nodes, two of which are buried in rows. After planting, the pasture must be kept clean of weeds. Weeding should be done as soon as possible after planting and continued during the entire growing period. Weeds can also be controlled using broad-leave herbicides at the time of pasture establishment. They tend to reduce the quality of pasture particularly when they invade large portion of land in the pasture. Weeds turn to compete with the pasture plant for space, nutrient, sunlight and moisture which could possibly affects

its growth. Other management practices such as pest and disease control and fertilizer application are necessary to maintain a good balance of the Napier grass.

For a higher biomass output, Napier grass should be harvested when it reaches a height of 1 to 1.2 meters, roughly 90 to 120 days after planting. Napier grass currently has a sufficient amount of high-quality dry matter. After that, when the grass reaches the same height, it should be harvested every six to eight weeks. To encourage more development of new shoots during the initial harvest, it is advised that the cutting be done 5 cm above the ground.

#### **2.3.4 Limitation of pasture establishment**

Pasture establishment comes along with its own challenges which when not properly checked leads to low productivity. Among the challenges confronting pasture establishment are high initial cost of establishment. Initial cost of preparing the land in terms of ploughing and harrowing, fencing, and weed control are very high which makes it very expensive to smallholder farmer to establish it for the grazing animals.

Another challenge is difficulties in securing seeds of improved pastures by the farmer. Furthermore, land tenure system practice in Ghana makes it difficult for farmers to acquire sizable land to develop pasture. Again, lack of technical knowhow, intensification of cereal and cash crop farming as well as abundance of rangelands makes it difficult for farmers to adopt pasture cultivation. Lack of awareness by farmers about the importance of pasture production for feeding especially during dry season periods where there are acute shortages of fodder.

## **2.4 Systems of Cattle Production in Ghana**

Beef production is the primary focus of Ghana's cattle production system. It is however associated with the dairy production system in which milk is shared between the herdsman and a calf, with the surplus being sold at the market (Opong-Anane, 2005). Ownership can take the form of trusteeship for assets held in trust for a family group or it can be direct, personal, and individual ownership. According to Opong-Anane (2005), where a large herd is present, the owner family group may consist of numerous units with a wide range in size and relationship. It frequently happens that the seeming owner is not the only owner, in which case he is unable to allow or approve significant actions without first consulting the co-owners.

In general, the extensive (free range) or grazing system, semi-intensive/grazing system with supplemental feeding, and intensive (confinement) or zero grazing (cut-and-carry) system are the three main systems of cattle production in Ghana.

### **2.4.1 Extensive System**

The extensive or grazing system of cattle production is the easiest form of keeping cattle as less capital is required. It is generally and widely practiced in Ghana with the animals allowed access to household and kitchen wastes after grazing in the urban and the peri-urban areas. Typically, in the rural areas, the herdsmen, who are mostly Fulanis, move the animals from one communal pasture to another, especially during the dry season in search of forage and water. The grazing animals sometimes are difficult to control and as a result causes destruction of crops leading to misunderstanding between crop farmers and the cattle herders. Productivity of cattle in this system of production is very low as animals are exposed to adverse weather conditions and it takes a long time to detect ill health in animals. The significant

weight gain made during the rainy season is lost in the dry season as animals survive on poor quality forages for body maintenance and have to draw on their body reserve for much needed energy for metabolic processes. This makes it impossible for the animal to reach market weight or size in time (Otte and Chilonda, 2002). Furthermore, lack of provision of mineral blocks makes the animals lick and consume indigestible plastic materials leading to the blockage of the alimentary canal and subsequently death may result. There is also the possibility of losses to motor traffic, thieves and predators in this production system. In the urban centers, animals generally become nuisance to motorist causing heavy road traffic.

Reproductive performance of the cow is generally poor as they receive minimum care and animals on heat go undetected and would not be serviced. Animal growth is very low in an extensive production system, and the risk of mortality in calves ranges from 4 - 23% (Otte and Chilonda, 2002). The free-range system of cattle production is gradually taking shape in the urban and the peri-urban centers as cattle population has increased particularly in the Muslim dominated Zango<sup>1</sup> communities such as Aboabo, Sawaba, Nima, Asawasi, Bouban and Parkoso. Because it is difficult for cattle farmers in these communities to feed their animals intensively, the animals are taken out to graze in the morning and brought back in the late afternoon or evening (Figure 2.6) with little to no supplement. The animals are allowed to access water in their kraal.

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<sup>1</sup> Zango is the name for a type of settlement in Ghana mostly dominated by Muslims who comes from different parts of Ghana and largely speak Hausa language.



**Figure 2.6: Cattle herder grazing animals at Ibadu-Rahman Senior High School, Bouban, Asokore Mampong.**

Source: Author (Fieldwork, 2019)

#### **2.4.2 Intensive System**

Animals in the intensive system in Ghana are kept in well-built wooding structure and are properly managed in terms of feeding, provision of clean water and drug administration. There are two categories of intensive systems. In the first type, pastures are cultivated and the field is divided into paddocks. The animals are given water and are allowed to graze between paddocks.

To keep the animals out of direct solar radiations, trees are planted on the pastures. Cattle are being kept in a well-constructed pens with slatted floor covered in bedding in the intensive system (Sonkor, 2001). The term "zero grazing" or "cut-and-carry" refers to a method in which animals are not allowed to graze but instead have grass gathered and transported to them in their pens. In Ghana, this system is practiced by smallholder cattle farmers mostly in the Zongo communities for fattening animals for festive seasons (Figure 2.7). The animals are fed on crop residues such as cassava peels as well as agro-industrial by-products (brewers spent grain, rice bran) in

confinement. The major constraint of this system is the high cost of feed and medication but it gives a high return on investment when managed well.



**Figure 2.7: Fattening cattle under intensive system at Asawasi, Asokore Mampong**

Source: Author (Fieldwork, 2019)

### **2.4.3 Semi-intensive System**

This is a hybrid system between the intensive and extensive system. In the semi-intensive system, some sort of housing and feeding are provided. Cattle are taken out to graze on rangelands in the morning and are brought back to the kraal in the evening. The animals are fed on preserved grasses or legumes in the form of hay throughout the dry season. In Ghana, the semi-intensive system is mainly practiced by smallholder farmers and in government institutions and research centers or ranches where animals are kept on large but enclosed expanse of land which may be under natural or established pastures (Figure 2.8). The animals are allowed to graze freely on the ranch and supplementary feeding and mineral blocks may be provided in their shed or paddocks. The animals are protected from environmental hazards, thievery and appreciable productivity in terms of meat and milk can be obtained. Slaughter age

of animals varies from 2½ - 4 years on the average depending on the animal breed in this system of production. Jabbar et al. (1995) reported a weight of 320 kg in 3 – 3½ years, 200 – 220 kg in about 3½ years and 450 kg in 3½ - 4 years for N'dama, Muturu and Zebu breeds respectively.



**Figure 2.8: Cattle grazing on natural pasture at the Animal Science Department, KNUST**

Source: Author (Fieldwork, 2019)

#### **2.4.4 Type of ownership in cattle production system in Ghana**

Three important stakeholders have been recognized in Ghana's cattle production, according to Ameleke et al. (2020): a kraal owner, a cow owner, and a herdsman. Few foreigners' own cattle, and the majority of kraal owners and cow owners are locals. However, herdsman are a blend of residents Fulanis and nomads (Ameleke et al., 2020). Other tribes particularly Northerners in Ghana are also hired to tender cattle. A kraal is an enclosure mostly constructed using pieces of woods to house cattle with partially roofed or without roofing (Figure 2.9). The person who built the kraal is called the kraal owner and he may keep few cattle. Furthermore, the kraal can be passed on from generation to generation depending on the location and maintenance

culture. Cattle owners usually seek the services of the kraal owner to keep their cattle for fee at the end of the production cycle. Cattle owners also pay for services rendered on their cattle such as feeding, medication and other husbandry practices (Personal observation). A kraal owner sometimes hired a cattle herder or provides family labour to graze the animals. A kraal owner may own other kraals individually or jointly with a number of close relatives (Ameleke et al., 2020). Few kraal owners own all of the cattle in the kraal; however, according to Ameleke et al., (2020) the kraal owner typically owns the service bull.



**Figure 2.9: Cattle in a kraal**

Source: Author (Fieldwork, 2019)

A cattle owner is someone who owns cattle but lacks the necessary facilities or labor to keep them and thus entrusts the animals to the care of a kraal owner (Ameleke et al., 2020). These cattle owners are mostly influential people which include politicians, civil servants, traditional rulers, religious leaders, businessmen among others (Figure 2.9.1). The cattle owner pays for the services rendered to them directly to the kraal owners. However, cattle owners sometimes built their own kraal with detached housing for the herdsmen. These classes of owners engage the services of the herdsmen and pay them some remuneration at the end of every month. The remuneration can be in the form of cash or kind (Personal interview).



**Figure 2.9.1: Cattle owner in his Kraal at Drobonso, Ashanti Region**

Source: Author (Fieldwork, 2022)

A cattle owner or kraal owner may entrust a herdsman with the care of their herd. Some of the herders do, however, also own some livestock. The herdsman are mostly resident Fulanis and/or Nomads whose duty is mainly to provide general husbandry practices in terms of feeding, watering and medication (Fig. 2.9.2). The herdsman received remuneration from the cattle owners based on the stated agreement between the parties. The remuneration is in three different arrangements (Personal interview). Every year, depending on the size of the herd, the herder receives one calf. The second is ownership of the milk that the lactating animal produces. The third is fixed monthly payment in cash and in kind (provision of food items). Ameleke et al. (2020) stated that herdsman are entrusted with taking care of cattle for which they are compensated in the form of calf sharing, ownership of milk gathered, and a regular monthly payment. However, in certain contracts, the herdsman received no milk but just a predetermined payment in kind or cash. Additionally, according to Driel (1999),

herdsmen in northern Benin received compensation in the form of a portion of the milk collected and calf, however the amount of milk distributed to the herdsmen varied by location.



**Figure 2.9.2: Fulani herder injecting a bull with an antibiotic**

Source: Author (Fieldwork, 2022)

## **2.5 History of the Fulani Herdsmen in Ghana**

The Fulani people, also known as Fulbe, who reside in the Sahel part of the sub-region are the most significant pastoral tribe in West Africa (Tonah, 2003). Cattle-herding is the main job of the Fulani ethnic group across Africa (Institute for Economics and Peace, 2018). According to Azarya (1996), despite numerous attempts to sedentarize Fulani herders, their nomadic and semi-nomadic lifestyle has persisted for generations. Their nomadic lifestyle does not appear to have changed as a result of modern agriculture or civilization. According to Oppong (1999), cattle rearing continues to be a significant source of income for Fulani herders, and as a result, their general attitude toward cattle rearing has not modified. The numerous failed attempts to sedentarize their herding operations through grazing reserves were the main

civilizational demand to modernize them (Agaptus et al., 2021). This has caused their movement and migration across sub-Saharan regions of which Ghana is part.

Their initial migration was from the northern region of modern-day Ghana (Bukari and Schareika, 2015). Additionally, Bukari and Schareika (2015) stated that before the British established themselves in the Gold Coast, the Fulani were migrating to Ghana every season. They come to the southern Sahara on a seasonal basis to search for grazing land and water (Tonah, 2003). Furthermore, according to Tonah (2006), There are three main factors which accounted for the migration of Fulani into the Gold Coast in the twentieth century: first, the expansion of the cattle trade; second, the emergence and development of native farms by colonial authorities; and third, continuous drought and animal diseases in the 1960s and 1970s, which account for approximately 30% loss of livestock. Many Fulani herders have been compelled to shift to West African savannah zones where they may find adequate grazing pasture for their cattle in order to avoid frequent livestock losses owing to poor climatic conditions in the Sahel region (Adebayo et al., 2008).

In Ghana, Fulani herdsmen first arrived during the colonial era, and by the 20th century, they had made permanent settlements there (Baidoo, 2014). The Fulanis took part in 1911 census due to their presence along the White Volta in northern Ghana (Bukari and Schareika, 2015). By 1921, their population increased from 100 to about 302 people, according to the Lawra-Tumu District census report (Tonah, 2002). Again, as a results of their family presence, their number increased to 784 in the 1931 census, with 400 males and 384 females (Tonah, 2006). Furthermore, Tonah (2003) reported that water and pasture availability for grazing cattle were factors that contributed for the Fulani migration to Ghana. These circumstances attracted a

significant number of seasonal nomads from Burkina Faso, Niger, Nigeria, and Mali to Ghana, especially during the dry or lean season (Tonah, 2006). Nowadays, Fulani can be found in nearly every region of Ghana, and some of them are businessmen who participate in a wide range of societal activities (Oppong, 2002). Although their exact numbers in Ghana are unknown, it is believed that there are about 14,000 of them (Oppong, 2002).

Recently, migrant herdsmen have moved further south to the middle and southern parts of Ghana, particularly communities along the Volta River, due to the Savannah zone's extremely unattractive forages and water resources (Tonah, 2006). The Afram Plains, the Agogo area in the Ashanti Region, and parts of the Eastern and Volta regions are now enclaves for nomadic activities (Tonah, 2006).

Cattle herding is the major occupation for the Fulani man in Ghana (Fig. 2.9.3) whereas milk processing into local soft cheese popularly known as 'Wagashi' is left for the Fulani women. They normally trek distance with large cattle herd in groups searching for grazing lands and water resources for the cattle particularly during the dry season. According to Tamou et al. (2018), Traditional Ecological Knowledge (TEK) is produced and learned in pastoral production systems by being involved in livestock movement and herding. A pastoralist child is given a calf at birth. The child begins small-scale herding activities such as tethering and herding calves not far from the homestead under the oversight of the family head (Tamou et al., 2018). Progressively, the young pastoralist will begin herding animals to longer distances in the company of family members and friends, up to transhumance (Tamou et al., 2018). At this stage, learning takes place through interactions with other herdsmen, herds, and landscapes. Tamou et al. (2018) stated that when making herding decisions,

pastoralists look at the soil characteristics first to determine the presence of good pasture based on the moisture content of the soil. If good forages are available, livestock is used primarily to determine whether herding should continue or not, because in practice, pastoralists look at the livestock's characteristics during and after grazing: dull coats and livestock showing restless behavior to resume herding are signs that their feed demands are possibly not met by the grazing (Tamou et al., 2018). Furthermore, if the pasture is good for grazing, herders remain for several months in the bush grazing animals and return to their families during the onset of rainy season. In the bush however, the Fulani herders usually erect a wooden housing structure with polythene sheet cover to rest in the evening (Figure 2.9.4). The uncontrolled movement of grazing cattle by Fulani herders has resulted in several conflicts with crop farmers, resulting in the loss of lives and property.



**Figure 2.9.3: Fulani herding cattle**

Source: Author (Fieldwork, 2022)



**Figure 2.9.4: A wooden housing structure with polythene sheet cover**

Source: Author (Fieldwork, 2022)

## **2.6 Causes of Farmer-Herder Conflicts in Ghana**

Conflicts between crop farmers and livestock herders have been around since the beginning of agriculture. Depending on the environment, the economy, and other factors, these conflicts have either increased or diminished in frequency and intensity. As an illustration, in Quran 21:78 Allah stated “And mention David and Solomon, when they judged concerning the field, when the sheep of a people overran it at night, and We were witness to their judgment”. A man's herd of sheep that wandered into a farmer's field at night and destroyed the field crops was described in the verse. When Prophet David heard the case, he gave the farmer the flock of sheep as payment for his losses. However, Prophet Solomon proposed another solution that would repay the farmer while not ruining the herdsman. He decided that the farmer could keep the sheep and use their milk and wool until the herdsman repaired the damaged field. After that, the flock would be returned to the herdsman.

According to Shettima and Tar (2008), the Fulani herders bring their cattle to graze on farmlands owned by crop farmers, while the farmers also need animal nutrition in the form of meat and dairy products for their daily consumption as well as dung to fertilize their fields. In addition, Monod (2018) believes that the Nomad group's survival is formed through interaction with sedentary farmers. As a result, the interdependence becomes clear, as each group requires water, land, fodder, and other land uses for their economic activities. Unfortunately, this centuries-old relationship has been shattered, with many disputes arising across the regions, resulting in widespread violence, death, and internal displacement of people (Akerjiir, 2018).

Furthermore, increased herd sizes due to improved cattle conditions compelled cattle herders to seek out more pastures beyond their limited range. Climate change has posed a significant threat by increasing pressures on the land and thus causing conflicts between them. However, advances in human health and population have increased the demand for land. As a result, cultivation of riverine and valley-bottom areas has increased significantly since the 1980s (Abbas, 2009). This means that both farmers and cattle herders have engaged in fierce battles for access to such valuable lands, which frequently results in increased conflict and violence (Abbas, 2009).

The reasons for confrontations between farmers and herdsmen are frequently not improbable. But it seems that neither party can agree on what is causing their ongoing hostility with one another. The primary direct causes of conflicts cited by farmers, according to De-Haan (2002), are cattle destroying crops and other property (irrigation infrastructure and equipment), whereas cattle herders cite blocking stock routes and water sources with crops and burning rangelands, riverine areas, and valley bottoms as significant direct causes. De-Haan (2002) further suggested that the rising

incidence of cattle theft, which is sometimes accompanied by violence, as another reason for clashes between farmers and herd.

Another important factor of the conflict in Ghana between crop farmers and herders is the rapid growth of human and cattle populations. The survival of both humans and livestock is dependent on the same resources. The use of the Afram Plains' and Volta Basin's land and water resources by both crop farmers and the herders increases competition over who gets what, when, and how. According to Opoku (2014), the continuous grazing of cattle over the same area for long periods of time, combined with the expansion of farming communities into deeper areas of the Afram Plains, is depleting land or vegetation and water resources, escalating competition into conflicts.

Land tenure system and ownership was seen as a contributory factor to the conflicts. Insecure land tenure affects Fulani herders and small-scale farmers in West Africa's Savannah and Sahel regions (Campion and Acheampong, 2014). The nature of the current customary land tenure system, particularly in Ghana, exacerbates the current land tenure insecurity prevalent throughout the nation (Tsikata and Seini, 2004). The poorly managed and corrupt land tenure system in Ghana sometimes leads to disputes amongst land tenants about the exact parcels of land that belong to them. The Fulani take advantage of the poor land management policies and the uncertainties in the system of customary land tenure (Baidoo, 2014). For example, the Agogo Traditional Council (ATC) initially leased land to four individuals for cattle rearing (Kuusaana and Bukari, 2015). However, due to poor land monitoring, other Fulani herdsmen, particularly from Nigeria, encroached and grazed their herds on the land, destroying the field crops (Kuusaana and Bukari, 2015).

It was also proposed that grazing cattle may have contributed to the dispute through their contamination of nearby water sources. Cattle herders most often drive their animals to water bodies carrying firearms like AK-47. Usually, the animals drink from streams and rivers which are also used by the crop farmers and other community members. Polluting the water bodies by the grazing cattle can result to conflict between the two parties as competition exist between humans and animals on water resources. According to Tonah (2006), herdsman allow cattle to enter water bodies, muddying them and rendering the water unsuitable for domestic use. Furthermore, Okoli and Atelhe (2014) reported that when the sources of a farmer's livelihood are threatened by environmental variability, particularly drought and water scarcity, desperate measures are taken to ensure survival.

Through blockades, the farmers attempt to halt these behaviors by obstructing the pastoralists' access to water sources (Opoku, 2014). According to Agyeman (2017), the majority of herders carrying AK-47 rifles and herding cattle to graze are not the true owners of the animals they tend. According to Hoffmann (2004), access to land and water are therefore inseparable pastoral resources.

### **2.6.1 Farmer-Herder Conflicts across West Africa**

Farmer-herder conflict is widespread in West Africa and beyond and not limited to only Ghana. This is due to the presence of Fulani herders across the continent, especially in the West and Central African sub-regions (Agaptus et al., 2021). The only regional body in Africa that has enacted explicit legislation to protect local cattle mobility is ECOWAS. A regional framework (Appendix VII) is provided by the ECOWAS Transhumance Protocol (1998) and Regulation pertaining to its implementation (2003). ECOWAS acknowledge the economic value of transhumance

and permit cross-border transhumance under specific conditions. Agaptus et al. (2021) claimed that there has long been hostility between Fulani herders and crop farmers in Nigeria, mainly over access to land and water supplies as well as crop damage.

According to Agaptus et al. (2021), one of the numerous factors contributing to the current herder-farmer disputes in Nigeria is the Fulani herders' reluctance to adopt modern-day methods for raising cattle as a result of their preference for the extensive or free-range grazing system. Most often the conflict is fatal leading to loss of lives and properties. Bukari (2017) reported that between 2005 and 2010, Nigeria recorded 302 death, 7000 hectares of farm destruction and loss of 1300 cattle as a result of the conflict. In 2014, Fulani militants killed a total of more than 1,200 people in Nigeria (Bukari, 2017). There have been countless reports of violent clashes between Fulani herders and crop farmers in Burkina Faso (Brockhaus, 2005), Nigeria (Ofuoku and Isife, 2009), and Cote d'Ivoire (Diallo, 2001). Different assessments of farmer-herder conflicts in few West African nations are shown in Table 2.6. Since many violent incidents are not recorded or reported, these figures are not exhaustive (Bukari, 2017).

**Table 2.6: Cases of Violent Farmer-Herder Conflicts in Certain West African Countries**

Country	Years	Number of deaths	Other consequences
Ghana	2001 to 2016	682	Destruction (burning) of farms, killing of cattle, more than 100 injuries
Nigeria	2005 to 2010	302	7000 hectares of farms destroyed, 1300 cattle lost; 7 communities sacked
Burkina Faso	2005 to 2011	55	Many cattle killed, injuries and destruction of farms
Benin	2006-2007	NA	Cattle killed, destruction of farms, injuries, destruction of property
Mali	2012	25	Cattle killed; property destroyed

Source: Bukari, 2017

### 2.6.2 The ‘Operation Cowleg’

The most widely and common policy used in resolving the conflict between the cattle herder and the crop farmer in Ghana is the ‘Operation Cowleg’. The aim of this operation was to drive the herders and their livestock out of the Volta Basin and the Afram Plains owing to their hostile behavior.

According to Tonah (2006), ‘Operation Cowleg’ was first introduced by the government of Ghana in 1988 with the aim of flushing out nomadic herdsman with their cattle occupying the lands of local people as well as to check the spread of animal diseases. However, the intervention was not sustainable despite huge financial losses to both the government and the cattle owners. In 2018 alone, the cost of Operation Cowleg to the Asante Akim North District Assembly amounted to GH¢3 million as the assembly bears the cost of the joint military and police operation according to the District Chief Executive. Additionally, since the inception of the ‘Operation Cowleg’ policy, the farmer-herder conflict still exists when pasture becomes unavailable to the cattle and this suggest that the policy is not a sustainable solution to rely on. The cattle again belong to some of the influential people in government, politicians, civil servants, chiefs, security service personnel among others with the Fulanis only employed as caretakers. The effort, according to Baidoo (2014), has so far failed to drive the herders out of the region since the herdsman continue to operate there.

The ‘Operation Cowleg’ again is been carried out to drive the animals from the conflict zone like Agogo and other areas such as Kintampo, Gushegu, Kumawu, Asante Mampong and as a result of this, cattle population have increased in the urban

and peri-urban regions. Cattle population in the Asokore Mampong Municipality has increased by 43.4% within one year as shown in Table 2.7.

**Table 2.7: Livestock population in Asokore Mampong**

Livestock	2019	2020	%Change
Cattle	18741	26875	43.4
Sheep	5654	7521	33.0
Goat	3219	5698	77.0
Poultry	28784	34416	19.6

Source: Asokore Mampong Municipal Assembly

Previously, only few individuals in the urban centres kept cattle for fattening unlike the small ruminants such as sheep and goat. Cattle population in the urban areas including cities of Accra and Kumasi keeps on increasing and are becoming a nuisance as they cause road traffic, environmental pollution and damage to properties (Figure 2.9.4). There are bye-laws regulating rearing of livestock such as cattle, goats and sheep in the urban and rural areas however the law enforcement agencies are failing to enforce those bye-laws (Appendix VI). The Municipal and District Assemblies have the right to auction any stray animals found on the street without supervision. For example, Tano South Municipal Assembly in the Ashanti Region recently announced the auction of some stray small ruminants in pursuant to Section 300 Sub-section 4 of Act 29/60 (Appendix VI).



**Figure 2.9.4: Stray animals spotted crisscrossing the road at Aboabo, Asokore Mampong**

Source: Author (Fieldwork, 2019)

### **2.6.3 Ghana Cattle Ranching Project (GCRP)**

The Ghanaian government instituted the Ghana Cattle Ranching Project Committee in 2017 in response to a dispute that broke out in Kintampo in the Brong-Ahafo Region. This was done under the supervision of the Ministry of Food and Agriculture (MoFA) and National Security. The committee's task was to find and suggest a long-term, viable solution to the ongoing disputes between crop farmers and cattle herders that were terrorizing Ghanaian civilians and hampering agricultural productivity.

### **2.7 Feed resources for cattle production in Ghana**

Natural pastures, browsing plants, crop residues, and agro-industrial byproducts are some of the feed resources used in Ghana for ruminant livestock production. According to Oppong-Anane (2013), the primary feed resources for cattle include natural pasture, forage re-growth in cultivated fields, and crop residues that become available after crops are harvested. According to Ansah et al. (2013), agro-industrial

by-products from cereals, legumes, and tuber crops also contribute to the feed resource pool available to cattle. Plant materials such as cereals, tubers and legumes that remains on the field after harvesting are normally classified as crop residues and according to Sanon (2007), they are the main source of feed for ruminants in the Sahelian zone. Because of population growth and the need to satisfy food demands, a larger part of land is being used for food cultivation; as a result, crop wastes have become an important source of livestock feed (Harris, 2002). Their availability, however, is determined by the quantity of production and the yield of a certain crop under cultivation. According to Sanon (2007), crop residue management as feed varies depending on the composition of the residue.

According to Tarawali and Hiernaux (2002), leguminous leftovers are collected as haulm for sale or for use as stall-feeding material whereas cereal straws are mostly grazed on the field. In addition to being used as animal feed, cereal straws are also utilized as fuel and a construction material for roofing and fences (Sanon, 2007). But Fulani herders often collaborate with crop producers to allow their cattle to graze on fields soon after harvest in exchange for manure (Sanon, 2007). The low nutritional value of cereal straws when compared to legumes makes it difficult to use them as animal feed; therefore, urea treatment and appropriate chopping size are ideal to increase their nutritional value and utilization.

### **2.7.1 Nutrient Requirements of Cattle**

The amount of nutrients an animal needs for a certain function is known as its nutritional requirement (Gadberry, 2007). Because of the unique anatomical and physiological features of the ruminant digestive system, provision of cattle with the nutrient found in appropriate and suitable material such as roughages and concentrate

comprise the major factor in carrying out a viable cattle project. The kind and amount of nutrient required by an animal are determined by its physiological activities (Reddy and Krishna, 2009). For the beef cattle industry, achieving cattle herd production and profitability targets is largely dependent on meeting the basic nutritional needs of beef cattle. For healthy cow and calf development, appropriate cow reproduction, and the growth of all kinds of cattle, proper nutrition is essential (Mertens, 1997). Cattle's dietary needs vary throughout the year depending on the environment, stage of the production cycle, age, sex, breed, amount of activity, and disease load (Hersom, 2010). Each nutrient has a distinct role in metabolism, production, and development (Hamilton, 2007). Hersom (2010) observed that without insight of cattle's adequate basic nutritional requirements, cost-effective supplementing procedures will be challenging to implement.

### **2.7.2 Mineral requirement of cattle**

Minerals are essentially elements needed for structural integrity, metabolic function and immune function. Minerals are classified as macro or trace minerals depending on the amounts needed (Gadberry, 2007). Wahlberg (2005) noted that deficiency of mineral in certain feeds can be remedied with supplementation. Mineral supplementation is determined by the type of feed in the diet and the animal's needs (Hamilton, 2007). Calcium is the most common mineral in the body and is essential for bones, teeth, membrane permeability, muscular contraction, and a variety of other metabolic activities (Hersom, 2010). Calcium absorption is mostly influenced by the balance between demand and consumption. Skeletal reserves are a significant reservoir of calcium that may be used to keep blood concentrations stable. Phosphorus is frequently mentioned in conjunction with calcium since the two minerals work

together in bone metabolism. Phosphorus is typically connected with bones and teeth, but it also plays important roles in cell development, energy usage, and membrane creation (Hersom, 2010). Although studies have shown that ratios between 1:1 and 7:1 result in equivalent performance provided that the dietary phosphorus requirement was satisfied, the conventional calcium: phosphorus ratio recommended was 2:1. (Hersom, 2010).

### **2.7.3 Water requirement of cattle**

Cattle need water, a crucial yet underappreciated resource. Water is crucial for many bodily processes, including temperature control, development, reproduction, breastfeeding, and other metabolic processes (Hersom, 2010). Feedstuffs and ad libitum eating are the two main sources of water. Feedstuffs and ad libitum eating are the two main sources of water. Pregnancy, lactation, exercise, type of diet, intake level, and surrounding temperature are just a few of the variables that might affect how much water is needed by the animal. Limiting water consumption below what is necessary will decrease feed intake, which will decrease cattle performance (Rasby and Walz, 1996). Numerous processes cause cattle to lose water from their bodies. Water is lost by urine, feces, perspiration, and water vapor from the skin and lungs, among other things. Activity level, ambient temperature, water intake, and other variables all affect urine production. The nature of the diet also affects how much water is lost in the faeces. Clean water is extremely important for young developing calves, but unclean water can reduce cattle performance and be a cause of ill-health (Hersom, 2010).

## **2.8 Management of Calves**

### **2.8.1 Housing**

The management of calves requires the use of housing. Individually housed calves typically start feeding earlier than those kept in groups. A well-built pen also makes it easier to detect any signs of ill-health in calves. Calves that are not housed, however, are exposed to severe environmental factors, which may have a negative impact on performance. To prevent excessive heat from the sun and to protect the calves from predators, precipitation, and wind speed, calves are often kept in pens that are partially covered by roofs and enclosed by fencing. Rulofson et al. (1993) reported that keeping calves individually in their pens is necessary for observing feed intake and monitoring diarrhea. According to Emanuelsson and Pettersson (2000), keeping calves separately lowers their chance of developing chronic respiratory diseases than maintaining them in group pens with automated milking. Olsson et al. (1994) also found that individual pens are associated with a lower probability of diarrhea outbreaks than group pens for calves. Due to ammonia buildup in the pen, adequate air circulation in the calves' pen is critical. Simensen (1981) also reported that keeping calves individually have resulted in low levels of ammonia buildup as compared to keeping calves in groups. Hence provision of good housing is critical in calves' management.

### **2.8.2 Feeding and rumen development of Calves.**

The first two to three weeks of a newborn calf's life are a time of fast development for its digestive tract. According to Heinrichs and Lesmeister (2005), liquid feed flows directly via the reticulo-rumen and into the omasum and abomasum through the oesophageal groove, where digestion is identical to that of a monogastric mammal.

The amount of feed consumed and the kind of feedstuffs have a significant impact on rumen development and microbial production. The consumption of solid feed has the tendency to stimulate rumen microbial growth and the generation of volatile fatty acids. Heinrichs and Lesmeister (2005) claimed that solid diet including concentrates can improve rumen development more quickly than forages. Contrarily, giving calves milk or milk substitutes typically causes rumen growth to delay (Heinrichs and Lesmeister, 2005). Calves fed just liquid diets may exhibit normal development, according to Heinrichs and Lesmeister (2003), but their rumens may still be underdeveloped at weaning, which will be noticeable. Due to its inability to properly absorb solid meals like forages and grains, the calf will continue to be unhealthy and exhibit stunted growth.

### **2.8.3 Energy requirements of Calves**

The amount of metabolizable energy is used to determine the calves' energy requirements (NRC, 2001). Metabolizable Energy (ME) requirements may be underestimated in the first week after birth because of calves' high and erratic metabolic rates (NRC, 1999). Calves must be offered with highly nutritious starter diet and fresh water by the second week of life for rumen functioning and development. The NE needs for maintenance and development should thus not change depending on diet. The following equation is used to compute the requirements for ME according to (NRC (2001):

$$\text{ME requirement (Mcal/d)} = 0.100 \text{ BW}^{0.75} + (0.84 \text{ BW}^{0.355}) (\text{BWG}^{1.2}).$$

Where, BW = body weight in Kilogram and BWG = body weight gain in Kilogram.

#### 2.8.4 Protein requirements of Calves

Weight gain and maintenance are the two categories that define the protein requirements of calves. Weight gain is defined as nitrogen retained in tissues while maintenance is nitrogen losses in urine and faeces NRC (2001). The apparent digested protein implies a protein need (ADP).

The following equation is used to compute the apparent digestible protein according to (NRC (2001):

$$\text{ADP (g/d)} = 6.25 [1/\text{BV} (\text{E} + \text{G} + \text{M} \times \text{D}) - \text{M} \times \text{D}].$$

Where BV = biological value (the efficiency of nitrogen uses for growth above maintenance, equal to a value of 0.80), E = endogenous urinary nitrogen, G = the amount of nitrogen in gain, M = metabolic fecal nitrogen, and D = the amount of dry matter consumed. Nitrogen loss from the skin and hair is not considered.

#### 2.8.5 Colostrum

Dams secrete colostrum, a yellowish fluid rich in nutrients and antibodies, before the actual milk is produced. Due to its ability to protect against disease through passive immunity and serve as a source of energy, colostrum is essential for newborn calves (Pedersen et al., 2000). Calves must consume large amounts of high-quality colostrum immediately after birth in order to survive. Low blood IgG concentrations have a direct impact on long-term calf performance as well as morbidity and death in calves (Pedersen et al., 2000). According to Arthington et al. (2000), colostrum IgG concentrations and IgG absorption have a positive linear relationship. The amount of immunoglobulin in colostrum varies greatly. A calf must consume 3 liters of multiparous cows' colostrum within an hour of birth in order to get at least 100 grams

of IgG. (NRC, 2001). In addition, NRC (2001) noted that, in contrast to colostrum substitutes, colostrum includes a number of growth factors and hormones that stimulate the growth and improvement of the digestive tract and other organ systems.

#### **2.8.6 Water requirement of Calves**

Water is required for calves to develop and eat dry feed at their maximum levels. Water is essential for osmoregulation and thermoregulation since it accounts for 70 to 75 percent of a calf's weight (NRC, 2001). Controlling bodily fluids is difficult for newborn calves suffering from diarrhea. Calves suffering from scours may lose 10 to 12% of their body weight, lose electrolytes, and perhaps die (NRC, 2001). According to Heinrichs and Lesmeister (2005), calves ought to have access to water from a young age. Additionally, they concluded that doing so increased feed intake, body weight, and lowered the probability of diarrhoea.

#### **2.9 Haematology**

According to Merck Veterinary Manual (2012), haematology is the study of the quantities and morphologies of the cellular components of red blood cells (RBC), white blood cells (WBC), and platelets and their application to the diagnosis and follow-up of disease. According to Mmereole (2008) and Isaac et al. (2013), studying haematology is crucial for choosing animals that are genetically resistant to disease and environmental factors. Furthermore, haematological measurements, according to Khan and Zafar (2005), are excellent indications of the animal's physiological health. Calves with better blood composition have a better chance of surviving.

### **2.9.1 Haematological Parameters**

Blood and the organs that produce blood are connected to haematological markers (Bamishaiye et al., 2009). According to the animal's physiological state, the blood parameters change. Common haematological measurements include the number of red and white blood cells, the concentration of haemoglobin, the packed cell volume (PCV), the mean corpuscular volume (MCV), the mean corpuscular haemoglobin (MCH), and the mean corpuscular haemoglobin concentration (MCHC) (Chineke, 2006).

### **2.9.2 Red Blood Cell**

A blood test called a red blood cell count quantifies the percentage of red blood cells in an animal's entire blood according to Wikipedia (2013). Bunn (2011) asserts that a red blood cell analysis can assist in identifying anemia in animals as well as other diseases that affect red blood cells. Red blood cells carry hemoglobin, which is subsequently responsible for carrying oxygen to different parts of the animal body. Red blood cells, commonly known as erythrocytes, are responsible for carrying hemoglobin (Awodi et al., 2005). Oxyhaemoglobin is produced when hemoglobin and oxygen in the blood mix during internal respiration. The standard reference range for cow red blood cells, according to Merck Veterinary Manual (2012), is between  $5.0 \times 10^6/\text{mm}^3$  and  $10.0 \times 10^6/\text{mm}^3$ . High red blood cell counts are associated with congenital heart disease, severe diarrhea-related dehydration, and low blood oxygen levels. In addition, anemia, toxicity-induced bone marrow failure, starvation, and hemorrhage are all indicators of very low red blood cell counts (Gernsten, 2009; Bunn, 2011).

### **2.9.3 White Blood Cell**

White blood cells (WBC), commonly referred to as leucocytes, are immune system cells that help animals fight against diseases, infections, and foreign objects (Chineke et al., 2006). According to Maton et al. (1997), hematopoietic stem cells are the source of all five kinds of white blood cells that cover the bodies of animals. According to the Merck Veterinary Manual (2012), cows' white blood cell, neutrophil, and lymphocyte counts normally range from 4 to 12 (K/L), 0 to 5%, and 2.5 to 7.5%, respectively.

The presence of infectious diseases is indicated by a high white blood cell count. Valencia (2012) claims that stress, immune system disorders, and infections can all contribute to an increase in white blood cells. In addition, a decrease in white blood cell counts indicates a decrease in the number of disease-fighting cells in an animal's body (Mayo, 2013). Animals with very low white blood cell are more susceptible to infection. Bagby (2007) suggests that liver or spleen dysfunction, radiation exposure, and bone marrow shortage are all possible causes of low white blood cell counts.

### **2.9.4 Haematocrit**

According to Purves et al. (2003), Packed Cell Volume, commonly known as Haematocrit, is the percentage of red blood cells remaining in the entire blood after centrifuging. The Packed Cell Volume is important in the transportation of oxygen and nutrients, according to Isaac et al. (2013). The Packed Cell Volume of animals can be used to assess the animal's health and degree of anaemia, according to Wikihow (2013). Furthermore, according to Wikipedia (2013), a low haematocrit level is a sign of prolonged anaemia, which causes atypical haemoglobin production throughout erythropoiesis. Additionally, diarrhea and dehydration are linked to an extremely high

haematocrit level (Chineke et al., 2006). According to RAR (2009), a cow's normal haematocrit ranges from 24 to 48%.

### **2.9.5 Haemoglobin**

Hemoglobin plays a significant role in animal respiration. They transport the oxygenated blood from the lungs to the rest of the body, where it is utilized for tissue respiration and helps the animal produce energy. Costanzo (2007) stated that mammalian hemoglobin can bind up to four oxygen molecules. According to MedicineNet (2012), deficiencies in vitamins, bone marrow problems, and blood loss are all associated with low hemoglobin levels while elevated hemoglobin levels are linked to exposure to high temperatures and dehydration. Merck Veterinary Manual (2012) states that the normal hemoglobin range for cows is 10 to 15 (g/dl).

### **2.9.6 Glucose**

Glucose is the type of free sugar found in blood. After consumption and absorption, the amount of blood sugar in an animal's body immediately increases. A fasting animal's blood glucose concentration is determined to be around 80 mg per 100 ml (Rastogi, 2008). However, the glucose level is almost constant and only fluctuates within a narrow range when abnormal conditions like hyperglycemia or hypoglycemia occur (Angelov et al., 1996). Rastogi (2008) states that blood sugar serves as the body's main energy source and that it is produced as a result of the breakdown of the carbohydrates that the animal consumes on a daily basis under the control of the processes known as glycogenolysis and gluconeogenesis. Diet absorption and insulin keep blood sugar levels stable. Having too much insulin decreases blood sugar levels below normal, causing hypoglycemia, according to Rastogi (2008). Rastogi (2008)

has demonstrated that a deficiency in insulin slows down the transfer of blood sugar, causing it to rise and ultimately leading to hyperglycemia. Blood sugar levels must be measured in order to diagnose carbohydrate-related disorders (Rastogi, 2008). Calves' blood glucose levels are affected by their age, feeding regimen, and feed type. According to Ilgaža and Birgele (2003), when calves are given a concentrate mixed diet and forages, the glucose level in their blood becomes more stable and is unaffected by feeding or time after feeding. The level of glucose in calf blood after birth is thought to be as low as 1.68-0.19 mmol/L, according to Angelov et al. (1996). The amount of glucose in newborn calves' blood, however, is said to range from 4.1 to 4.3 mmol/L before they take their first feed. While Tietz (1995) discovered a range of 3.33-6.11 mmol/L, Tighe and Brown (2003) observed a range of 2.1-3.8 mmol/L.

#### **2.9.7 Total protein, Albumin and Globulin**

Even with dietary changes and abnormal situations, the concentration of plasma proteins stays stable. Prolonged malnutrition, on the other hand, has an effect on protein concentration. The normal range of total protein in serum is 6.3 - 7.8 g/dl (Rastogi, 2008), 70 - 94 g/L (Tighe and Brown, 2003), and 6.0-7.8 g/dl (Singh, 2003). Albumin levels in serum have been reported to be normal at 3.2-5.1 g/dl (Rastogi, 2008), 34-43 g/L (Tighe and Brown, 2003), and 3.5-5.0 g/dl (Singh, 2003). The normal values for globulin in serum are 2.5 g/100 ml (Rastogi, 2008) and 2.3 - 3.5 g/dl (Singh, 2003). The albumin concentration of plasma is reduced in some pathological circumstances. Oedema is usually linked with concentrations less than 2 g/100 ml. Additionally, globulins carry the lipid component of proteins and include antibodies that activate immune responses (Rastogi, 2008). In blood, the albumin/globulin ratio is 1.2 - 1.5. (Singh, 2003). When multiple myeloma is caused

by dehydration, hyperproteinemia, also known as hyperalbuminemia, is a common side effect. Its symptoms include severe vomiting and diarrhea in animals (Rastogi, 2008). Malnutrition, nephritic syndrome, malabsorption, and severe liver cirrhosis are among the common causes of hypoproteinemia or hypoalbuminemia (Rastogi, 2008). Table 2.8 provides a breakdown of the chemical components in cow blood.

**Table 2.8: Cattle Blood Chemical Composition**

Parameters	values
Blood Glucose (mg %)	35 – 55
Total Plasma Protein (g %)	6.74 – 7.46
Albumin (g %)	3.03 – 3.55
Globulin (g %)	3.00 – 3.48
Serum Total Cholesterol (mg %)	50 - 230

Source: Pampori (2003)

### 2.10 Inferences from literature review

There is potential to increase cattle production in Ghana, however, cattle production is largely on the free-range management system where animals are taken out to graze in the morning and returns to the kraal in the evening. The free-range system most often leads to the seasonal conflict between the cattle herders and the crop farmers which has largely affected cattle production. The conflict has also led to loss of lives and properties as well as displacement of women and children. Furthermore, the conflict's consequences in rural areas, where cattle are often kept, have resulted in an inflow of cattle into urban and peri-urban areas, increasing the number of cattle in these areas. In the urban and the peri-urban areas, the animals become nuisance to the community as they pollute the environment with their faecal materials and causes road traffic.

The problems associated with the increased cattle population in the urban and the peri-urban centers are insufficient feed for the animals, particularly during the dry season. Furthermore, because of the population increase, there is a massive infrastructural development in the urban and the peri-urban centers and that has led to the shrinkage of the communal grazing land for the animals. There is again high demand for animal protein and hence to address the challenge of farmer-herder conflict as well as keeping cattle in the urban and the peri-urban centers under friendly environment, there is a need to investigate new methods of cattle production in order to boost productivity.

Furthermore, there is high demand for forages especially by the small-scale cattle farmers in the urban and the peri-urban centers. However, growing forage is not a typical practice in Ghana because the majority of agricultural areas are dedicated to growing food crops and other infrastructure-related projects. Cattle farmers are mostly seen along the major roads harvesting grasses for their animals. Majority of the small-scale cattle farmers usually used agricultural by-products which sometimes contains anti-nutritional factors as basal feed for their animals. These results in fluctuations in the growth rate of cattle, emaciation and disease as the nutrient requirements of the animals are not met. There is therefore, the need to cultivate forage that gives higher biomass within the shortest time, taken into consideration its nutrient content and digestibility for ruminant cattle in Ghana, both for production and for sustenance.

Napier grass cited in the literature are important fodder for cattle production however cattle farmers in Ghana are not utilizing the grass in their production. Napier grass is widely used by the smallholder cattle farmers in eastern Africa under zero grazing system to increase meat and milk production because of its higher biomass and

nutritive value. Some researchers have been carried out in Ghana on chemical composition of Napier grass and its effect in sheep production. However, to the best of the researcher knowledge, no work has been done to assess protagonist (crop farmers and cattle farmers) perspectives of crop farmer-herder conflict and sustainable cattle production in Ghana using animal feeding trial.

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## CHAPTER THREE

### 3.0 PROTAGONIST ALTERNATIVE SOLUTION TO CROP FARMER- HERDER CONFLICT.

#### 3.1 Introduction

The majority of cattle herdsman are transhumance pastoralist popularly known as Fulani who herd their cattle to places where they can find grazing pastures and water for them. The major problem facing the cattle herders is inadequate and shortage of feeds and feeding materials due to seasonal fluctuation of rainfall distribution. In the wet season, there is abundant forages for grazing animals but they become unavailable due to arable crop farming. In the dry season, farmers burn their crop residues which could serve as a feed resource for cattle as they prepare the field for the next cropping season. The uncontrolled burning of the crop residues also affects the grass on the field and subsequently cause migration of herdsman from northern savanna regions to southern part of the country in search of grazing pasture and water. Ofuoku and Isife (2009) noted that the Fulani herders go southward to the coastal zone in the wet season in search of pasture and water as a result of the withering of pasture during the dry season in the north. The crisis becomes worse when migrant Fulani herdsman arrive from nearby West African subregions including Burkina Faso, Mali, Niger, and Nigeria to graze their cattle in areas like Gusheigu, Kumawu, Agogo, Kintampo, Atebubu, Ejura and others. The influx of the alien herders together with the uncontrolled movements of their cattle most often creates tension with the arable crop farmers.

The relationship between the crop farmers and cattle herders should be seen as mutual because they interdepend on each other for survival. Arable crop farmers need animal protein as well as manure for sustenance and soil fertility improvement whereas cattle

herders also need the crop farmers to supply them with food and farmlands to graze their animals after harvest. However, the symbiotic relationship has been confronted with several problems as grazing cattle sometimes destroy farms of indigenous people leading to conflicts, family displacement, burning of farmland and properties, closure of schools and businesses and death.

Conflicts between crop farmers and cattle herders have been recurrent and become more violent over the past few decades in Ghana and throughout sub-Saharan Africa due to competition over grazing pasture and limited resources. These conflicts have become a major problem threatening peaceful coexistence and affecting farmers' livelihood. Conflicts primarily revolve around competition for access to and use of land and water resources. Both crop farmers and cattle herders are involved in the conflicts through their activities. Azeez (2015) reported that farmer-herder conflict has been a common feature of economic livelihood in West Africa for longer time period with consequences on human and animal lives, properties, peaceful coexistence and orderliness. One of the major causes of these conflict is as a result of destruction of farmlands and farm produce by the grazing cattle during the day or night. According to Baidoo (2014), the destruction of fields is unavoidable since the Fulani herders are unable to manage the movement of the herds at night. Even though forage and water become more limited during the dry season and because Fulani herders depend on crops like plantains and watermelons as supplies of water for their cattle, the majority of agricultural devastation takes place during this time (Baidoo, 2014). There are several protests by the local people in Agogo area in the Ashanti Region for authorities to drive away the Fulanis' with their cattle from their community as a result of crop destruction by the grazing cattle. In 2012, Kumasi High Court ruled and ordered the Regional Security Council (REGSEC) to drive out all

Fulani herdsmen and their cattle from the Agogo area with immediate effect when some arable crop farmers took the matter to court to seek justice (Republic of Ghana, 2012). However, the Fulani herdsmen and their increased number of cattle irrespective of the court ruling and the myriad of protests are still on Agogo farmlands grazing animals. In an attempt to expel the herdsmen and their cattle from Agogo, the government of Ghana revisited an expulsion policy called “Operation Cowleg” as recommended by Dadson committee set by REGSEC in 2010 through the use of military and police task force. Operation Cowleg was coined in the year 1988 by the government of Ghana with the aim of flushing out illegal Fulani herdsmen with their cattle occupying the lands of local people and also to check the spread of diseases (Tonah, 2001). Nonetheless, this government strategy wasn’t sustainable and it is causing huge economic losses to both the government and the cattle owners as millions of Ghana cedis is being lost through the operation.

According to the Agogo District Chief Executive, Operation Cowleg and the farmer-herder conflict cost the assembly GH¢3 million that was earmarked for development projects. The assembly is responsible for covering the costs of the operation, which has become an annual tradition of deploying Police and Military men to Agogo, especially during the dry season (Personal interview, 2018). Furthermore, since the inception of the ‘Operation Cowleg’ policy the farmer-herder conflict still exists when pasture becomes unavailable to the animal and this suggest that the policy is not a solution to rely on. The cattle again belong to some of the influential people in government, politicians, civil servants, chiefs, security service personnel among others and the Fulanis are only employed as caretakers though they also have few numbers of the animals. Furthermore, most of the research works related to farmer-herder conflict in different parts of the country, focused on the causes and the effects

of the conflict without pointing out a sustainable solution. In order to mitigate the farmer-herder conflict, there is the need to explore a more scientific and modern method of cattle rearing and this can be achieved by cattle intensification, pasture establishment with the paddocking system. This can significantly reduce the perennial clashes between the crop farmers and herders and avoid the confusion of cattle trespassing to other people's crop farms to create problems.

### **3.2 Objective**

The broader objective of this study was to assess the causes of farmer-herder conflict and outline possible solutions to the conflict.

The specific objectives of the study were to:

- a. Describe the socio-economic characteristics of the respondents in the study areas
- b. Examine the factors responsible for the conflict between crop farmers and cattle herders in the study area
- c. Examine the institutions involved in the management and resolution of the conflict between farmers and Fulani herders in the study area, and
- d. Identify and describe the possible solution in resolving the conflict.

### **3.3 MATERIALS AND METHOD**

#### **3.3.1 Description of the study area**

The study was conducted in six selected towns in the Agogo traditional area in the Ashanti Region of Ghana. These towns were selected because of the frequencies of clashes between the crop farmers and cattle herders.

In Ghana, the Asante Akim North district was established in 2012, with Agogo serving as the district capital. The district is located in the Ashanti Region, between latitudes 6° 30' and 7° 30' North and longitudes 0° 15' and 1° 20' West. The District is bordered to the north by the Sekyere Kumawu District, to the east by Kwahu East, to the south by the Asante Akim South District, and to the west by the Sekyere East District. It has a land size of 1,126 km<sup>2</sup> and accounts for 4.6% of the region's land area. The District has a total population of 69,186 people, with 51.2% being female and 48.8% being male (Ghana Statistical Service 2014). Akim North is primarily a rural District with population of 53.5% and 46.5% being rural and urban, respectively. The District is dominated by the Akan ethnic group (Ghana Statistical Service 2014). The population structure of the district is largely youthful and middle-aged with agriculture as the major economic activity. Food crops like plantain, rice, yam, cassava watermelon and others are major crops grown in the area. Ruminant livestock especially cattle rearing is also a major economic activity predominantly among the Fulani people. The District falls within the moist semi-deciduous forest zone with 54.5% open forest area, 21.9% closed forest and 23.3% wooden savannah area (Ghana Statistical Service 2013). The District has bi-modal rainfall pattern and extensive grassland is favorable for subsidiary crop and livestock farming. The annual total rainfall ranges between 1250 mm and 1750 mm. The dry harmattan season, which lasts from December to March, is connected with drought conditions.

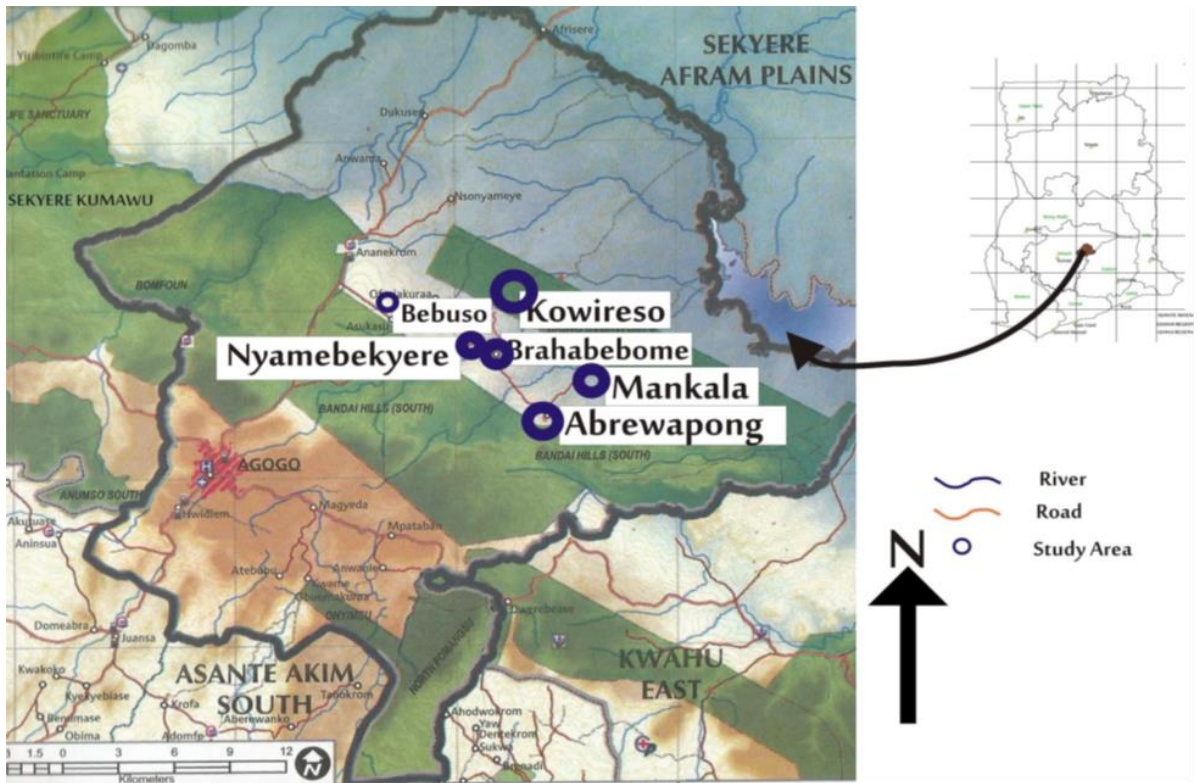
This time of year is distinguished by relatively high and low temperatures during the day and night, respectively. Streams dry up at this time, and agricultural production, with the exception of vegetable planting along river and stream banks, comes to a standstill (Ghana Statistical Service 2013).

### **3.3.2 Sampling Procedure and Sample Size**

Cattle herders and Crop farmers are the target populations in this study. The respondents were selected using a multi-staged sampling technique (Appendix I). The first stage involved the purposive sampling technique that helped in the selection of six farming communities or villages in the Agogo traditional area. This decision was made based on how frequently farmer-herder conflict occurred in those localities (Baidoo, 2014). These areas are Mankaila, Nyamebekyere, Kowereso, Aberewapong, Bebuoso and Brahabebome (Figure 3.1). Sixty (60) crop farmers were interviewed in total, ten from each village.

In the case of cattle herders, the data were collected during a training workshop titled ‘Basic Animal Feed Production and Preservation’ under the auspices of Ghana National Association of Cattle Farmers (GNACAF) in Tamale in the year 2022. The workshop brought together cattle owners and herders involved in cattle business from Agogo (Ashanti Region), Kintampo (Bono East Region) Dambai (Oti Region) and Gusheigu (Northern Region). The stakeholders were invited in the wake up of increasing clashes between cattle herders and crop farmers in those selected regions. The purpose of the training was to educate the stakeholders on the modern methodology of cattle husbandry geared at promoting peaceful coexistence among cattle herders and crop farmers. One hundred and forty cattle herders were

interviewed in total, 35 from each of the selected region. In total, 200 respondents were interviewed in this study.



**Figure 3.1: Map of Asante-Akim North District**

Source: Adapted from the Ministry of Local Government and Rural Development, 2014.

### 3.3.3 Sources of Data Collection

Primary and secondary data were collected for this study. Primary data were collected using 200 structured interviews. The structured questionnaires consisted of both open ended and close ended questions (Appendix I). By the use of the questionnaires, the selected farmers were interviewed and asked questions relating to the set objectives. Focus Group Discussion (FGD) were conducted to validate the findings from the quantitative result. The questionnaires were administered in the local language (Hausa, Zabarma, and Twi) for farmers who could not read and write English. The

questionnaire was designed to seek information on the demographic characteristics of farmers, causes of the conflicts, institutions involved in managing conflicts and solution to farmer-herder conflict.

### **3.3.4 Statistical analysis**

The data collected were analyzed using Statistical Package for Social Sciences (SPSS, 2015; version 23). Descriptive statistics, specifically, the mode, frequency counts and percentages were used to achieve research objective. Cross tabulation was also employed to establish the relationships between the variables.



### 3.4 RESULTS AND DISCUSSION

#### 3.4.1 Demographic characteristics of crop farmers and cattle herders

*Sex:* Table 3.1 shows the sex of the respondents. The analysis of the results shows that, out of 60 crop farmers interviewed, 37 (61.7%) were males whilst 23 (38.3%) were females. In the case of the cattle herders, majority (78.6%)110 were male whereas females constituted 21.4% of the respondents. The results suggest that both crop farming and cattle herding is a male dominated activity. This may be as a result of culture and tradition in the Ghanaian family system as men were perceived to be the household heads and breadwinners of the family. Additionally, it takes a lot of energy to herd cattle because they might travel long distances in search of water and pasture, which contributes to the predominance of males in this profession. The result also implies that the propensity to be engaged in conflict is greater in males who are more energetic than their female counterparts and therefore regarded as the defenders of life and properties. Fulani women are mostly engaged in milking processing and sale of milk and milk products (Tonah, 2006). This agrees with the findings of Agyeman (2017) who reported that in Ghanaian households, customs and tradition, men are the heads of the families, and they cannot be circumvented to interview women when they are present. Similarly, Urdal (2006) affirms that males are more predisposed than females to be involved in conflict-related situations.

**Table 3.1: Sex distribution of crop farmers and cattle herders**

Sex	Crop farmer		Cattle herders	
	Frequency	Percentage	Frequency	percentage
Male	37	61.7	110	78.6
Female	23	38.3	30	21.4

***Sex of respondents and their reaction to disturbances:*** A cross tabulation in Table 3.2 indicate that majority (43.2%) of the crop farmers chose to retaliate or revenge to any disorder when their crops or any other properties are damaged by grazing cattle or herder as compared to majority (52.2%) of their female counterpart who preferred the herders are relocated to a different environment. Only 2.7% of the male cattle herders agreed to relocate to a different community. None of the female cattle herders agreed to relocate to a different community as they find their means of livelihood in the current location. Similarly, majority (30.0%) of the cattle herders preferred open confrontation or hit back their opponent when their cattle are harmed as compared to their colleague females of which majority (56.7%) preferred to report any damages to their cattle. However, only 26.1% of the female crop farmers agreed to report their case to authorities for compensation or any other action. Furthermore, 10.8% of the male crop farmers showed commitment to peaceful resolution of any misunderstanding and 39.1% of the male cattle herders also agreed to solve any issue between the two parties. The dominance of the males in farming activities is a major factor contributing to the incidence of conflicts as suggested by John (2015).

In effect 70% of the male cattle herders and 86.7% of the female cattle herders preferred peaceful coexistence between them and the crop farmers and this could be as a result of them been strangers on the indigenous community which is largely occupied by the crop farmers. Likewise, 56.7% of the male crop farmers and 87.0% of their female colleagues preferred to settle any matter of dispute with the cattle herders other than open confrontation and this might be as a result of benefitting directly or indirectly from the activities of the herders. For instance, cattle manure used as organic fertilizer helps in improving soil fertility thereby reducing the cost of production by the farmer. This finding contradicts that of John (2015) who found out

that majority (53.9%) of the male crop farmers and cattle herders (72%) chose open confrontation when their crops and/ cattle or properties are damaged while 46.1% and 28% of crop farmer and cattle herder preferred other method of settlement and attributed their choice to their mistrust to the local authorities and the police service. However, the findings agree to the findings of John (2015) when it comes to the issue of female crop farmers. He reported that majority (82.0%) of the female crop farmers preferred to settle their misunderstanding amicably rather than by violent means and only 18% of the female farmers approached the herders for crop damages.

**Table 3.2: Effect of sex on resolution of conflict between crop farmers and cattle herders**

Sex	Crop farmer				Cattle herders			
	Retaliate	Report	Relocate	Resolve	Retaliate	Report	Relocate	Resolve
Male	16(43.2)	3(8.1)	14(37.8)	4(10.8)	33(30.0)	31(28.2)	3 (2.7)	43(39.1)
Female	3(13.0)	6(26.1)	12(52.2)	2(8.7)	4(13.3)	17(56.7)	0(0.0)	9(30.0)
<b>Total</b>	<b>19</b>	<b>9</b>	<b>26</b>	<b>6</b>	<b>37</b>	<b>48</b>	<b>3</b>	<b>52</b>

*\*Figures in parenthesis are percentages*

**Age:** The results in Table 3.3 indicate that majority of the crop farmers were 30 to 39 years (40%) whereas 8.3% of them fell below 30 years and only 5% were beyond 60 years. This suggest that more youth were involved into crop farming than those above 40 years. This may also imply that due to the unemployment in the formal sector, the educated youth now venture into farming for livelihood. This finding is contrary to the findings of John (2015) who stated that more youth disregards farming activities when educated and prefer to work in the formal sector. The results further revealed that majority of the cattle herders were between the ages of 20 and 29 years (43.6%) while 4.3% were below 20 years. Nearly 3% were above 60 years. The herders above 50 years were however quitting the nomadic job after decades of practice and have

restricted their movement to few distances to take the opportunity to teach the young ones the skills of herding. In addition, the results shows that herding is carried out by energetic youth who have a lot of stamina to trek long distances grazing their animals. The youth largely inherit the herd from the family which is passed on from generation to generation. This implies that both the crop farmers and cattle herders are in their youthful ages and have the energy to physically confront each other whenever there is disagreement.

**Table 3.3: Age of the crop farmers and cattle herders**

Age	Crop farmer		Cattle herders	
	Frequency	Percentage	Frequency	percentage
10 – 19	2	3.3	6	4.3
20 – 29	5	8.3	61	43.6
30 – 39	24	40.0	19	13.6
40 – 49	17	28.3	35	25.0
50 – 59	9	15.0	15	10.7
60+	3	5.0	4	2.9

**Age of crop farmers and cattle herders and their reaction to disturbance:** The age of the respondents is very important in the determination of their reaction towards disturbance. According to Hagberg (2000), the direct cause of conflict escalation is the ages of the crop farmer and the herders. Table 3.4 shows the ages of crop farmers and herders and how disputes between them are resolved. It was observed that majority of the respondent from both the crop farmers and the cattle herders were aged between 10 and 39 and preferred to resolve their dispute by retaliation rather than by reporting or relocation or amicable resolution. However, the respondents aged above 40 preferred other settlement apart from open confrontations. The results obtained might be as a result of youthful exuberant where each party wanted to show their might whenever there was a misunderstanding. The older ones preferred

peaceful cohabitation as they indicate the negative impact of conflict they experience in the past in their means of livelihood. This agrees with John (2015) who opined that in the event of misunderstanding between the farmer and the herder, majority of the youth preferred retaliation to reporting or relocation. Hagberg (2000) also reported a positive correlation between age and reaction towards farmer-herder conflict. The findings agree with John (2015) who suggested that age is a determinant factor of respondent's attitude towards conflict.

**Table 3.4: Effects of age on resolution of conflict between crop farmers and cattle herders**

Age	Crop farmer				Cattle farmer			
	Retaliate	Report	Relocate	Resolve	Retaliate	Report	Relocate	Resolve
10 – 19	1(50.0)	1(50.0)	0(0.0)	0(0.0)	3(50.0)	2(33.3)	0(0.0)	1(16.7)
20 – 29	13(54.2)	6(25.0)	5(20.8)	0(0.0)	35(57.4)	18(29.5)	1(1.6)	7(11.5)
30 – 39	2(40.0)	0(0.0)	2(40.0)	1(20.0)	7(36.8)	6(31.6)	1(5.3)	5(26.3)
40 – 49	3(17.6)	1(5.9)	11(64.7)	2(11.8)	2(5.7)	9(25.7)	1(2.9)	23(65.7)
50 – 59	0(0.0)	0(0.0)	7(77.8)	2(22.2)	0(0.0)	3(20.0)	0(0.0)	12(80.0)
60+	0(0.0)	1(33.3)	1(33.3)	1(33.3)	0(0.0)	1(25.0)	0(0.0)	3(75.0)
<b>Total</b>	<b>19</b>	<b>9</b>	<b>26</b>	<b>6</b>	<b>47</b>	<b>39</b>	<b>3</b>	<b>51</b>

*\*Figures in parenthesis are percentages*

**Marital status:** Majority of the respondents were married; 71.7% for crop farmers and 66.4% for cattle herders while 28.3% and 29.3% of crop farmers and cattle herders were single, respectively. Only 4.3% of cattle herders were widow. This means that, majority of the respondents from both groups have at least, one dependent family member, which makes them responsible and as such takes up their various occupation as a means of livelihood. This finding agrees with John (2015) who attributed the large family sizes to commercialization of agriculture which requires the use of family members as workers on the farm. Additionally, according to Agyeman (2017),

marriage serves as a method of acquiring property, obtaining family labourers for the farm, and providing security from the threat of Fulani herdsmen.

**Table 3.5: Marital status of the respondents**

Marital status	Crop farmer		Cattle herders	
	Frequency	Percentage	Frequency	Percentage
Single	17	28.3	41	29.3
Married	43	71.7	93	66.4
Divorced	0	0	6	4.3

**Marital status of the respondent and reaction to disturbance:** Table 3.6 shows that majority (75%) of the herders who are single preferred to retaliate than to report or settle the dispute between them and the crop farmers peacefully. This might be due to their bachelorhood, lack of family responsibility and their show of bravado. None of the cattle herders who are single opted for relocation and 24.4% preferred to report the dispute to police for cordial settlement. On the other hand, majority of the crop farmers who were single preferred to report or relocate the herders when there is conflict whereas 47% of them preferred to retaliate. Similarly, majority of married crop farmers and the cattle herders representing 74.5% and 83.8% respectively chose to settle their matter peacefully other than through violent means. This result might be as a result of their family responsibilities and preferred to go on with their day-to-day activities to be able to fend themselves and their families. Furthermore, majority (83.3%) of the herders who are divorced preferred peaceful coexistence than open confrontation and this might be as a result of family burden on them.

**Table 3.6: Effect of marital status on resolution of conflict between farmers and herders**

Marital status	Crop farmer				Cattle farmer			
	Retaliate	Report	Relocate	Resolve	Retaliate	Report	Relocate	Resolve
Single	8(47.1)	5(29.4)	4(23.5)	0(0.0)	31(75.6)	6(14.6)	0(0.0)	4(9.8)
Married	11(25.6)	4(9.3)	22(51.2)	6(14.0)	15(16.1)	31(33.3)	3(3.2)	44(47.3)
Divorced	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(16.7)	2(33.3)	0(0.0)	3(50.0)
<b>Total</b>	<b>19</b>	<b>9</b>	<b>26</b>	<b>6</b>	<b>47</b>	<b>39</b>	<b>3</b>	<b>51</b>

*\*Figures in parenthesis are percentages*

**Family size:** Crop farmers had smaller family sizes (1-5) compared to cattle herders (45 vs 35.7%; Table 7) and only 15% of both crop farmers and cattle herders had family sizes above 16. The large family size of cattle herders might be as a result of labour required in cultivating a large expanse of land and dependence on family labour at the expense of hired labour for increase production. John (2015) reported that large household size implies more mouth to feed and more hands to work resulting in decrease hired labour.

In respect to the herders, half of the respondent (35.7%) recorded a family size of 1 – 5 whereas 22% recorded a family size of 16 above. The results obtained was expected due to the polygamous nature in the Fulani set up who marry up to four wives. This was contrary to what was reported by John (2015) who stated that small family size of Fulani herders could be attributed to the nomadic lifestyle which makes migration with the family monotonous. There is a positive relationship between a family size and conflict as usage of land for agricultural activities increases (Manu, 2014). As the family size increases the space required for farming also increases resulting in dispute between crop farmers and the herders which could lead to a conflict.

**Table 3.7: Family size of crop farmers and cattle herders**

Family size	Crop farmer		Cattle herders	
	Frequency	Percentage	Frequency	Percentage
1 – 5	27	45.0	50	35.7
6 – 10	17	28.3	41	29.3
11 – 15	7	11.7	27	19.3
16+	9	15.0	22	15.7

**Educational level:** The results from Table 3.8 revealed that majority (41.7%) of the crop farmers had basic education with 20%, 5% and 4% having secondary, tertiary and Quranic education respectively whilst 10% of the respondent had no formal education. This report contradicts the findings of John (2015) who reported that majority of the farmers had no formal education and only 32% of the farmers together had Quranic or basic education while 3% had secondary education. No cattle herder had secondary or tertiary education. The increase number of the farmers who had secondary education, could be as a result of the introduction of the ‘free senior high school’ policy in Ghana in 2017 that pushes a lot of basic student leavers into the senior high school.

Majority (52.1%) of the cattle herders had Quranic education, 30.7% had no formal education whereas 17.1% had basic education (Table 3.8). None of the cattle herders had secondary and tertiary education. Comparing the educational status of both the crop farmers and the herders, it was observed that the crop farmers had more formal education than the cattle herders because in the Fulani set up who are mostly cattle herders, formal education is not a priority to determine one’s ability and skills to herd cattle as most of the learning outcomes are non-formal and through observation from senior herders. Herding skills are also passed on from generation to generation. Quranic studies are vital in the tradition of cattle herders as majority were practicing Muslims and are required to study the Quran and this could be the reason why

majority of them had Quranic education. This current finding agrees with John (2015) who found out that majority (88%) of the cattle herders interviewed in his work had Quranic education and none had both secondary and tertiary education.

**Table 3.8: Educational level of crop farmers and cattle herders**

Education	Crop farmer		Cattle herders	
	Frequency	Percentage	Frequency	percentage
Basic	25	41.7	24	17.1
Secondary	20	33.3	0	0
Tertiary	5	8.3	0	0
Quranic	4	6.7	73	52.1
Nonformal	6	10.0	43	30.7

***Educational level of the respondent and reaction to disturbance:*** Table 3.9 shows the level of education of crop farmers and cattle herders and how they resolved conflicts. The results indicated that majority of crop farmers (68.0%) and the cattle herders (66.6%) who had basic education preferred other method of responding to disturbances than retaliation. However, 32.0% and 33.3% respectively preferred retaliation. Same trend was observed among crop farmers who had secondary and tertiary education from the crop farmers. None of the cattle herders attained secondary nor tertiary educational level. Similarly, majority of the respondents 75% and 67.1% respectively of both the crop farmers and the cattle herders who had Quranic education favoured to resolve their differences peacefully. Those with no formal education opted for similar resolution of conflicts than retaliation. The results implies that educational attainment had no direct effect on the choices they made as reported by John (2015).

**Table 3.9: Educational level of crop farmers and cattle herders and conflict resolution**

Education	Crop farmer				Cattle herders			
	Retaliate	Report	Relocate	Resolve	Retaliate	Report	Relocate	Resolve
Basic	8(32.0)	5(20.0)	10(40.0)	2(8.0)	8(33.3)	8(33.3)	0(0.0)	8(33.3)
Secondary	8(40.0)	3(15.0)	7(35.0)	2(10.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Tertiary	1(20.0)	0(0.0)	4(80.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Quranic	1(25.0)	1(25.0)	2(50.0)	0(0.0)	24(32.9)	20(27.4)	3(4.1)	26(35.6)
Non-formal	1(15.7)	0(0.0)	3(50.0)	3(33.3)	15(34.9)	11(25.6)	0(0.0)	17(39.5)
<b>Total</b>	<b>19</b>	<b>9</b>	<b>26</b>	<b>6</b>	<b>47</b>	<b>39</b>	<b>3</b>	<b>51</b>

*\*Figures in parenthesis are percentages*

**Ethnicity:** The result from Table 3.10 indicates that majority (53.3%) of the crop farmers are Akans by ethnicity, 13.3% belong to Ewe group whilst 33.3% belongs to other ethnic groups. The results obtained was expected as the Akan culture specifically the Asante in the district is most prevalent even though in the settlement, there are other migrant settlers who are primarily from the Northern and Volta areas do work on farmlands. The results obtained is in agreement with GSS (2013) report which indicated that because they are the locals, Asante tradition and culture predominate in the area. Furthermore, the results also revealed that not all cattle herders are Fulanis likewise not all Fulanis are herders however they are majority shareholders in the cattle industry.

**Table 3.10: Ethnicity of crop farmers and cattle herders**

Ethnicity	Crop farmer		Cattle herder	
	Frequency	Percentage	Frequency	Percentage
Akan	32	53.3	6	4.3
Ewe	8	13.3	9	6.4
Dagomba	3	5.0	8	5.7
Komkomba	6	10.0	5	3.6
Fulani	4	6.7	88	62.9
Gonja	5	8.3	6	4.3
Hausa	2	3.3	10	7.1
Waala	0	0	5	3.6
Wangara	0	0	3	2.1

### 3.4.2 Farm size and type of crop cultivated by the respondents

Table 3.11 shows the farm size of the respondents. Majority (43.3%) of the crop farmers operate on a land size ranging from 1 to 15 acres, 23% had a land size range of 16 – 30 acres, 8% of the crop farmers cultivate on 31 – 60 acres and only 3% farm on more than 60 acres of land. This shows that farming in the surveyed area is mostly on commercial basis rather than subsistence. Similar observation was reported by John (2015) who stated that farming in the Afram plains is mostly done on large scale rather than on small land size.

It was also observed that, majority (40.0%) of the respondents are into plantain production, 23.3% cultivate maize, 26.6% are into watermelon and cassava farming while 6.7% are engaged in tomato. Fewer farmers (3.3%) cultivated cocoa. Agyeman (2017) recounted in his studies that the major crop cultivated in Agogo was plantain and that 100 acres of plantain got destroyed by cattle herders which resulted in a conflict. Similarly, John (2015) stated that farmers in Agogo usually engaged in cultivating plantain, maize, cassava and tomato on a commercial basis.

**Table 3.11: Farm size and type of crops cultivated**

Farm size	Crop farmer	
	Frequency	Percentage
1 – 15	26	43.3
16 – 30	23	38.3
31 – 45	5	8.3
46 – 60	3	5.0
60+	3	5.0
<b>Crop cultivated</b>		
Maize	14	23.3
Watermelon	8	13.3
Plantain	24	40.0
Cassava	8	13.3
Cocoa	2	3.3
Tomato	4	6.7

### 3.4.3 Herd size of the respondents

Results presented in Table 3.12 shows that majority (40%) of the herders kept between 1 and 50 cattle, 22.1% had a herd size between 51 and 100 and more than 200 cattle. About 9.3% of the herders kept 151 – 200 animals and only 6.4% kept between 101 and 150 cattle. Among the Fulani people, cattle are very important and the number of cattle one possess determines his wealth and social prestige in the society in which he lives. Usually, the Fulani keep cattle as a tradition passed on from generation to generation and not as purposely for business and only sell the animal when the need arises. Mostly, the terms of engagement between the cattle herders and the cattle owners are such that the Fulani herdsman are entitled to the milk of the herd and a calf per year plus monthly stipend. Hence, the greater the herd size, the more he earns from the milk. This agrees with Adogi (2013) who stated that the greater the number of cattle the wealthier the farmer is and more income the herder earns from the sale of milk. Operation Cowleg had a great influence on the cattle population in the study area as most cattle owners relocated their animals to avoid loses through

killing and rustling. The smaller herd size according to the respondents was due to the ‘Operation Cowleg’ and cattle rustling that posed a serious threat to their operations.

**Table 3.12: Herd size of the respondents**

Herd size	Cattle herders	
	Frequency	Percentage
1 – 50	56	40
51 – 100	31	22.1
101 – 150	9	6.4
151 – 200	13	9.3
200+	31	22.1

### 3.4.4 Causes of the conflict

#### 3.4.4.1 Crop damage by cattle

As shown in Table 3.13 majority (of both the crop farmers (83.3%) and the cattle herders (68.6%) agreed that damage to food crops is one of the factors that causes conflict between them. About 15% of the crop farmers however did not consider crop destruction as the possible cause of conflict. Similarly, damage to crop farms was not considered as the cause of the conflict among 27.9% of the cattle farmers. About 4% of the herders were undecided. Ideally grazing cattle must be managed under the intensive management system so as to prevent destruction of the farms and the farm produce. However, cattle herders largely due to the size of the herd, failed to control the graze animals which might end up straying into farms causing damages to crops. Sometimes the herders may deliberately send their animals to graze on cultivated food crops particularly in the dry season when feed and water are unavailable. This agrees with the findings of Baidoo (2014) who stated that the damage to food crops is primarily unavoidable owing to the Fulani herdsman's failure to regulate herd movement at night. The majority of farm damage happens during the dry season

because water becomes limited during this time, and Fulani herders rely on crops such as plantain and water melon as source of water for their cattle (Baidoo, 2014).

**Table 3.13: Causes of conflicts between crop farmers and cattle herders**

Parameters	Crop farmer					Cattle farmer				
	SD%	D%	U%	A%	A%	SD%	D%	U%	A%	SA%
Damage of food crop	8.3	6.7	1.7	38.3	45	23.6	4.3	3.6	25.7	42.9
Encroachment	11.7	11.7	1.7	43.3	31.7	12.9	14.3	5.0	37.9	30.0
Water contamination	13.3	1.7	0	35.0	50.0	21.4	8.6	0	38.6	31.4
Pasture poisoning	26.7	35.0	3.3	21.7	0	13.6	5.7	2.9	57.9	20.0
Killing of stray animal	66.7	0	8.3	13.3	11.7	3.6	0	9.3	33.6	53.6
Cattle rustling	63.3	0	6.7	15.0	15.0	3.6	0	8.6	30.7	57.1
Bush burning	18.3	10.0	3.3	45.0	23.3	10.0	13.6	7.1	31.4	37.9
Sexual harassment	11.7	0	1.7	51.7	35.0	36.4	6.4	6.4	20.7	30.0
Drug abuse	13.3	20.0	11.7	33.3	21.7	17.9	11.4	6.4	35.7	28.6
Under-aged herders	6.7	3.3	10.0	61.7	18.3	14.3	7.9	18.6	28.6	30.7

***SD = Strongly Disagree, D = Disagree, U = Undecided, A= Agree, SA = Strongly Agree***

A crop farmer recounted how he lost 20 acres of maize farm as a result of grazing cattle. He stated;

*I had a 20-acre land on which I planted maize hoping for good harvest. I left the farm in the evening to go home. The following morning, I came and realized massive destruction on the farm. I cried whole day as I could not trace the Fulani who did that to me. Imagine I get him what will happen. These herders are killing us in our own territory.*

Stanley et al. (2017) also ranked damage to field crops as the major cause of farmer-herder conflict in his studies. Okeke (2014) also reported that lack of control of grazing animals by the cattle herders without proper supervision results in crops destruction which are largely inevitable.

Amadu Fulani has this to say:

*My brother, some of the problem is caused by my people. Some intentionally send their animals to destroy people's farm. Honestly that's not good.*

This was not surprising as most the resident Fulani herders attributes the intentionally damages to crops to alien herdsman. According to Ojukwu et al. (2020), Crop farmers also lament and claim that the destruction of crops by cattle leads to widespread poverty and unemployment in the country. They also claimed that they are prevented from coming to the farm by the dread of armed herders.

Another crop farmer narrated;

*The kind of weapons the cattle herders hold is very scary. The state should do something about it. Whenever they come to your farm you have no any other option than to surrender to them. The Fulani can look at you and tell you his cattle want to chew plantain or maize. So, we have to pray for safety always when we going to the farm.*

Furthermore, 15% of the cattle herders disagreed that crop damages cause conflict between crop farmers and the herders. They stated that, local herders compensate crop farmers for crop destructions. They further argued that, alien nomads from neighbouring countries are those who normally bring their animals to graze on cultivated field causing crop damages. Hussein (1998) argued that damage to crops by the cattle herders ordinarily does not lead to conflict when appropriate compensations were paid.

#### **3.4.4.2 Land Encroachment**

Table 3.13 further shows that majority (75%) of the crop farmers and 67.9% of the cattle herders agreed that encroachment of farm land also leads to conflict while 23.4% and 27.2% of crop farmers and the cattle herders respectively disagreed, 1.7% and 5.0% were undecided respectively. The results implies that both agreed that encroachment to either farms or grazing land can lead to tension build up between the two parties. The crop farmers accused the cattle herders of deliberately grazing their animals close to where they are planting in order to push them further away from their farms. Similarly, the cattle herders also accused the crop farmers of cultivating along the pathway of grazing field. It can further be stated that due to population increase and the large number of animals that are been kept put pressure on the land use which could lead to conflict if one of the parties is denied access to the land use. This agrees to Yahaya (2008) who argued that land encroachment is among the causes of farmer-herder conflict.

#### **3.4.4.3 Water contamination by grazing cattle**

It was observed from Table 3.13 that more of the respondent from the crop farmers (85.0%) and the cattle herders (70.0) agreed that contamination of water bodies by the grazing animals also leads to reprisal. Again, 15% and 30% respectively of both the crop farmers and the cattle herders disagree. Clean and uncontaminated water is vital for the survival of man and animals. Crop farmers apart from using water for domestic activities also use it to irrigate or water their field crop. Likewise, cattle herders need clean water for home consumption and to refresh their animals. However, due to inadequate mechanized water facilities such as boreholes, both the crop farmer and the herder in the rural communities depends on the surface water

such as rivers and streams for their activities. Any contamination of the water is a potential cause of conflict between them (Figure 3.2). Kofi, a 35-year-old crop farmer stated this in an interview;

*The Fulanis and their cattle cause more damage to our source of water. We use this water for washing and other things but they will bring their cattle to drink while defecating and muddying the water making it difficult for us to use the water. Once they bring the cattle to drink, we have to wait till they finish. You cannot challenge them.*



**Figure 3.2: Water been contaminated by cattle**

Source: Baidoo, 2014

From the results it can be said that contamination of water from the cattle was largely agreed to be one of the causes of the conflict as the herders' inability to control the animals thereby allowing the animals to walk directly into the water bodies to drink. This also led to the animals openly defecating into the water to make it unsafe for consumption. This agrees to the findings of (Tonah, 2006; Ofuoku and Isife, 2009; Abdulai and Yakubu, 2014 and Manu, 2014). They argued that both farmers and herders considered pollution of water as a major cause of farmer-herder conflict.

#### 3.4.4.4 Pasture poisoning

The results further revealed majority of the crop farmers (61.7%) disagree that spraying pasture was a cause of conflict between them, 21.7% agree to that assertion with only 3.3% remaining neutral (Table 3.13). On the contrary, 77.9% of the cattle herders agreed that pasture poisoning is a major cause of the conflict, 19.3% disagree while 2.9% were undecided. The results implies that crop farmers differed in their opinion with the cattle herders on the possibility of pasture poisoning as a cause of the conflict. This could be as a result of the use of agro-chemicals such as herbicides and pesticides which has increased in crop farming for increase yield. Meanwhile the cattle herders accuse the crop farmers of intentionally poisoning the pasture to drive them away from sending their animals to graze and to kill their animals should in case the animals feed on them. In an interview with a cattle herder called Muntouch Fulani, he stated that;

*Malam (sir), why is the crop farmers spraying the grass with poison? Is it not to kill our animals and drive us away from feeding the animals? We will resist any attempt of denying our animals the right to grass. Do you know the animals have the right to grass? That is why Allah created the grass for them and you go and spray it because you want to bring 'fada' (conflict).*

Another cattle herder recounted;

*Malam (sir), last year we lost five bulls and three cows due to pasture poison. I want to ask you if that is fair. Now if I retaliate the people will say we the Fulanis like fighting. But next time if that happened, I will not agree and will use my gun.*

The crop farmers on the other hand denied that spraying the field is a deliberate attempt to kill the animals. They spray their crops to control weeds which compete with the crops for nutrient, space, water and sunlight as well as insects from destroying their crops since they want to maximize yield.

Kwame Boateng who planted maize on 10-acre land stated;

*Bra (brother), crop farming is labor intensive and it is very expensive to cultivate 10 acres and do not make profit. I use 'kondem' (a weedicide) to spray my farm to control weeds and not to kill any animal. But they will bring their animals to eat around and if something happened to it they accuse us of killing their animals. This Fulani issue can't it be resolved forever? He quizzed.*

This agrees to the findings of Agyeman (2017) and Baidoo (2014) who found out that pasture spraying is also a cause of the conflict between the crop farmer and the cattle herder.

#### **3.4.4.5 Killing of stray animals**

Results from Table 3.13 also revealed that majority of the crop farmers (66.7%) disagree that killing of stray animals leads to conflict, 25.0% agree to that allegation with only 8.3% remaining impartial. On the contrary, 87.2% of the cattle herders agreed that killing of stray animals is a major cause of the conflict, 3.6% disagree while 9.3% were ambivalent. From the result, significant number of crop farmers' disregard killing of stray animals is a factor that leads to conflict whereas the cattle herders agreed to the fact that it leads to the conflict. This implies that the two have divergent views since their occupation differs. The cattle herder accused the farmers

of deliberately shooting and killing their animals that stray into their farms instead of driving the cattle away and that might lead to reprisal (Figure 3.3).



**Figure 3.3: Cattle killed by some members of the community**

Source: Zuria FM, 2022

In agreement, Ofuoku and Isife, (2009) opined that one of the major causes of farmer-herder conflict is killing of Fulani animals that strayed into farms to cause damages. Odoh and Chilaka (2012) stated that cattle herders suffer material damages when the crop farmers inflict physical injuries on their cattle by using cutlasses, spears or guns or by poisoning the cattle.

One Fulani herder recollected that;

*Aboki (friend), one of my animals got lost on our way back from grazing. I went round searching for it and found that it has a deep cut on the back. I suspected that it strayed into someone's farm and the farmer instead of driving it away or reporting it used sharp cutlass to cut it. The animal later on died.*

The crop farmers who agreed that killing of the strayed animals lead to conflict argued that the animals sometimes are deliberately allowed by the herder to invade their farms. And in trying to drive them some of the animals do sustain wounds and it led to open confrontation between them.

#### **3.4.4.6 Cattle theft and rustling**

The results from Table 3.13 show that majority of the crop farmers (63.3%) disagree that cattle rustling leads to conflict, 30.0% agree to that claim and 6.7% were undecided. On the contrary, 87.8% of the cattle herders agreed that cattle rustling is a major cause of the conflict, 3.6% disagree while 8.6% were hesitant. The crop farmers attributed the stealing to criminals in the community who are not necessarily farmers (Figure 3.4). The results implies that majority of the crop farmers disregard cattle stealing and accuses the cattle herders of stealing the animals themselves to be sold to butchers and other people. This allegation is not far from the truth as most of the cattle herders are found of doing that.



**Figure 3.4: Cattle rustlers on tricycle**

Source: Zuria FM, 2022

In an interview with cattle owner, Issa Dagomba, he stated that,

*I have a herder which I employed for two years to take care of my animals. I went to the farm one day to realize that one of the bulls is missing. When I questioned the herder, he said the animal was bitten by snake and died later on. On further check I got to know he sold the animal to a butcher in the next town. That is one of the risks of entrusting your animals to them.*

Another cattle owner recounted;

*I am having 50+ cattle, one day my herder sent them to graze and he went away with 18 animals and till date he never shows up. When they steal your animals, you cannot trace them back he concluded.*

This assertion is true and might be as a result of low wages received by the cattle herders from their employers but not to justify the stealing. Mostly the agreement between the owners and the herders is keeping the milk with monthly wages not exceeding GHS 300. The cattle herders see this as a cheat from their pay masters thereby selling some of the animals to take care of their extra expenses. This agrees to the findings of Abdulai and Yakubu (2014) who stated that farmers often alleged that cattle rustling are committed by Fulani herdsmen in Northern Region of Ghana. Furthermore, Gambo Kramu, a cattle herder stated that;

*Baba (father), our masters don't pay us well and they always cheat on us in the end. You will take care of his animals for several years but when the time comes for you to retire, he will just thank you without giving you anything meaningful. The only reward we get from this work is the cow milk. That is why some of our brothers run away with the animals. It is very sad! He added.*

This statement is true for most of the Fulani herders and as stated by Umaru Sanda (2017), a Fulani journalist of City TV in Accra;

*“My father and his employer agreed to do everything it required to make sure the more than 100 cattle were fed and provided with water. This entails taking them several kilometers into the bush every morning to find pasture and bringing them back on an empty stomach in the late afternoon or evening. The task is more challenging during the dry season when the grass is scarce or nonexistent and the animals become leaner. The only thing my father received as payment for this "slavery" was the cows' milk.”*

He further posited that,

*“My father's other six children, with the exception of the youngest, were prevented from going to school so they could assist him in caring after his masters' livestock. My father pulled me from school so that I could help him herd the cattle when he reached the age of 60 and grew unfit for the laborious task. He returned the cattle to his owner and calmly ended the nearly four-decade-old contract out of frustration due to old age, ill health, and a lack of support in the kraal”*

On the issue of how the cattle owners normally exploit the services of the herders without proper end of service benefit, He again narrated;

*“The employer of my father thanked him and made no effort to reward him with even one cow for his more than 40 years of work. He arrived back at his hut empty-handed and with grey hair. He could only take pride in his old, rickety bicycle, which was kept outside the home under a tree”.*

This could be the reason why most of the herders escape with their owners' animals. This can be addressed when proper contract with salary is signed and documented by the parties. The cattle rustling by the herders was confirmed by the herders but alluded it to the alien nomads. Furthermore, cattle owners should invest in securing land for pasture development with proper fencing so as to monitor the movement of their animals to eliminate theft and rustling.

#### **3.4.4.7 Bush burning**

Another cause of farmer-herder conflict as reported in Table 3.13 was burning of the bush. Majority (68.3%) and (69.3%) of crop farmers and the cattle herders agreed that bush burning causes conflict between them. Nonetheless, 28.3% and 23.6% respectively disagree with 3.3% and 7.1% decline to comment. The result denotes that bush burning is a major cause of the conflict. The crop farmers accuse the cattle herders of deliberately setting fire on their farms to burn so as to allow emergence of new grass during early rainy season whereas the cattle herders also alleges that the crop farmers intentionally set the fire during the dry season to prevent their animals access to grass. This agrees to Baidoo (2014) who reported that activities of crop farmers who engaged in charcoal business can also lead to bush burning.

#### **3.4.4.8 Sexual harassment**

Results from Table 3.13 also revealed that majority of the crop farmers (86.7%) agreed that sexual harassment often leads to conflict, 11.7% disagree to that allegation with only 1.7% abstained from commenting. Similarly, 50.7% of the cattle herders agreed that sexual harassment is a cause of the conflict and 42.8% disagree while 6.4% were indecisive. The results indicates that while significant number of the

farmers agreed that sexual harassment breed out conflict, the cattle herders marginally agreed to that assertion. Several researchers reported that sexual harassment is a major cause of farmer-herder conflict. Ofuoku and Isife (2009) reported that sexual harassment and the rape of community girls by the nomads also causes conflict. The crop farmers mostly tried to survive any sexual harassment. As captured by Agyeman (2017), *"I can no longer even go to the farm alone, much less return home at night eeeee! (Screaming). "Aaaa, yen didi or yen kyekya," they (Fulani herdsman) yell as soon as they see you (sex or butchering). They will all have sex with you even if they are only four"*. Some of the herders agreed to this fact as a cause of the tension between them but attributed the act to alien nomads.

#### **3.4.4.9 Drug abuse**

The results from Table 3.13 also indicates that drug abuse is a factor that causes conflict. The result show that 55.0% of the crop farmers agreed, 33.3% disagreed with 11.7% undecided. Similarly, 64.3% of the cattle herders agreed while 17.8% disagreed and 6.4% remained neutral. The result indicates that drug abuse by most of the cattle herders leads to their unwarranted and aggressiveness. They claimed that mostly hard drugs like tramadol and weed used by the herders energize them to withstand the tedious nature of herding cattle as they walk several kilometers to find pastures for their animals. Zoomo Alhassan, a cattle herder narrated that;

*I was with my friend one day herding our cattle in the bush. My friend used tramadol and became intoxicated. On our way back he was unable to control his herd. You see if something should happen and the animals strayed into farm it can bring confusion.*

The farmers also agreed that illicit drugs are becoming common in their communities without control and both the crop farmers and cattle herders are engaging into it.

#### 3.4.4.10 Activities of under-aged herders

The majority (80.0%) of the crop farmers agreed that activities of under-aged herders is a major cause of conflict between them (Table 3.13). About 10.0% of the respondents disagree to that claim and 10.0% also were undecided. Likewise, 59.3% of the cattle herders also agreed that activities of under-aged herders cause conflict, 22.2% disagree while 18.6% were uncertain. Largely the skill of herding is a learning process and the younger herders learned it from the older ones through practice and observation. In the course of the process some older herders entrust young children to herd animals (Figure 3.5). The under-aged herder most often loses control of the animals depending on the number and that could lead to straying into farms to cause destruction. Baba Bukari Wangara, a cattle herder stated that;

*It is part of our culture to train our children on how to herd cattle but sometimes the number of the cattle overwhelm their guides, and when they stray, they often destroy crops.*



**Figure 3.5: Underaged cattle herder**

Source: Field Data, 2022

This finding agrees to Yahaya (2008) who observed that cattle herders sometimes allow young children to herd large number of cattle who do not care much about the consequences in the event of crop damages.

### **3.4.5 Institutions involved in managing conflict**

The results presented in Table 3.14 revealed various stakeholders that are involved in managing and resolving farmer-herder conflict in the study areas. The results showed that majority (43.3%) of the crop farmers preferred the matter to be settled by the community leaders. About 26.7% considered religious leaders as preferred authority to mediate, 13.3% and 6.7% favored crop farmers and cattle farmers association respectively, 5.0% preferred the Police Department, 3.3% and 1.7% also decided to go to the District Assembly and the law court to seek redress.

On the other hand, many of the cattle herders (45.7%) preferred religious leaders to settle dispute between them followed by 21.4% considered cattle farmers association, 19.3% preferred community leaders, 5.0% favored crop farmers association, 3.6% chose district assembly whilst 2.9 % and 2.1% also decided to go to the police department and the law court to seek justice.

The contrary opinion has to do with the trust each party has with his own people. The farmers' choice to get the community leaders involved in the mediation of the conflict with the cattle herders has to do with their close relationship with their leaders. This agrees to John (2015) who opined that due to the proximity with their leaders they preferred matters of dispute sent to them for swift action. On the contrary, the cattle headers choice of the religious leaders (Imams and/or Pastors) is in line with the perception they have with their unbiasedness in dealing with issues of conflict. Again,

the Crop farmers Association recorded low pooled percentage (13.3%) this could be as a result of weak cooperative and unofficial representation in most villages. However, the cattle herders' choice of their association as mediators might be due to wider membership of the association and the effort of Ghana National Association of Cattle Farmers (GNACF) to bring all its members under one umbrella. The government institutions such the police service, the law court and the District Assembly scored low percentage and might be due to the mistrust and the long paperwork in their processing of such cases.

**Table 3.14: Crop farmers and herders' preference for institutions in managing conflicts**

Institution	Crop farmer		Cattle herders	
	Frequency	Percentage	Frequency	percentage
Community leaders	26	43.3	27	19.3
Religious leaders	16	26.7	64	45.7
Police Service	3	5.0	4	2.9
Law court	1	1.7	3	2.1
District assembly	2	3.3	5	3.6
Cattle farmers association	4	6.7	30	21.4
Crop farmers association	8	13.3	7	5.0
<b>Total</b>	<b>60</b>	<b>100</b>	<b>140</b>	<b>100</b>

***Educational level of the crop farmers and the institution involved in conflict resolution:***

Table 3.15 shows a cross tabulation of the educational levels of the crop farmers and the preferred institutions involved for managing conflict. Majority (68.0%) of the crop farmers with basic education preferred the community leaders to settle the dispute between them and the cattle farmers, 20% favoured religious leaders, 8% and 4% preferred crop farmers association and police department respectively. None favoured cattle farmers association and other government institution. Similarly, 60% of those

with secondary education preferred community and religious leaders to intervene the issue of misunderstanding between them. 20% chose police department and district assembly respectively and 20% again preferred the association to intervene whilst none chose the law court. Furthermore, 60% and 40% of those with tertiary education preferred the religious leaders and the cattle farmers association to settle the matter of conflict between them.

**Table 3.15: Crop farmers educational level and the preferred institution for managing conflict**

Education	Crop farmer						
	Community leader	Religious Leaders	Police department	Law court	District assemblies	Cattle farmers association	Crop farmers association
Basic	17(68.0)	5(20.0)	1(4.0)	0(0.0)	0(0.0)	0(0.0)	2(8.0)
Secondary	6(30.0)	6(30.0)	2(10.0)	0(0.0)	2(10.0)	1(5.0)	3(15.0)
Tertiary	0(0.0)	2(40.0)	0(0.0)	0(0.0)	0(0.0)	3(60.0)	0(0.0)
Quranic	2(50.0)	0(0.0)	0(0.0)	1(25.0)	0(0.0)	0(0.0)	1(25.0)
Non-formal	1(16.7)	3(50.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	2(33.3)
<b>Total</b>	<b>26</b>	<b>16</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>4</b>	<b>8</b>

*\*Figures in parenthesis are percentages*

Interestingly none favoured the other institution involve in conflict resolution (Table 3.15). Again, 50% of the respondent with Quranic education preferred community leaders, 25% and another 25% favoured the law court and the crop farmers association respectively. The results also indicates that majority of those with no education preferred religious leaders followed by 33.3% chosen the crop farmers association whilst 16.7% chose community leaders.

Table 3.16 also shows the educational levels of the cattle herders and the institutions involved in managing conflict. Majority (37.5%) of the cattle herders with basic education preferred the religious leaders to settle the dispute between them and the

crop farmers, 29.2% favored cattle farmers association, 20.8% preferred community leaders whilst 12.6 were in the favour of the crop farmers association, police department and the law court respectively. None favoured district assembly. Similarly, 42.5% of those with Quranic education preferred the religious leaders to intervene the issue of misunderstanding between them. About 20% chose police department and district assembly respectively and 20% again preferred the association to intervene whilst none chose the law court. Furthermore, 60% and 40% of those with tertiary education preferred the religious leaders and the cattle farmers association to settle the matter of conflict between them. Interestingly none favoured the other institution involve in conflict resolution.

Again, 50% of the respondent with Quranic education preferred community leaders, 20.5% each of the community leaders and the cattle farmers association, 4.5% favoured the crop farmers association whilst 10.9% of the respondents preferred the government agencies to intervene. The results also indicates that majority (55.8%) of those with no education preferred religious leaders followed by 18.6% who favoured chosen the cattle farmers association whilst 16.3% chose community leaders and 4.7% each were also in the favour district assembly and the crop farmers association. The import of the results is dependent on their educational level. Both the crop farmers and the cattle herders have their preferred institution they trust in conflict resolution.

**Table 3.16: Cattle herders educational level and the institution involved in conflict resolution**

Level of education	Cattle herders						
	Community Leader	Religious Leaders	Police Department	Law Court	District Assemblies	Cattle farmers association	Crop farmers association
Basic	5(20.8%)	9(37.5%)	1(4.2%)	1(4.2%)	0(0.0%)	7(29.2%)	1(4.2%)
Quranic	15(20.5%)	31(42.5%)	3(4.1%)	2(2.7%)	3(4.1%)	15(20.5%)	4(4.5%)
Non-formal	7(16.3%)	24(55.8%)	0(0.0%)	0(0.0%)	2(4.7%)	8(18.6%)	2(4.7%)
<b>Total</b>	<b>27</b>	<b>64</b>	<b>4</b>	<b>3</b>	<b>5</b>	<b>30</b>	<b>7</b>

*\*Figures in parenthesis are percentages*

### 3.4.6 Awareness of cattle herders of government established ranch

Table 3.17 cattle herders' educational level and their awareness of government's established ranch. From the results it was observed that majority (82.2%) of those with Quranic education were aware of the establishment of ranch. This was followed by 75.0% who had basic education whilst 51.2% of those without formal education were unaware of the ranch in some of the selected regions in Ghana. This result indicated that those who have had education were more exposed to information than those without it. According to John (2015), an educated population is more likely to have better access to information regarding their existence. This means that the educational attainment of the herders may have influenced their awareness of government projects.

**Table 3.17: Educational level and awareness of cattle herders of government established ranch**

Level of education	Aware		Unaware	
	Frequency	Percentage	Frequency	Percentage
Basic	18	75.0	6	25.0
Quranic	60	82.2	13	17.8
Non-formal	21	48.8	22	51.2

### 3.4.7 Willingness of cattle herders to patronize government established ranch

The government of Ghana in 2017 commissioned a cattle ranch in Wawase in the Afram Plains as a measure to curb the seasonal conflict between farmer and the cattle herder. Majority (54.8%) of the respondent with Quranic education were willing to send their cattle to the ranches established by government (Table 3.18). They were of the view that the ranches were very secured and will save them the hustle of searching for feed and water for their animals thereby reducing the seasonal farmer-herder conflict. In contrast, 62.8% and 58.3% of those with no formal education and herders with basic education were not willing to send their animals to the ranch by the state. They stated lack of feed, security and accountability for their choice of answer. In an interview with Mouzu Fulani, he stated that;

*I will never send my cattle to Wawase Ranch, can you imagine that the management couldn't account for four of my animals. They told me the animals went to graze and couldn't return back. Also, there is no feed there. How can you feed cattle with cotton seed cake? He queried.*

**Table 3.18: Educational level and willingness of cattle farmers to patronize the ranch established by the Ghana government**

Level of education	Willing		Unwilling	
	Frequency	Percentage	Frequency	Percentage
Basic	10	41.7	14	58.3
Quranic	40	54.8	33	45.2
Non-formal	16	37.2	27	62.8

### 3.4.8 Willingness of cattle herders to acquire land to established ranch

Table 3.19 show that All the cattle herders who had basic education were determined to acquire land for ranching or were willing to confine of their animals to avoid

conflict with the farmers. About 94.5% of those who had Quranic education were willing and ready to acquire land for ranching whereas 88.4% of those with no formal education agreed to get land for ranching purpose. Their reason was to establish and cultivate fodder for their animals all year round for increase production and also to prevent theft and conflict with the crop farmers. However, 5.5% and 11.6% of those with Quranic and those with no formal education, respectively, were reluctant to acquire land for establishment of cattle ranches. This might be as a result of their nomadic lifestyle which allows them to walk long distances with their animals for grazing. They indicated that land ownership in the country is difficult and very expensive. It may take time to change their mindset on the traditional way of cattle rearing to a more modern method which demand ranching with paddocking system for improved performance.

**Table 3.19: Educational level and willingness of cattle herders to acquire land to established ranch**

Level of education	Willing		Unwilling	
	Frequency	Percentage	Frequency	Percentage
Basic	24	100	0	0.0
Quranic	69	94.5	4	5.5
Non-formal	38	88.4	5	11.6

### 3.4.9 Respondents recommended solution to farmer-herder conflict

Table 3.20 shows recommended solution to the farmer-herder conflict. The results show that majority (41.7%) of the crop farmers believed that farmer-herder conflict can be resolved through establishment of cattle ranch. This was followed by 25.0% of the crop farmers who suggested that relocating herders to other areas where crop farming is not on a large scale will solve the conflict between them. About 15% of the

respondent also assumed that movement of the alien nomads from the neighbouring countries should be restricted by the Ghanaian border authorities. Furthermore, 10.0% of the crop farmers suggested that creating grazing reserves for cattle farmers to graze their animals without encroaching crop land. Only 8.3% of the crop farmers agreed to forceful evacuation of the cattle herders through the government policy of ‘Operation Cowleg’. None of the crop farmers however supported the lease of land to the cattle herders with fear that they will encroach into their territory when allowed to own land.

Majority (56.4%) of the cattle herders considered the establishment of a cattle ranch by the Ghana Government as is the best solution to farmer-herder conflict. Again, 22.9% of the respondent believed that movement of the alien nomads should be strictly restricted as they mostly cause the conflict through their movement through unapproved route and close to farmlands. These herdsmen migrate and exit freely into the country without any proper scrutiny and documentation at the borders. About 13.6% of the cattle herders suggested that creation of grazing reserves and cattle route will solve the conflict between them and crop farmers. Nearly 6% of them opined that leasing land to them just like crop farmers should be encouraged to avoid the seasonal clash with crop farmers. Only 1.4% of the cattle herders recommended relocation to other safer communities to prevent the conflict. None of the cattle herders suggested ‘operation cowleg’ as a lasting solution to farmer-herder conflict as it leads to loss of their properties and animals.

The respondent according to the findings agreed that cattle ranching is the best solution to farmer-herder conflict. In an interview with a crop farmer, he posed this question;

*Why can't the rich cattle owners start to ranch their cattle just like poultry, goat, fish and piggery farmers pen their livestock? If all the cattle farmers in the country are allowed to do that just as it is happening in other countries there wouldn't be any conflict.*

It was evident that the cattle herders are ready to commit their resources to securing land for ranch establishment. Asbat Fulani stated that;

*Malam (teacher), if only we will get support from the government and the traditional rulers, I will sell some of my cattle and invest the money into ranching. We also need the support from you the researchers to help us get the training and how to do things right. We are peaceful people and it hurt us always when we are tagged as criminals in the airwaves.*

The problem of farmer-herder conflict is not only caused by the indigenes but the alien nomads also contribute to the conflict. In line with this, both the crop farmers and the cattle herders recommended that movement of the alien herders should be restricted in the country as they are mostly the perpetrators of the conflict in order to curb the menace. To support this claim, one of the cattle herders stated;

*You see we are Ghanaians and we are against any form of violence. It is the herders who come from Niger, Burkina Faso, Nigeria and Mali to graze their animals here. These alien herders don't know the route very well so they graze their animals on crop farms and cause damages. The crop farmers will turn around and blame us. If the authorities can check this it will help us.*

Some of the farmers also agreed that the influx of alien herders in the country should be checked and their movement controlled. According to Owusu Issac, a 46-year-old crop farmer;

*My brother to be fair to the Fulanis, some of their brothers who are foreigners from other countries like Niger come here to graze their animals in the dry season. Mostly they cause destruction of crops but because we don't know them, we turn around to blame those here.*

It can also be deduced from Table 3.20 that section of the respondents from both the crop farmers and the herders are in favour of creation of grazing reserves across the country. They argued that grazing reserves and cattle route distance away from arable farmland can also help mitigate the conflict. However, the government of Ghana should do broader consultation in order not to disadvantage some people from losing their lands. Okeke (2014) reported that the Nigerian government method of establishing a grazing reserve would further worsen farmer-herder conflict if stakeholder engagement is not held.

Furthermore, greater number of crop farmers suggested relocation of the herders in order to prevent clash with them. They stated that so far as the herders are allowed to graze their animals openly in their territory, the seasonal problem will not be solved as either intentionally or not some of the herders will graze their animals on their land to cause problems. Only few of the cattle herders agreed to relocation. They indicated that it is better to go to safer area than to stay and lose your cattle to rustling, killing as well as 'Operation Cowleg' where security forces target them. Baba Fulani, a 55-year-old cattle herder said;

*If they say they don't like me here so I should relocate why not. It is better to move your animals to somewhere safe to avoid trouble than to remain and lose your properties.*

None of the cattle herders supported 'Operation Cowleg' as alternative solution to farmer-herder conflict. The policy of 'Operation Cowleg' was introduced to flush out the cattle herders from the country in order to curb the conflict between them and the crop farmers. However, the policy seems to be unsustainable as the state failed to do so since its inception. The decision to kill the animals does not only result to loss of properties but also amount to animal cruelty. It is against the welfare of the animals. Cattle herders and owners accuses the security forces of deliberately killing their animals and do away with the carcasses causing more harm than good to them. Alhaji Umaru, a cattle herder and owner said;

*I lost more than 100 cattle in 2017 due to 'Operation Cowleg'. The soldiers will just come and shoot our animals to kill without justification. It is proper to pay compensation to the farmer whose crop is damaged by cattle than killing the cattle. We will appreciate any good effort to change cattle rearing in Ghana.*

In a similar vein, Alhaji Muddy recounted how he lost over 300 cattle in that same year.

*My son, I don't see the use of 'Operation Cowleg'. It is illogical to kill the animals and leave the carcasses to decompose. Instead of shooting and killing the animals, why don't they transport the animals to orphanages, hospitals and schools and donate to them. That can serve as 'sadaka' (charity). It is painful and sad to lose that number of animals. When I quantified them into monetary terms, they can cost more than six*

*billion old currencies. It is sad my son. So, if you say you can help us with modern technology, we are ready to invest.*

The CEO of King Faisal Football club, Alhaji Karim Gruzah also said;

*'Operation Cowleg' has outlived its usefulness. The purpose is to derive the animals from Agogo but the soldiers will end up killing the animals. My animal caretaker called me while in Accra to inform me about killing of my animals. We like eating meat in Ghana but we hate cattle.*

With respect to crop farmers, only 8.3% support 'Operation Cowleg' as the only solution to the conflict. They cited that the activities of the herders can only be stopped by killing their animals and driven them away from their community. Some of the farmers also see the joint police-military task force as waste of time and resources. The operation, according to Agyemang (2017), is unsustainably and expensive (\$970,000,000). Tonah, (2006) also opined that 'operation cowleg' relatively worsened the already waning condition. This current finding agrees with the previous findings of John (2015) and Agyemang (2017) that farmer-herder conflict resolution should be looked at holistically not to derive people from losing their means of livelihood.

**Table 3.20: Respondent recommended solution to farmer-herder conflict**

Solution	Crop farmer		Cattle herders	
	Frequency	Percentage	Frequency	percentage
Operation Cowleg	5	8.3	0	0.0
Relocation of herders	15	25.0	2	1.4
Creating grazing reserves	6	10.0	19	13.6
Establishing cattle ranch	25	41.7	79	56.4
Lease land to cattle farmers	0	0.0	8	5.7
Restrict movement of alien nomads	9	15.0	32	22.9
<b>Total</b>	<b>60</b>	<b>100</b>	<b>140</b>	<b>100</b>



## **3.5 CONCLUSION AND RECOMMENDATION**

### **3.5.1 Conclusion**

The findings indicate that gender and age have a significant effect on the conflict between crop farmer and the cattle herder. Crop cultivation and herding animals are largely carried out by the male and youth (31 – 39 years), who are more active and hence more prepared to join in violent conflict than the elderly persons who preferred to live peacefully with their counterparts. Furthermore, educated people have better understanding of issue pertaining to conflict than those without education. The main factors that cause conflicts between crop farmers and herders was destruction of food crop, land encroachment, pasture poisoning, killing of stray animals and cattle rustling. The farmers accused the herders of damaging their crops while the herders are also blaming the farmers of killing their animals. However, the struggle over space as a result of rapid population increase is putting much pressure on the land usage and as such each party wanted to protect his territory for survival. Farmers wanted to cultivate their crops without fear of damage by grazing animals likewise the herder wants to graze his animals for sustenance.

They also recognized that influx of alien nomads who from neighbouring countries to graze their animals as perpetrators of the conflict as they mostly graze their animals on farmer's crop field causing severe damages. Furthermore, the respondents preferred community leaders and the religious leaders as mediators of the conflict between them. Only few preferred government institutions such as the Ghana Police Service and the law court as dispute settlers. It can also be concluded that cattle herders preferred to secure land to establish pasture and keep the cattle in paddocks as the preferred solution to farmer-herder conflict than other methods such as the 'Operation Cowleg' which led to loss of lives and properties.

### 3.5.2 Recommendation

The following recommendations are suggested for resolving farmer-herder conflict.

1. Sensitization of both the crop farmer and the herder on the need to peaceful coexistence must be strengthened through education with the help of extension officers and research institution.
2. More training workshops on the pasture development and conservation should be organized for the cattle farmers.
3. Cattle farmers should be encouraged to own land to establish ranches for cattle intensification in order to prevent recurring conflict.
4. The government's policy of 'Operation Cowleg' should be discouraged and replaced with more sustainable methods of conflict resolution.
5. Indiscriminate burning of bushes and water pollution should be strictly controlled.
6. The influx of alien herders and their movement should be checked across the borders.
7. Cooperation between the farmers and the cattle herders should be fortified to enhance effective communication.
8. Due to the influx of cattle from the conflict areas into urban and the peri-urban areas, it is also recommended that further studies be conducted for the adoption of better cattle feeding management in order to prevent future clashes. Hence another survey was carried out to assess the willingness of urban and the peri-urban cattle farmers to cultivate pasture.

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## CHAPTER FOUR

### 4.0 URBAN AND PERI-URBAN CATTLE FARMERS AWARENESS OF IMPROVED FORAGES AND THEIR WILLINGNESS TO CULTIVATE PASTURE IN SOME SELECTED COMMUNITIES IN THE ASHANTI REGION OF GHANA.

#### 4.1 Introduction

The contribution of the livestock sector to gross domestic product (GDP) of Ghana is 9.16% with cattle, sheep, goat, pigs and poultry being the major livestock reared in Ghana (MoFA, 2020). Ruminant livestock are kept by households for various reasons in the urban and peri-urban communities. They contribute to food security, income and employment generation, savings, insurance and social status and are central and integral part of most farming systems in Ghana. Ruminants also serve as a 'living bank' for the farmer as an economic backup for periods of fiscal distress and economic hardships such as crop and business failure, as well as a primary source of cash income.

According to Hoddinott (2006), raising cattle is a type of insurance that gives farmers assets that may be sold during difficult times. However, as animals in Ghana rely mostly on natural pasture for survival, feed shortages continue to be the key obstacle to optimum animal performance. Due to seasonal weather variations, these grasses and forages are either not available in sufficient quantities or are available but of such poor quality that they do not provide enough nutrition for optimal production. Moe (1994) reported that, grasses are the main source of nutrition during wetter season of the year; however, mineral contents in grasses become deficient for normal maintenance of health and growth of ruminants during dry season.

Traditionally, natural grazing pasture is the main forage feed source for cattle. However due to urbanization the size of grazing lands for livestock have been substantially reduced over time and this has affected the quality, and palatability of forages species for grazing animals. According to Birhan and Adugna (2014), the remaining uncultivated pasture land produced less forage due to overgrazing and decreased soil fertility in urban communities as a result of rapid population growth and rising land demand for crop cultivation.

Conflicts between the crop farmers and the cattle herders in Agogo and other surrounding communities in recent times has led to the influx of cattle in the urban and the peri-urban areas. In the urban areas like Aboabo, Asawasi, Sawaba and Bouban in the Asokore Mampong Municipality have seen an increase in cattle population. Cattle population in the Asokore Mampong Municipality has increased from 18741 in 2019 to 26875 in 2020 representing 43.4% (GSS, 2020). These animals are mostly from areas where the conflicts are recurring as indicated in chapter three. Likewise, Achiase and Abrem which are new developing sites in the Ejisu Municipality, have also experienced increased cattle population. These animals in the urban and the peri-urban areas are allowed to scavenge for feed under a free-range system with minimal supervision leading to road traffic and environmental pollution.

However, due to rapid infrastructural development, communal grazing land is shrinking leading to shortages of forages for the grazing animal. Due to the increased demand for forages brought on by the scarcity of feed in these places, young people are used to collect grasses along the sides of the road to sell to cattle farmers. The demand is seasonal, it peaks in the dry season and festive occasion (Eidul Adha and Christmas) and declines in the raining season. The harvested grasses are carried on

tricycles (Aboboya) or wheelbarrow and sent to the market for sale. Majority of the cattle farmers rely on this harvested grass by the road side to feed their animals. Although there are bye-laws in the urban and the peri-urban areas regulating animal rearing, the enforcement agencies are not fully enforcing the bye-laws to ensure animals are not left out to graze without supervision (Appendix VI)

Furthermore, urbanization is associated with an increased demand for animal protein, including meat, milk, eggs and other livestock products. Existence of the urban and peri-urban dairy production in Ethiopia is chiefly enthused by availability of good market for animal products (Prain et al., 2010). The difficulties threatening the urban and peri-urban cattle farmers is inadequate feeds and feeding materials due to fluctuation of rainfall distribution, infrastructural development, road construction and expansion and rapid population growth.

Cattle production are commonly practiced by several household in the study area which is largely dominated by Muslims. Osman et al. (2018) reported that keeping of cattle within urban areas has become a common prospect especially in the Zango communities mostly dominated by Muslims. The constraint faced by the producers is seasonality in quality and quantity of forages. Masikati (2010) reported that livestock production in communal areas in sub-Saharan Africa is constrained by feed shortages during the dry season which constitute the utmost challenge in terms of quantity and quality. In order to enhance the productivity of the cattle in the study area, there is the need to introduce improved forage species coupled with appropriate conservation techniques for all year round feeding. According to Mekonnen et al. (2014), in order to overcome the feed-related issues in livestock production, it will be necessary to provide new forage technologies that can be integrated into the current land use

system and enhanced feeding systems. However, forage cultivation and establishment of pasture is not commonly practiced in Ghana due to limited land resources, lack of awareness of benefits of cultivating forage crops and unavailability of forage seed and planting material. Farmers in the study area have not adopted improved forage very widely. As a result, one of the first steps in developing effective solutions is identifying issues that prevent farmers from using this technology. Therefore, the objective of this study was to assess farmers' awareness of the availability of improved forage and pasture and their willingness to adopt the technology in their production.



## 4.2 MATERIALS AND METHOD

### 4.2.1 Description of the study area

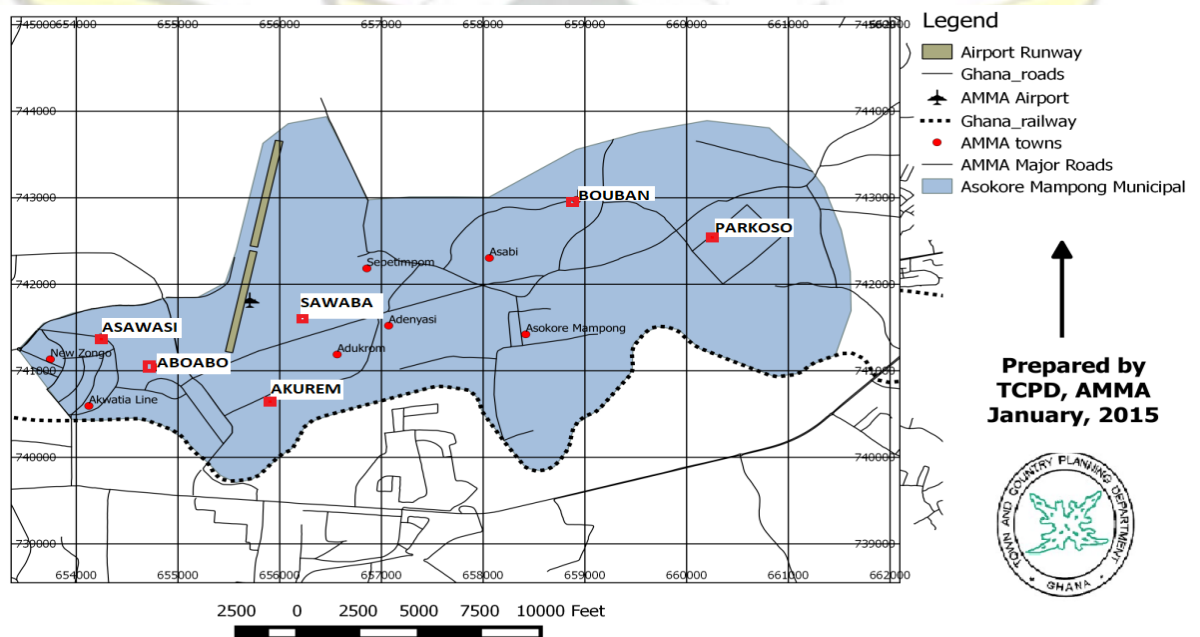
The study was conducted in seven selected towns in the Ashanti Region of Ghana; five from the Asokore Mampong Municipality and two from Ejisu Municipality. These towns were selected because smallholder cattle production was the most common among the settlers (Osman et al., 2018).

The Asokore Mampong Municipal Assembly is one of the thirty (30) administrative districts in the Ashanti Region. It was carved out of Kumasi Metropolitan Assembly due to the growing population of the Kumasi Metropolis. The Municipality covers a total land area of 23.91 km<sup>2</sup> and it is located in the North-Eastern part of the Kumasi Metropolis. The average minimum temperature is 21.5°C, while the average maximum temperature is 35.7°C (Ghana Statistical Service, 2014).

The Ejisu Municipality on the other hand lies within latitude 1.37 degrees and 1.54 degrees North and longitude 6.6 degrees and 6.79 degrees West. The capital, Ejisu is approximately 17km from the regional capital, Kumasi. It covers an approximate area of 238km<sup>2</sup> and shares boundaries with Kwabre East Municipal to the North-West, Juabeng Municipal to the North-East, Bosomtwe District to the South-West and Oforikrom Municipal to the West. Rainfall in the Municipality is bimodal. The main rainy season lasts from March to July, with an annual rainfall of 1,200 mm to 1,500 mm. The minor rainfall period likewise starts in September and ends in November, with minor yearly rainfall averaging between 900 and 1,120 mm. (Ghana Statistical Service, 2014).

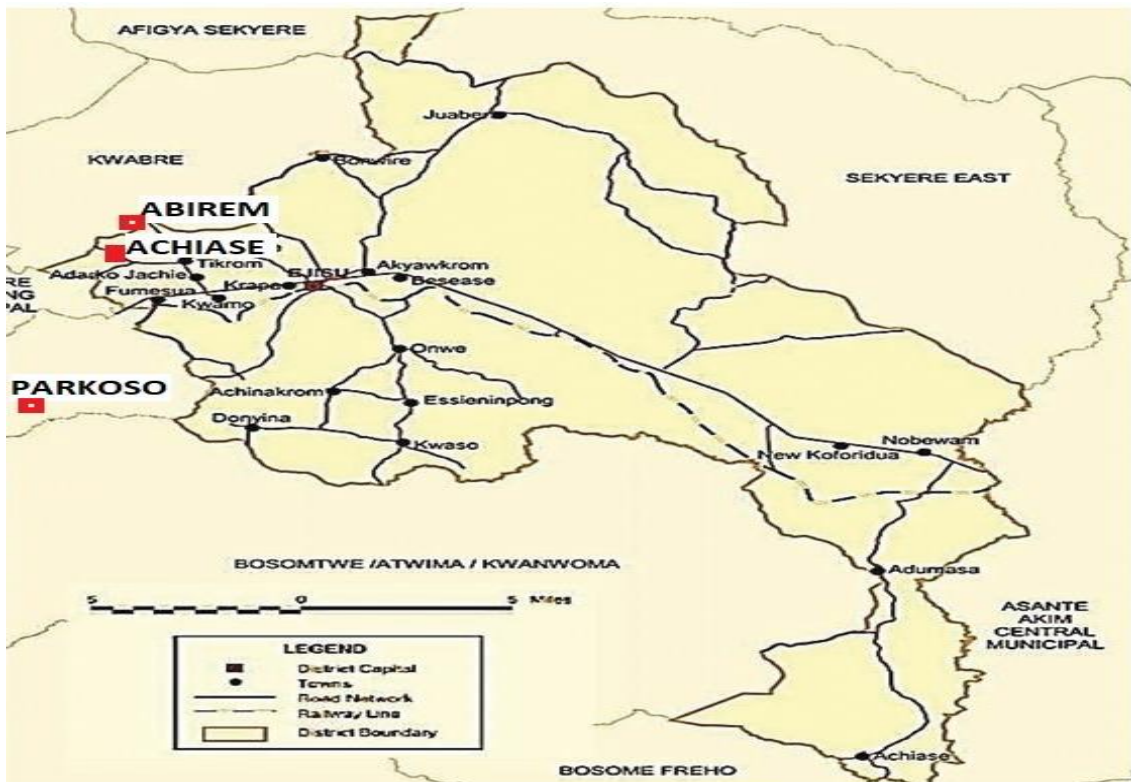
#### 4.2.2 Sources and types of data

A total of 105 individuals involved in cattle value chain from four urban communities namely Aboabo, Asawasi, Sawaba, Bouban (Figure 4.1) and three peri-urban communities namely Parkoso, Achiase and Abrem (Figure 4.2) were selected randomly and interviewed independently. These communities were selected because smallholder cattle production is most common among the dwellers. The information was gathered by questioning various farmers at their farm gates using a pre-tested questionnaire. There were both single- and multiple-response items in the prepared questionnaire. Questions with a single response were those in which the sampled household would only have one answer, whereas questions with multiple answers were ones in which a single home might give more than one response. The percentage of responses (respondents) in the latter would be higher than 100%.



**Figure 4.1: Map of Asokore Mampong**

Source: Ministry of Local Government and Rural Development, 2014.



**Figure 4.2: Map of Ejisu Municipal**  
 Source: Ghana Statistical Service, 2014

#### 4.2.3 Sampling size and procedure

Cattle farmers in the selected districts which were purposively chosen to reflect cattle producing areas in the region. Thereafter seven cattle producing communities from each district were selected by a purposive sampling technique. Finally, the snowball technique was employed in the selection of cattle producers from each community.

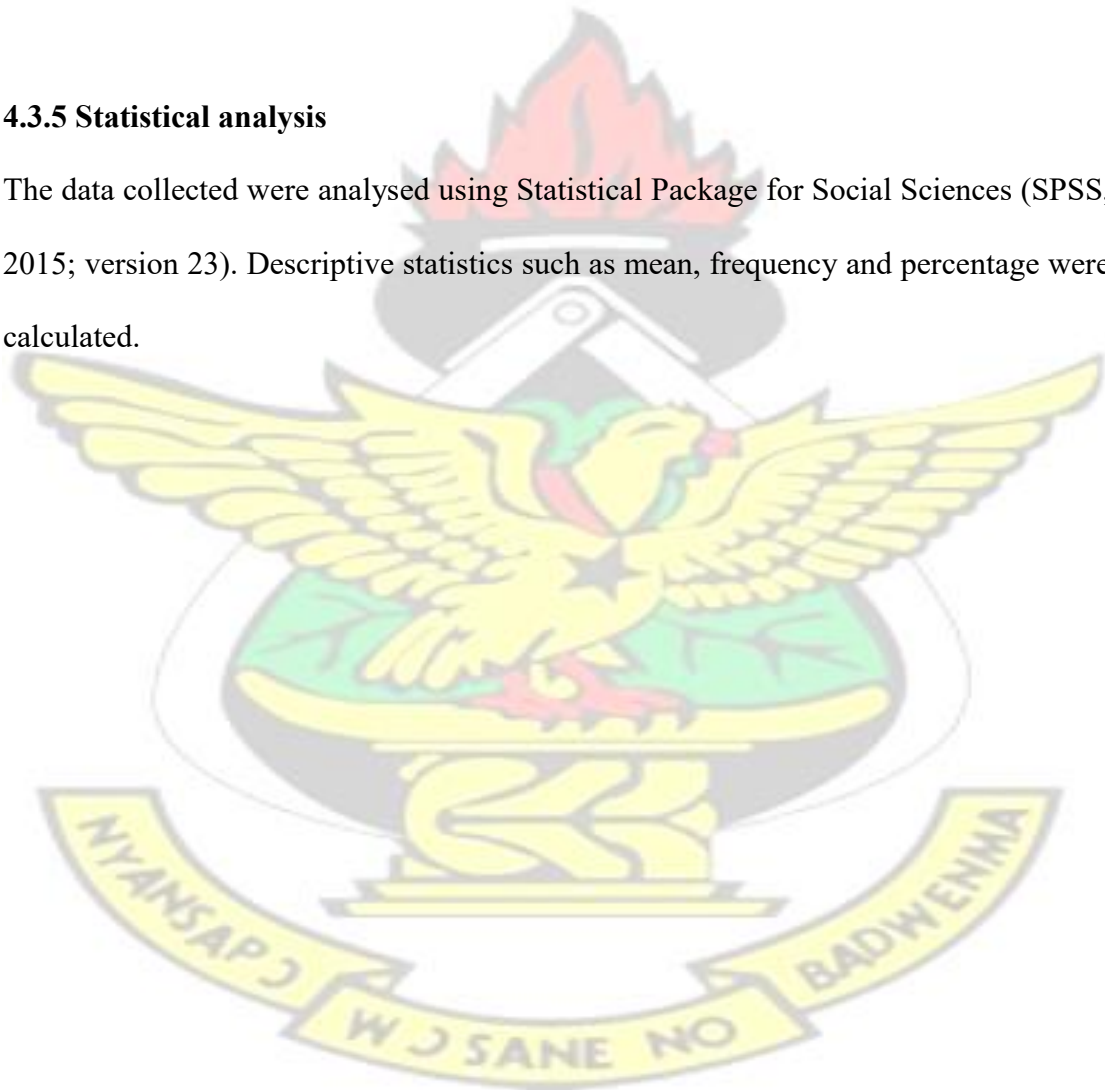
#### 4.3.4 Data collection

Data was collected with content-validated and structured questionnaires (Appendix II) for smallholder urban and peri-urban cattle producers. The structured questionnaires (main instrument for the data collection) consisted of both open ended and close ended questions. By the use of the questionnaires, the selected farmers were

interviewed and asked questions relating to the set objectives. The questionnaires were administered in the local language (Hausa, Zabarma, and Twi) for farmers who could not read and write (Appendix II). The questionnaire was designed to seek information on the demographic characteristics of farmers (age, gender, marital status, household size, level of formal education, tribal and religious affiliation), farm operation, knowledge on animal feed and feedstuff, and knowledge on improved pasture and forage production.

#### **4.3.5 Statistical analysis**

The data collected were analysed using Statistical Package for Social Sciences (SPSS, 2015; version 23). Descriptive statistics such as mean, frequency and percentage were calculated.



## 4.4 RESULTS AND DISCUSSION

### 4.4.1 Demographic characteristics of respondents

**Sex:** The sex or gender of the respondents are presented in Table 4.1. In this survey about 99% of respondent engaged in cattle production were male and only 1% were female. This shows that cattle production unlike small ruminants (sheep and goat) in Ghana is male dominant enterprise because of the task involved in keeping cattle. In the cattle value chain, the females are mostly involved in milking and processing of milk into various dairy products like ‘Wagashe’ to local consumers. This current result is in agreement with the result of Osman et al. (2018) and Umunna et al. (2014) who reported 98% and 92.8% of cattle farmers respectively being male.

**Table 4.1: Sex or gender of the respondents**

Sex	Frequency	Percentage
Male	104	99
Female	1.0	1.0
Total	105	100

**Age:** A larger proportion of the respondents (36.2%) were youthful (21 to 30 years), which indicates that a vast majority of cattle farmers in the selected communities are strong and energetic to engage in cattle production and its related activities (Table 4.2). Only 3.9 % were beyond 50 years. Osman et al. (2018) reported that 4% small-holder urban cattle farmers in Kumasi Metropolis and Asokore Mampong Municipality were above 50 years.

**Table 4.2: Age of the respondents**

Parameters	Details	Frequency	Percentage
<b>Age</b>	10 – 20	20.0	19.0
	21 – 30	38.0	36.2
	31 – 40	33.0	31.4
	41 – 50	10.0	9.5
	51 – 60	4.0	3.9
	<b>Total</b>	<b>105</b>	<b>100</b>

**Marital status and religious affiliation:** Majority (51.4%) of the farmers were not married (Table 4.3). Married cattle farmers were 47.6% while only 1% were divorced. The implication of the distribution is that more youth in the study area are involved in cattle production. Most of the married farmers had children and enjoyed the services their children rendered by way of assisting in gathering feed for the cattle. This current finding agrees with that of Osman et al. (2018).

The information gathered from the respondents again showed that majority of cattle farmers are Muslims (99%) with only 1% being Christians (Table 4.3). This is not surprising because the areas are dominated by Muslims.

**Table 4.3: Marital status and religious affiliation of the respondents**

Parameters	Details	Frequency	Percentage
<b>Marital Status</b>	Single	54.0	51.4
	Married	50.0	47.6
	Divorced	1.0	1.0
	<b>Total</b>	<b>105</b>	<b>100</b>
<b>Religion</b>	Islam	104	99.0
	Christian	1.0	1.0
	<b>Total</b>	<b>105</b>	<b>100</b>

**Educational level:** Out of the total 105 respondents, 28.6% had no formal education and the rest (73.3%) have at least basic education (Table 4.4), with 3.8 % having tertiary education, 14.3% had secondary school education, 21.9% had Arabic and secular education, 11.4% had junior high school education and 21.9% had primary school education. The ability of farmers to accept new agricultural technologies is largely dependent on the knowledge and technology that is transferred to them through education. It provides a scope for an information interface between farmers, extension officers, researchers and development agents. Cattle producers who had some level of formal education adopt better to husbandry practices and may see cattle production as a profit-based enterprise rather than tradition more than those without formal education. Osman et al., (2018) reported that 98% of the respondent interviewed in his study on smallholder cattle farmers have formal education and can read and write. Furthermore, Umunna *et al.*, (2014) opined that for the purpose of adopting new technologies, education is an important factor which if lacking can have adverse impact on future small ruminant production improvement.

**Table 4.4: Respondent educational level**

Parameter	Frequency	Percentage
Primary	23.0	21.9
JHS	12.0	11.4
SHS	15.0	14.3
Tertiary	4.0	3.8
No formal education	30.0	28.6
Arabic education	23.0	21.9
<b>Total</b>	<b>105</b>	<b>100</b>

**Cattle herding and ethnicity:** About 48% of farmers herd animals in search of grazing pasture. As shown in Table 4.5, these herders include Fulanis (33.3%), Zabarma (24.8%) and Hausa (13.3%). This agrees with the findings of Abdul Aziz et al. (2020) who reported that majority of respondents involved in processing dairy products in the Kumasi Metropolis and Asokore Mampong Municipal were Fulani (36%) and Zabarma (30%).

**Table 4.5: Cattle herding and ethnicity of the respondents**

Parameter	Detail	Frequency	Percentage
Herding animals	Yes	50	47.6
	No	55	52.4
	<b>Total</b>	<b>105</b>	<b>100</b>
Ethnicity	Fulani	35	33.3
	Dagomba	15	14.3
	Zabarma	26	24.8
	Hausa	14	13.3
	Others	15	14.3
	<b>Total</b>	<b>105</b>	<b>100</b>

#### 4.4.2 Primary Occupation and Type of Stakeholders in Cattle Enterprise

Respondent farm operations are presented in Table 4.6. Majority (61.9%) of the respondents were cattle owners which indicates that cattle production in the study areas was essentially a good business and more people are into it. Cattle rearing is a highly profitable business, and an increasing number of individuals are investing in it. About 46% of respondents identified as cattle herders, who often led their herds to graze in the morning and return in the late afternoon. The study results (Table 4.6) also indicates that 22.9% of the respondents were cattle butchers. Butchering is also one of the lucrative enterprises in the area which involves purchasing and slaughter of

cattle for sale in and around the communities. The study further revealed that the butchering business included meat sellers, offal and hides sellers on the streets and a small scale retailers.

The results further showed that majority (52%) of the respondents have been in the cattle business between 1 and 10 years. This was followed by those who had spent between 11 – 20 years (21.4%) and the least (9.5%) were those who spent more than 30 years in the industry. This result agrees with the findings by Osman et al. (2018) who reported that majority of small holder urban cattle producers spent more than 5 years in the industry.

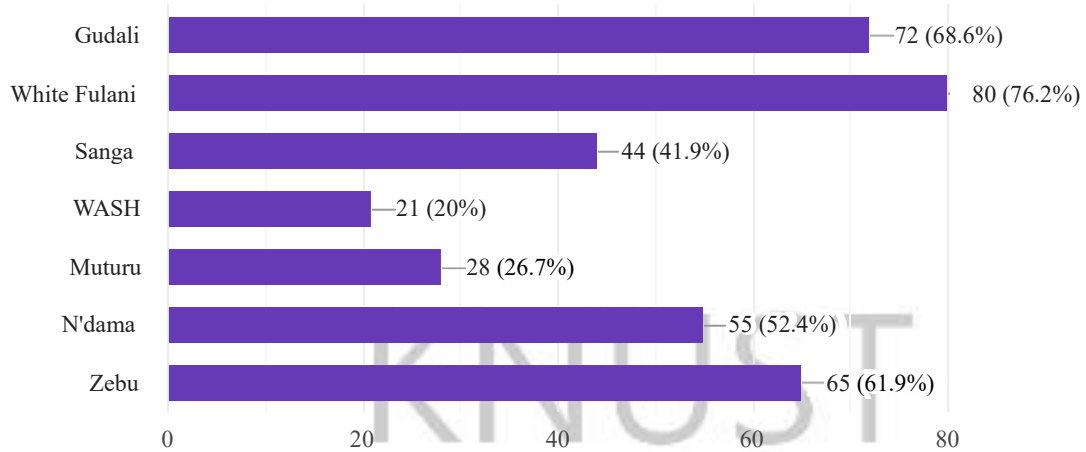
Table 4.6 further revealed that, 62.9% of the respondent had no training in cattle production and only 37.1% had some training in cattle husbandry. According to the respondents, they had the training from family members, friends, local Fulanis and sometimes Nomads (Fulanis from neighbouring countries). This result contradicts the report by Osman et al. (2018) who stated that, none of the cattle farmers interviewed had training in keeping cattle.

Majority of the respondents (31.4%) had between 21 and 30 cattle (Table 4.6), 22.9% had a herd size of between 11 and 20 and 15.2% had 1 – 10. The results also showed that, 13 % of farmers had a herd size of more than 60 cattle which indicates increased in cattle population in the area. The greater number of animal population was recorded in the peri-urban communities because of availability of space to contain stock size.

**Table 4.6: Primary Occupation and Type of Stakeholders in Cattle Enterprise**

Parameter	Detail	Frequency	Percentage
Primary occupation	Cattle herder	42	40
	Butcher	23	21.9
	Artisan	20	19
	Imam	9	8.6
	Others	11	10.5
Category of stakeholder	Cattle owner	65	61.9
	Cattle herder	48	45.7
	Butcher	24	22.9
Years of operation	1 – 10	55	52
	11 – 20	22	21.2
	21 – 30	18	17.3
	>31	10	9.5
Training on cattle production	Yes	39	37.1
	No	66	62.9
Herd size	1 – 10	16	15.2
	11 – 20	24	22.9
	21 – 30	33	31.4
	31 – 40	13	12.4
	41 – 50	0.00	0.00
	51 – 60	5	4.8
	>61	14	13.3

Results in Figure 4.3 reveal that majority (76.2%) of the respondents kept White Fulani cattle, followed by Gudali (68.6%), Zebu (61.9%), N'dama (52.4%), Sanga (41.9%), Muturu (26.7%) and WASH (20%) breed. The results suggest that White Fulani and Gudali were predominant cattle breeds in the study area. Aboagye et al. (2014) reported that most prominent breed of cattle is West African Shorthorn (WASH) and Sanga which is a cross between WASH and the large hump Zebu cattle. In the study area, White Fulani and Gudali were prominent because of their faster growth rate as expressed by the respondents.



**Figure 4.3: Breeds of cattle kept**

#### 4.4.3 Management system and Feedstuffs used and its availability

Feedstuff availability is related with the type of management system, location, season and other husbandry practices. Forages (100%) and cassava peels (98.1) are the major feed resources used by the respondents as shown in Table 4.7. Majority (50.5%) of the respondents practiced extensive system of cattle management, followed by semi-intensive system (28.6%) and the least was intensive system of management represented by 20.9%. The results suggest that, cattle production in the study area is dependent on natural pasture. Furthermore, 97.9% of the respondents sourced their feed from cattle market and only 42% obtained their feed from feed processors. This suggest that apart from the natural pastures, cattle producers provide other feedstuff to their animals as supplementary feed. This agrees with Umunna *et al.*, (2014) who reported that, cattle owners supplement their animals with purchased fodder to augment grazing pasture.

**Table 4.7: Management system and Feedstuffs used and its availability in the study area**

Parameter	Detail	Frequency	Percentage
Feed resources*	Forage	105	100
	Cassava peel	103	98.1
	Agro industrial by-products	89	84.8
	Kitchen waste	79	75.2
	Crop residues	75	71.2
Management system	Extensive	53	50.5
	Intensive	22	20.9
	Semi-intensive	30	28.6
Source of feed*	Cattle market	46	97.9
	Feed processors	20	42.6
	Open market	33	70.2
	Roadside	22	46.8
Mode of transport	Tricycle	95	90
	Truck	0	0
	Motorbike	8	7.9
	Taxi	2	2.1
Shortage of feed	Yes	78	74.5
	No	27	25.5
Supplementary feeding	Yes	44.3	42.2
	No	61	57.8
Mineral block	Yes	105	100
	No	0	0
Water source*	Stream	49	48
	Borehole	24	23.5
	Well	55	53.9
	Pipe borne	30	29.4
Record keeping	Ye	8	7.6
	No	97	92.4

\*Multiple response

From Table 4.7, it was observed that, majority of the interviewed respondents used tricycle (90%) for transporting feedstuff from collection points to the farm, followed by motorbike (7.9%). The respondents argued that the used of tricycle to transport the feedstuff is cost effective and faster than other means of transport. Only 2.1% of the

respondents used taxi to transport feedstuff. The low patronage of taxis in transporting feed materials is as a result of high fares as expressed by the respondents.

Furthermore, Results from Table 4.7 showed that, 74.5% of the respondents encountered feed shortages and 25.5% faces no challenges. The respondents attributed the shortages to several factors including infrastructural development, road expansion, increased animal population and lack of conservation skills and technology. The higher percentage may also be a result of farmers and livestock dealers increasing their animal fattening operations, particularly during festival times.

The result of the study further indicates that, majority of the respondents 57.8% (Table 4.7) do not provide supplementary feed to their cattle after grazing as compared to 42.2% who supplemented their animals after grazing. This agrees with the findings of Mazimpaka (2017) who reported that majority of Ugandan farmers feed their animals on pasture only without supplementation.

All the respondents used mineral block. The mineral block increases feed and water intake by the animal as expressed by the farmers. This current result contradicts the findings of Osman et al. (2018) who stated that use of salt lick was uncommon (4%) among the smallholder urban farmers. Most of the farmers felt that their feeding regimens in addition to the common salt they added to the drinking water takes care of all the animals' nutritional requirements (Osman et al., 2018).

The study results from Table 4.7 again shows that, 53.9% uses water from the well to refresh their animals after grazing or feeding. This was followed by streams (48%), pipe borne (29.4%) and the least was water from borehole (23.5%). The use of boreholes recorded the least percentage because of the cost in digging boreholes. Majority of the respondents do not keep record (92.4%) and only 7.6% keep record on

their farm. They stated that it is not important to keep records of the animal. This agrees with the findings of Osman et al. (2018).

#### **4.4.4 Farmers' knowledge about improved pastures and willingness to establish pasture**

Table 4.8 shows the willingness of the respondents to establish pasture and their knowledge about improved forage. Majority of the respondents interviewed (75.7%) are not aware of improved forages (Table 4.8). According to the respondents, lack of access to extension officers and adequate training and workshops is the major factor contributing to their unawareness of improved forages and its adoption in their livestock feed. Only 24.3% of the respondents were aware of availability of improved forages through training programmes organized by the Department of Animal Science, KNUST in some years back. Furthermore, 92.4% of the respondents never attended any training on fodder establishment. Lack of the continuity of the training programs makes adoption of the technology difficult.

On their willingness to establish pasture for their animals, majority of the respondents (99%) confirmed their readiness to go into pasture development and only 1% were unwilling. Those unwilling to establish pasture stated that they prefer to see a model farm with improved forage and pasture crops before they make a decision. Again, from the results (Table 4.7), majority of the respondent (52.4%) were willing to purchase a planting material for pasture establishment at a cost beyond GHC 21. This was followed by GHC 11 – 15 (19%), GHC 16 – 20 (18.1%), GHC 6 – 10 (8.6%) and the least was GHC 1 – 5 (1.9%). Majority of the respondents showed willingness to buy planting materials to establish pastures if made available. This will minimize their walking distance trying to find unavailable or poor-quality pasture for their animals.

Land is the most important asset in every agricultural activity. Majority of the respondents (83.6%) from the survey result were willing to purchase land for pasture development. Only 16.2% were unwilling to buy land and the reason they expressed is the high cost of buying lands.

**Table 4.8: Farmer's knowledge about availability of improved pastures**

Parameter	Detail	Frequency	Percentage
Awareness of improved forage	Yes	26	24.3
	No	79	75.7
Willingness to establish pasture	Yes	101	99
	No	4	1
Purchasing of planting material per kg (GHC)	1 – 5	2	1.9
	6 – 10	9	8.6
	11 – 15	20	19
	16 – 20	19	18.1
	>21	55	52.4
Training on fodder and pasture establishment	Yes	8	7.6
	No	97	92.4
Willingness to buy land for pasture establishment	Yes	88	83.8
	No	17	16.2

## **4.5 CONCLUSION AND RECOMMENDATION**

### **4.5.1 Conclusion**

Cattle production is one of the main agricultural activities which plays a major role in improving the farmers livelihood. Nonetheless, animal feed shortage and lack of fodder conservation techniques is one of the leading constraints that impede productivity of this sector. Farmers in the study area have less access to grazing land for their animal as they trek with the animals to far distances to search for grazing pastures. Available feed also does not meet the requirement of the animals both in quality and quantity. Similarly, lack of supplementary feed to support the energy requirement of the animals is also a challenge for the farmers. Furthermore, the farmers' unawareness of improved forages and inadequate training is also a challenge they faced although they are willing to cooperate in adopting the technology and purchase of improved forages as well as pasture establishment.

### **4.5.2 Recommendation**

Based on the outcome of the survey, it was recommended that:

1. Farmers need be educated on improved methods of animal production, including intensification.
2. Intensive training on fodder production and pasture establishment should be organized periodically for cattle farmers so as to ensure all year-round feed availability.
3. More improved forage planting materials or seeds that gives higher biomass such as Napier grass should be made available to the farmers for planting.

4. Further studies are recommended on the effect of concentrate on nutrient digestibility and nitrogen balance on cattle fed Napier grass. Hence a feeding and growth performance experiment was carried out.

# KNUST



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## CHAPTER FIVE

### 5.0 EFFECTS OF VARYING LEVEL OF A CONCENTRATE SUPPLEMENT ON DRY MATTER AND WATER INTAKE, NUTRIENT DIGESTIBILITY AND NITROGEN BALANCE OF N'DAMA BULL CALVES FED NAPIER GRASS BASAL DIET

#### 5.1 Introduction

Forages in most tropical countries are mostly poor in nitrogen, energy or some essential nutrients needed for optimum animal growth and performance (Abdou, 2010). The demand for animal products like milk and meat is increasing, these forages cannot sustain sufficient levels of animal production. Further aggravating these issues is the fact that most developing countries are experiencing rapid population growth, which has resulted in the loss of communal grazing land for the expansion of agriculture. Furthermore, during the rainy season, the forages are in abundance, greenly, palatable, succulent and nutritious with less fiber and highly digestible. However, they become unavailable to the livestock because parts of the land are used for seasonal arable crop cultivation. Similarly, there is acute shortages of these forages in the dry season due to bush burning and land preparation for next cropping season. Therefore, what is available for the animal is less nutritious and fibrous leading to prolonged period of under-nutrition and malnutrition thereby affecting the general animal growth and performance. It is therefore necessary to identify alternative feed resources that are more nutritious to curtail these nutritional challenges. These alternatives could be achieved through cultivation of high yielding and quality forages that have the potential to adapt to the local environment as well as feeding concentrate supplement to improve the digestibility of such forage such as Napier grass (*Pennisetum purpureum*).

Nutrient availability is generally expressed as digestibility. Low digestibility normally gives impression of low feed intake in ruminants. The digestibility of a feed is largely determined by its lignin content. Plant fibre level increases directly with age of regrowth. In order to assess the digestibility of a given feedstuff, the productivity of an animal fed the particular feedstuff is the best measure but feeding trials are laborious, expensive and time consuming (Ansah, 2010).

Dry matter intake and digestibility of poor-quality forages are improved by increasing the activity of the rumen ecosystem in order to maximize fibre digestion and optimize microbial protein synthesis. This requires sufficient fermentable nitrogen, energy and minerals to support the rumen microbial population (Abdou, 2010). To satisfy these conditions, there is the need to provide concentrate supplement that are rich in protein to support animal growth and improve the digestibility of the Napier grass.

Supplementary feeds are additional feeds fed to livestock to make up for the shortfall of available feed, offered with the intention of increasing animal intake as well as preventing weight loss and enhancing weight gain (Sani, 2014). According to McDonald et al. (2002), concentrate feeds promote rapid growth of ruminants by reducing ruminal methane production and increase ruminal propionate production, thereby lowering energy losses and contributing to higher overall efficiency of utilization of dietary energy for body weight gain. Tessema and Baars (2004) studied the chemical composition, *in vitro* dry matter digestibility, and rumen degradation of Napier grass supplemented with concentrate at varying levels of and reported beneficial qualities that contribute to enhanced Napier grass utilization. To give realistic suggestions to ruminant livestock producers, this must be assessed through animal performance studies. Therefore, the objective of this study was to assess the

effects of concentrate supplement on dry matter and water intake, nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet.

## **5.2 Material and Methods**

### **5.2.1 Study site**

The experiments were carried out at the University of Cape Coast Teaching and Research Farm of the School of Agriculture, Cape Coast, Ghana from February to May 2020. The experimental location is bounded to the South by the Gulf of Guinea, to the West by the Komenda Edina Eguafo Abrem Municipality, to the East by the Abura Asebu Kwamankese District, and to the North by the Twifu Heman Lower Denkyira District. It is located on longitude 1° 15'W and latitude 5° 06'N. The annual minimum and maximum temperature ranges are 24° and 34°, respectively, and the relative humidity ranges from 50% to 85%. The region has a bimodal pattern of rainfall. The annual rainfall ranges from 800 to 1500 mm on average (Ghana Statistical Service, 2014).

### **5.2.2 Animals and housing**

Four N'dama bull calves averagely six months of age and weighing 61.63 kg were used in a 70 days experiment of which 14 days were used for adaptation period and 56 days for data collection. The animals were individually housed in a 2 m × 3 m roofed pens with enough air circulation. The bull calves were ear-tagged in order to facilitate their identification and handling. The animals were offered basal diet plus 1.0 kg DM of the concentrate during the 14 days adaptation period. At the start of the experiment, the calves' body weight was recorded using a weighing balance early morning before

they were allowed access to feed and water. All animals were treated for both internal and external parasite using Ivermectin<sup>2</sup> 1% and Albendazole<sup>3</sup> 10% respectively.

### 5.2.3 Experimental design and feeding management

The animals were assigned randomly in a 4 x 4 Latin Square Design to one of the four dietary treatments consisting of local Napier grass basal diet.

The treatments are as follows:

T1 – Napier grass only (Nap0<sub>Conc</sub>).

T2 – Napier grass + concentrate fed at 1.5% of LW (Nap1.5<sub>Conc</sub>)

T3 – Napier grass + concentrate fed at 2.0% of LW (Nap2.0<sub>Conc</sub>)

T4 – Napier grass + concentrate fed at 2.5% of LW (Nap2.5<sub>Conc</sub>)

During the 14 days adaptation period, the animals were adapted to the experimental diets after which they were individually weighed and randomly assigned to the four dietary treatments. The Napier grass basal diet was harvested at 60 days of planting and chopped into 10 cm lengths and fed individually to the bull calves. The concentrate supplement was compounded using Maize (30%), Rice Bran (50%), Palm Kernel Cake (19.5%), Oyster Shells (0.3%), Common Salt (0.1%) and Vitamin Premix (0.1%).

The concentrate supplement was offered at 07:30 am after which the basal diet was offered at 08:30 am. Bull calves had access to clean water and mineral block<sup>4</sup> *ad libitum* in an individual plastic bowls attached to the pen. The animals were weighed at the end of each period which lasted for 14 days and were rested for 7 days after

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<sup>2</sup> Ivermectin: Each ml contains 10 mg active ingredient Ivermectin.

<sup>3</sup> Albenol-100 oral: Each ml contains 100 mg Albendazole

<sup>4</sup> Selena mineral block: Sodium Chloride 95.5%, Calcium Carbonate 2.7% and Calcined Magnesita 1.0%

each period to acclimatize to new treatments diets for the next period. The digestibility trials lasted for 56 days of data collection.

#### **5.2.4 Measurement of feed intake**

The amounts of each feed offered were weighed daily and recorded. Samples of basal diet refusals were collected in the morning each day at 07:00 am, stored in plastic bags and recorded before offering fresh feed. Feed intake was determined by calculating the amounts of offered and refused feed. At the end of experiment, the composite samples were pooled, and 200 grams were collected as a representative refusal sample for each animal for laboratory analysis. The same process was used with the concentrate supplement. The concentrate refusals were observed during the first two periods of the experiment. A top pan balance was used to measure the feeds offered and the refusals.

#### **5.3 Digestibility trial**

Faecal output for each animal was manually collected daily, dried under shed and stored in a plastic bag. Daily faecal output was weighed and sub-samples (10%) of the faeces were taken at the end of the experiment for faecal dry matter (FDM) determination (oven dried to a constant weight at 65 °C for 48 hours). This was later bulked for proximate and fibre (NDF and ADF) analysis.

Daily urine output was collected in a plastic bottle containing 100 ml 0.1N H<sub>2</sub>SO<sub>4</sub>. Ten percent (10%) of the daily urine was taken from each animal, sub sampled and stored in the refrigerator for Nitrogen determination.

The apparent digestibility was calculated as:

$$\text{Apparent digestibility (\%)} = \frac{\text{feed taken} - \text{faeces}}{\text{feed taken}} * 100$$

## 5.4 Chemical analysis

### 5.4.1 Sample Preparation

Dried samples of Napier grass, concentrate supplement and the faecal dry matter were collected and dried at 60°C for 48 hours. The dried samples were then grounded using a laboratory mill (Wiley mill) and force to pass through 1mm sieve screens for analyses. Chemical analysis of the samples was carried out to determine the dry matter (DM), crude protein (CP), ash, ether extract, neutral detergent fibre (NDF) and acid detergent fibre (ADF). The Proximate analysis was performed according to the Association of Official Analytical Chemists (A.O.A.C., 1990). The NDF and the ADF fractions were determined following the technique described by Goering and Van Soest (1970).

### 5.4.2 Dry matter (DM)

A 200 g sample that was taken was weighed into an aluminum pan and heated for 24 hours in a forced-air oven at 110°C. The weight following oven drying was recorded and used to calculate the dry matter.

### 5.4.3 Ash

For ash determination, 2 g of the dried sample was weighed into a known weight of ash crucibles. The crucibles containing the samples were placed in a muffle furnace and heated to 500°C – 600°C for 1 h. The crucibles were then cooled in a desiccator and weighed.

The ash content was then calculated as:

$$\text{Ash} = \frac{\text{weight of ash}}{\text{sample weight}} * 100$$

#### 5.4.4 Crude Protein

The crude protein content was determined by weighing two grams of each dried sample and placed into Kjeldahl digestion tubes and a blank determination was done by digesting filter paper in each set of digestion. Approximately 15 ml of concentrated H<sub>2</sub>SO<sub>4</sub> and two Kjeldahl tabs containing K<sub>2</sub>SO<sub>2</sub> and CuSO<sub>2</sub> were added to the content of each digestion tubes to serve as a catalyst. The tubes were mounted on Kjeldahl digestion block with fume exhaust set and heated gradually to 420°C and maintained for 3 h. The tubes were then removed and allowed to cool to room temperature. 50 ml of distilled water was then added and distilled using an automated Kjeldahl distillation apparatus. The apparatus draws 50 ml of previously prepared 35% NaOH into the digestion tubes and 25 ml of 4% H<sub>3</sub>BO<sub>3</sub> into a 25 ml Erlenmeyer flask to trap the liberated NH<sub>3</sub> during the distillation period of 9 min per sample. The distillate was collected and titrated against 0.1 concentrated HCl. The average titre values were recorded and the percentage nitrogen (% N) as well as the percentage crude protein (% CP) were calculated by the formulae:

$$\%N = \frac{(T - B) * N * 1.4}{\text{sample weight (g)}}$$

$$\%CP = \%N * 6.25$$

Where:

T - Sample titre value

B - Blank titre value

#### 5.4.5 Neutral Detergent Fibre (NDF)

Neutral detergent fibre was determined by adding neutral detergent solution to 2.4 g sample placed in a refluxing beaker and refluxed for 60 minutes. The resultant solution was filtered and the residue washed with hot water. This was repeated three times and was followed by washing with acetone to remove any remaining plant pigments. The residue was transferred to a pre-weighed crucible and dried in an oven at 105° overnight. The residue was then weighed after cooling to determine the NDF content.

#### 5.4.6 Acid Detergent Fibre (ADF)

Acid detergent fibre was determined by placing 2.4 g of sample in a refluxing beaker and refluxed with acid detergent solution for 60 minutes. The refluxed samples were filtered and thoroughly washed with hot water followed by acetone to remove any remaining plant pigments. The residue was dried in a pre-weighed crucible in an oven at 105°C overnight. The residue was weighed after cooling to determine the ADF content.

#### 5.5 Statistical analysis

Data were analysed as a 4 x 4 Latin square using the General Linear Model (GLM) of Statistical Analysis System (SAS, 2012, SAS Institute Inc. Cary, NC, USA) according to the following model:

$$Y_{ijkl} = \mu + T_i + P_{j:k} + S_k + c_{i:k} + e_{ijkl},$$

where  $Y_{ijkl}$  is the dependent variable;  $\mu$  is the overall mean;  $T_i$  is the fixed effect of concentrate levels  $i$  ( $i = 1, \dots, 4$ );  $P_{j:k}$  is the fixed effect of period  $j$  within square  $k$  ( $j = 1, \dots, 4$ );  $S_k$  is the fixed effect of square  $k$ ;  $c_{i:k}$  is the random effect of calves; and  $e_{ijkl}$  is

the random residual. The means that were significantly different were separated using Tukey's test at  $p < 0.05$ .

## 5.6 Results and discussion

### 5.6.1 Chemical composition of Napier grass

Table 5.1 shows the chemical composition of the Napier grass basal diet. The dry matter (DM) content recorded at 60 days of harvesting was 26.90%. This value is lower than the values reported by Ansah *et al.* (2010) who reported a DM value of 48.4%.

The CP composition of Napier grass was 9.82% which is similar to 9.7% reported by Ansah *et al.* (2010). The CP level reported is higher than the critical CP level (7%) needed for voluntary feed intake in ruminant livestock as suggested by Nori *et al.* (2009).

The neutral detergent fiber (NDF), acid detergent fiber (ADF) and crude fiber (CF) were 61.53%, 45.27% and 20.05% respectively. In contrast, the values reported in this study were lower than those reported by Ansah *et al.* (2010) who recorded higher NDF (72.8%) and ADF (72.4%) values in both local and improved varieties. Ball *et al.* (2000) reported that higher quality forages have an ADF of 25 to 45% and NDF of 35 to 55% while lower quality forages are considered to have an ADF of 35 to 45% and NDF of 55 to 70% (as fed). The low NDF values recorded in this current study have the potential to enhance intake and rumen microbial fermentation. According to Gusha *et al.* (2015), high ADF and low N lead to a slow rate of degradation thus causing rumen fill resulting in a feed intake that is too low to meet the nutrient requirements of the goats. High quality forage has low ADF and NDF compared to

low quality forage. The low ADF values recorded in this current study suggested to improve voluntary dry matter intake.

**Table 5.1: Chemical composition Napier grass (*Pennisetum purpureum*)**

Chemical composition	Values g/kg DM
Dry matter	269.0
Organic matter	242.7
Moisture	731.0
Crude protein	98.2
Ash	26.3
Ether extract	13.5
Crude fiber	200.5
NDF	615.3
ADF	452.7
Hemicellulose	162.6

### 5.6.2 Ingredient and chemical composition of concentrate supplement

The proportion of ingredients of the concentrate and the chemical composition of concentrate supplement is shown in Table 5.2 and Table 5.3 respectively. The compounded concentrate supplement diet consists of maize (30%), rice bran (50%), palm kernel cake (19.5), oyster shells (0.3%), common salt (0.1%) and vitamin premix (0.1%) and had 85% DM, 14.30 % CP, 8.94% ash, 6.15% EE, 32.8% CF, 82.61% NDF, 62.37% ADF, 0.21% Ca, 1.0% P and 1813.33 Kcal/kg ME. The CP level of the concentrate supplement recorded was higher than the critical CP level (7%) needed for voluntary feed intake in ruminant livestock as suggested by Nori *et al.* (2009).

**Table 5.2: Ingredients composition of the concentrate supplement**

Proportion of ingredients	% Inclusion
Maize	30
Rice bran	50
Palm Kernel Cake	19.5
Oyster shells	0.3
Common salt	0.1
Vitamin premix	0.1
<b>Total</b>	<b>100</b>

**Table 5.3: The chemical composition of concentrate supplement**

Chemical composition	Values g/kg DM
Dry matter	850.0
Moisture	150.0
Crude protein	143.0
Ash	89.4
Ether extract	61.5
Crude fiber	328.0
Nitrogen Free Extract (NFE)	175.0
Neutral Detergent Fiber (NDF)	826.1
Acid Detergent Fiber (ADF)	623.7
Calcium %	0.21
Phosphorus %	1.00
*Metabolizable energy Kcal/kg	1813.33

\*Metabolizable energy (ME) was estimated according to Ponzenga (1985). ME (Kcal/kg) = (35 \* %CP) + (81.8 \* %EE) + (35.5 \* % NFE)

### 5.6.3 Effect of concentrate supplement on dry matter intake and water intake

The intake of N'dama bull calves is presented in Table 5.4. All the parameters measured showed significant ( $p < 0.05$ ) differences except the average daily water intake ( $p > 0.05$ ). The total DM intake was 36.92 kg, 42.37 kg, 44.55 kg and 44.74 kg for Nap0<sub>Conc</sub>, Nap1.5<sub>Conc</sub>, Nap2.0<sub>Conc</sub> and Nap2.5<sub>Conc</sub> respectively (Table 5.4). Calves fed Nap0<sub>Conc</sub> had the lowest DM intake and the highest was recorded for (Nap2.5<sub>Conc</sub>). As the level of concentrate supplementation increased, the total DM intake also increased. The increase in DM intake with increasing levels of concentrate supplement in the diet may be attributed to higher ingestion of protein and energy

from the concentrate supplement, which, in synergy, facilitated rumen bacteria growth to enhance digestion and absorption by the ruminant (Otaru et al., 2016). Different factors, including diet quality, feed chemical composition, and feeding management, have an impact on the overall amount of DM that ruminants ingest. The supplementation of concentrate had significantly ( $p < 0.05$ ) influenced the DM intake of the Napier grass basal diet. The high intake could be attributed to the palatability of the concentrate supplement. These observations are similar to those of Sairanen et al. (2005) and Arriola et al. (2011) who reported that daily feed intake increased with increasing levels of concentrate in dairy cows. Similarly, Mohammad et al. (2015) observed that goats fed a mixture of Napier grass and oil palm frond supplemented with soya waste had higher DM intake per kg unit of BW ( $p < 0.05$ ) than goats fed only Napier grass or oil palm frond.

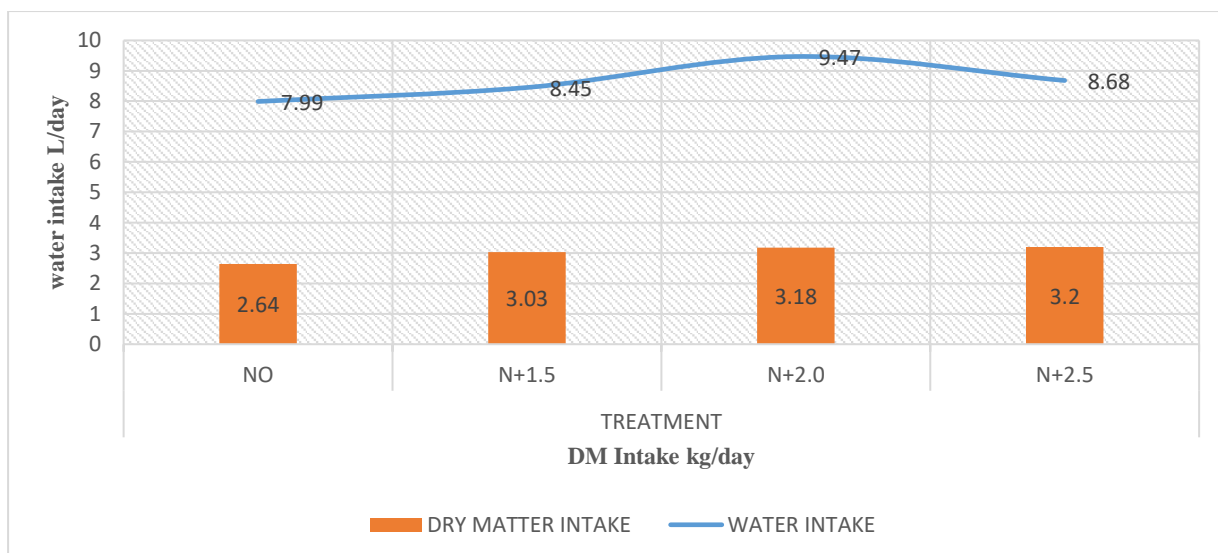
According to Quang et al. (2015), it is important to provide cattle with concentrate supplements. When compared to Nap<sub>0Conc</sub>, total feed intake increased in a curvilinear way from 4.0 to 6.4 kg DM/d as the amount of concentrate ingested increased in Brahman crossbred cattle fed a basal diet of grass and rice straw (Quang et al., 2015). Also, in agreement to this current findings, Hagos and Melaku (2008) reported an increase in total DM intake in Afar rams fed tef (*Eragrostis tef*) straw supplemented with graded levels of concentrate mix. The effect of concentrate level on DMI shown in this study contrasts with the findings of Mele et al. (2008), who found that varied concentrate levels fed to goats ingesting a basal roughage diet had similar dry matter intakes. The disparity between this study's findings and those of Mele et al. (2008) could be attributed to forage quality.

The average daily water intake was highest in Nap2.0<sub>Conc</sub> (9.47 L/day) and the least recorded in Nap0<sub>Conc</sub> (7.99 L/day) but the differences were not statistically significant ( $p = 0.1833$ ). It was observed that as DM intake increases, water intake also increases (Figure 5.1). Water intake, on the other hand, decreased non-significantly as the level of concentrate increased from 2.0% to 2.5%. From the study, the reason for the decline in water intake at 2.5% concentrate supplementation was not immediately known but probably it could be due to the limitation of space in the stomach as a result of the increased intake of dry matter. Also, when the stomach is full with feed, less water can be consumed before the animal reaches its limit of stomach distention. The results in this study indicate that the concentrate supplement had an effect on the water intake which is in agreement with the findings of Hicks et al (1998), who found that water consumption increased with an increase in dry matter intake. Similarly, Ahmed and Abdallah (2005) reported no significant differences in water intake when concentrate types of cotton seed cake, sesame seed cake, groundnut cake and sunflower seed cake were used in fattening of yearling sheep.

**Table 5.4: Effect of concentrate supplement on dry matter and water intake of N'dama bull calves fed Napier grass basal diet**

Parameters	Treatments				SEM	p
	Nap0 <sub>Conc</sub>	Nap1.5 <sub>Conc</sub>	Nap2.0 <sub>Conc</sub>	Nap2.5 <sub>Conc</sub>		
DM intake of grass (kg)	36.92	37.59	38.18	37.65	0.361	0.2088
DM intake of concentrate (kg)	0.00 <sup>b</sup>	4.79 <sup>a</sup>	6.37 <sup>a</sup>	7.09 <sup>a</sup>	0.568	0.0005
Total DMI (kg)	36.92 <sup>b</sup>	42.37 <sup>a</sup>	44.55 <sup>a</sup>	44.74 <sup>a</sup>	0.619	0.0003
Average DMI (kg/day)	2.64 <sup>b</sup>	3.03 <sup>a</sup>	3.18 <sup>a</sup>	3.20 <sup>a</sup>	0.044	0.0003
Total water intake (L)	111.79	118.28	132.63	121.50	5.810	0.1831
Average water intake (L/day)	7.99	8.45	9.47	8.68	0.415	0.1833

<sup>abc</sup> Values having different superscripts in the same row are significantly different at  $p < 0.05$ , SEM=Standard error mean; Nap0<sub>Conc</sub> = Napier grass only, Nap1.5<sub>Conc</sub> = Napier grass + 1.5% concentrate per kg body weight, Nap2.0<sub>Conc</sub> = Napier grass + 2.0% concentrate per kg body weight and Nap2.5<sub>Conc</sub> = Napier grass + 2.5% concentrate per kg body weight



**Figure 5.1: Relationship between water intake and dry matter intake**

#### **5.6.4 Effect of concentrate supplement on nutrient digestibility of N'dama bull calves**

The digestibility of dry matter, crude protein, crude fiber, ash, ether extract, neutral detergent fiber, acid detergent fiber and hemicellulose are presented in Table 5.5. Dry matter digestibility differed significantly ( $p = 0.0005$ ) between treatments and control animals. The least dry matter digestibility was recorded in Nap0<sub>Conc</sub> (512.8 g/kg). One of the most important factors in the measurement of nutritional value of animal feed is digestibility which is largely expected to increase ruminant performance. Feed digestibility determines the relation between nutrients contents and energy. The dry matter digestibility in the current study which ranged from 512.8 – 638.1 g/kg was in agreement with 580.6 – 674.2 g/kg reported by Sani et al. (2017) in Bunaji bulls fed diets containing graded levels of palm kernel cake. Mupangwa et al. (2002) reported a range of 510 - 660 g/ kg for sheep supplemented with grade levels of velvet bean hay. Similarly, Abadi et al. (2015) reported DM digestibility range of 578.6- 623.3 g/kg when Afar sheep were fed faba bean hull and wheat bran concentrate. In contrast, Wong and Wan Zahari, (1997) recorded DM digestibility range of 564 – 758 g/kg

when growing Sahiwal-Friesian bulls where fed diets containing PKC and cocoa pod husk. Dereje (2014) also reported a range of 684 – 713 g/kg in Arsi-Bale goats fed dried mulberry leaf. According to Koralagama et al. (2008), male Ethiopian highland sheep fed maize stover basal diet had their dry matter digestibility enhanced by the addition of cowpea haulms. The results of Koralagama et al. (2008) are higher than those found in the present study, which may be related to the type of animal and level of nutrient intake. The dry matter digestibility values recorded in this study is enough to meet the production and maintenance requirements of the animals.

The crude protein digestibility was different among treatments (Table 5.5). Calves on Nap2.0<sub>Conc</sub> (739.7 g/kg) and Nap2.5<sub>Conc</sub> (733.3 g/kg) had a higher CP digestibility than those on Nap1.5<sub>Conc</sub> (723.8 g/kg) but the differences were not statistically significant ( $p = 0.0001$ ). The least crude protein digestibility was recorded in Nap0<sub>Conc</sub> (564.0 g/kg). The higher crude protein digestibility values observed in the supplemented treatment groups could be attributed to the higher crude protein intake compared to the control group. In contrast, the lower crude protein digestibility values recorded for the control group could be attributed to the lower crude protein content of that diet. The most important quality indicator in animal feeding is crude protein (Dale *et al.*, 2012) and hence merits considerable attention. The CP digestibility falls within the range of 524.4 – 817.3 g/kg reported by Sani et al. (2017) in Bunaji bulls fed diets containing graded level of palm kernel cake. Abebe (2006) also reported that supplementation with oil seed cakes and wheat bran improved the digestibility of crude protein in Arsi-Bale sheep. Yashim et al. (2016) suggested that digestibility of nutrient in animals is the standard method for assessing feed digestion by ruminants. Accordingly, the digestibility of a feed is influenced not only by its own composition, but also by the composition of other feeds consumed with it (McDonald et al., 2002).

In agreement with similar studies, Abdul Razak et al. (1997) reported higher apparent crude protein digestibility coefficient in *Bos taurus/Bos indicus* steers offered Napier grass basal diet with concentrate supplement. Therefore, result of the current study suggested that feeding animals with Napier grass and concentrate supplement improved feed intake and nutrient digestibility.

**Table 5.5: Effect of concentrate supplement on nutrient digestibility of N'dama bull calves fed Napier grass basal diet**

Nutrient digestibility (g/kg)	Treatments				SEM	p
	Nap0 <sub>Conc</sub>	Nap1.5 <sub>Conc</sub>	Nap2.0 <sub>Conc</sub>	Nap2.5 <sub>Conc</sub>		
Dry matter	512.8 <sup>b</sup>	629.0 <sup>a</sup>	638.1 <sup>a</sup>	611.4 <sup>a</sup>	1.035	0.0005
Crude protein	564.0 <sup>b</sup>	723.8 <sup>a</sup>	739.7 <sup>a</sup>	733.3 <sup>a</sup>	0.587	0.0001
Organic matter	250.3 <sup>b</sup>	682.6 <sup>a</sup>	658.2 <sup>a</sup>	623.1 <sup>a</sup>	1.862	0.0001
Ash	278.6 <sup>b</sup>	498.0 <sup>a</sup>	502.7 <sup>a</sup>	514.5 <sup>a</sup>	1.850	0.0003
Ether extract	496.2 <sup>b</sup>	764.6 <sup>a</sup>	753.2 <sup>a</sup>	751.3 <sup>a</sup>	1.738	0.0001
Neutral detergent fiber	512.5 <sup>b</sup>	609.0 <sup>a</sup>	636.4 <sup>a</sup>	663.2 <sup>a</sup>	1.175	0.0005
Acid detergent fiber	393.2 <sup>a</sup>	347.6 <sup>ab</sup>	332.6 <sup>b</sup>	319.4 <sup>b</sup>	1.146	0.0167
Hemicellulose	222.1 <sup>b</sup>	478.5 <sup>a</sup>	493.5 <sup>a</sup>	506.7 <sup>a</sup>	1.145	0.0001

<sup>abc</sup> Values having different superscripts in the same row are significantly different at  $p < 0.05$ , SEM=Standard error mean; Nap0<sub>Conc</sub> = Napier grass only, Nap1.5<sub>Conc</sub> = Napier grass + 1.5% concentrate per kg body weight, Nap2.0<sub>Conc</sub> = Napier grass + 2.0% concentrate per kg body weight and Nap2.5<sub>Conc</sub> = Napier grass + 2.5% concentrate per kg body weight

Furthermore, there was significant difference ( $p = 0.0003$ ) in organic matter digestibility and ash digestibility as indicated in Table 5.5 above. The highest organic matter digestibility was recorded in Nap1.5<sub>Conc</sub> (682.6 g/kg) and the least organic matter digestibility was recorded in Nap0<sub>Conc</sub> (250.3 g/kg). Organic matter digestibility increases with increasing level of supplement (Table 5.5). According to Hughes et al. (2012), organic matter digestibility gives an indication of the proportion of organic matter in the feed that is apparently digested in the digestive tract of the ruminant animal and can be used to estimate the availability of energy in the diet. In this current study, animals fed Napier grass plus concentrate supplement had organic

matter digestibility values of above 600 g/kg, which puts them in the group of high-quality feeds as suggested by Meissner et al. (2000). Kariuki et al. (1999) reported that concentrate supplement enhanced organic matter digestibility in Sahiwal and Friesian dairy heifers fed Napier grass basal diet leading to improved animal performance. In the current study, organic matter digestibility of all supplemented animals was higher than the control diet. According to Tesfay and Solomon (2008), the organic matter digestibility of Afar rams fed teff straw and supplemented with concentrate mix was much higher than that of the control group. The results of this study also agree with those of Bonsi et al. (1997), who reported that adding *leucaena* to teff straw improved the ability of Ethiopian sheep to digest organic materials. Organic matter digestibility can be used to estimate the protein microbial synthesis in the rumen (Hughes et al., 2012). It can be deduced from this current study that concentrate supplementation of Napier grass can produce microbial protein better than the basal diet alone.

In the case of fibre digestibility, significant differences ( $p < 0.05$ ) among treatment diets were observed in both NDF and ADF digestibility (Table 5.5). From the results obtained, animals fed the concentrate-supplemented diets had higher ( $p = 0.0005$ ) NDF digestibility compared to the control group. However, increasing the level of concentrate supplementation did not increase NDF digestibility. The lower NDF digestion in the control group fed only Napier grass could be due to insufficient protein for rumen microorganisms to improve the digestion of the feed. In contrast to the findings of the current study, Ba *et al.* (2008) reported a decline in NDF digestibility with increasing concentrate consumption which is consistent with reports by Dung *et al.* (2013).

Ajayi et al. (2008) reported that forage legume supplementation significantly improved ADF digestibility in West African dwarf goats by enhancing efficient rumen fermentation, which optimizes microbial proliferation for better nutrient digestibility. Digestibility of NDF followed a similar pattern as DM, CP and OM digestibility. Zanton and Heinrichs (2009) observed that NDF digestibility was similar to OM digestibility when dairy heifers were fed either low (25%) or high (75%) concentrate and concluded that decrease of NDF digestibility was mainly as a results of decreased hemicellulose digestibility because ADF digestibility was not different between concentrate levels. Their observations agree with the finding of this current study. Similarly, Ermias (2008) revealed that adding linseed meal, barley bran, and their mixture to faba bean haulms fed to Arsi-Bale sheep enhanced organic matter, crude protein, and neutral detergent fiber digestibility without decreasing dry matter digestibility. Crawford et al. (2008) reported an increase in NDF digestibility as alfalfa hay inclusion decreased from 13.5% to 4.5% of DM in steers fed high-grain diets. Ward (2008) noted that as fiber content increases, the NDF digestibility decreases resulting in high fiber forages passing out of rumen slowly. This makes the animal feel fuller for longer thereby reducing intake. The overall effect of this is reduced production and animal performance.

There was no significant difference ( $p > 0.05$ ) in ADF digestibility between Nap1.5<sub>Conc</sub> (347.6 g/kg), Nap2.0<sub>Conc</sub> (332.6 g/kg) and Nap2.5<sub>Conc</sub> (319.4 g/kg) although Nap1.5<sub>Conc</sub> had higher numerical value than Nap2.0<sub>Conc</sub> and Nap2.5<sub>Conc</sub>. There was however a significant difference ( $p = 0.0167$ ) in ADF digestibility for animals in the control group (Nap0<sub>Conc</sub>, 393.2 g/kg) and the supplemented animals (Nap2.0<sub>Conc</sub> and Nap2.5<sub>Conc</sub>). It was observed that as the level of concentrate increases, ADF digestibility values decreases (Table 5.5). The ADF digestibility range (319.4 – 393.2

g/kg) recorded in this current study was lower than 420.3 g/kg – 663.9 g/kg recorded by Sani et al. (2017) in Bunaji bulls and heifers fed diets containing graded level of palm kernel cake but close to the range 333.0 g/kg – 427.9 g/kg reported by Sani (2014) in fattening Bunaji bulls fed raw or parboiled rice offal as energy source. Furthermore, the lower digestibility of ADF observed in the animals fed Napier without supplementation than the supplemented N'dama calves might be due to the lower intake of dietary CP and higher fiber fraction as compared to the other treatments. The ADF content indicate the digestibility and extent of energy that can be derived from the forage and the NDF content indicates the potential intake of this forage. Allen (2000) reported that as ADF and NDF content increases, the digestibility, energy content and potential forage intake decreases, therefore the changes in this fiber content ultimately affects production and animal performance. Similarly, there were significant ( $p < 0.05$ ) differences in hemicellulose digestibility (Table 5.5). Hemicellulose digestibility observed in this experiment followed the same trend as DM, CP, Ash and NDF digestibility. The hemicellulose digestibility value recorded in this study was lower than 759.8 – 787.8 g/kg reported by Sani et al. (2017) in Bunaji bulls fed diets containing graded level of palm kernel cake. There was no significant ( $p > 0.05$ ) difference in hemicellulose digestibility among the treatments and this agrees with the findings of Zanton and Heinrichs (2009) who reported that hemicellulose digestibility was similar between concentrate levels, and the effect observed in NDF and ADF digestibility was caused by a reduction in cellulose digestibility in the low concentrate diet.

### 5.6.5 Effect of concentrate supplement on nitrogen balance of N'dama bulls

There was a significant ( $p < 0.05$ ) difference in nitrogen intake between the supplemented animals and the control group (Table 5.6). The control animal recorded the least nitrogen intake (Nap0<sub>Conc</sub>, 38.94 g/day). Nitrogen intake and faecal nitrogen excreted increased as the level of concentrate supplementation increased. There were significant ( $p < 0.05$ ) differences in urinary nitrogen excreted among the treatment animals and the control. Concentrate supplementation resulted in a higher ( $p < 0.05$ ) excretion of urinary N. Similar observation was made in the total nitrogen output.

There was a ( $p = 0.0001$ ) difference in nitrogen retained among the supplemented animals and the control group (Table 5.6). Animals in Nap2.0<sub>Conc</sub> recorded the highest nitrogen retention (86.61 g/day) and this could be as a result of low faecal nitrogen excreted than Nap2.5<sub>Conc</sub> (86.03 g/day). There was no significant ( $p > 0.05$ ) difference in the percentage nitrogen intake between the treatment groups and the control.

**Table 5.6: Effect of concentrate supplement on nitrogen balance of N'dama bull calves fed Napier grass basal diet**

Parameters	Treatments				SEM	p
	Nap0 <sub>Conc</sub>	Nap1.5 <sub>Conc</sub>	Nap2.0 <sub>Conc</sub>	Nap2.5 <sub>Conc</sub>		
Nitrogen intake (g/day)	38.94 <sup>b</sup>	113.94 <sup>a</sup>	119.79 <sup>a</sup>	120.32 <sup>a</sup>	4.395	0.0001
Urinary nitrogen (g/day)	3.07 <sup>b</sup>	6.06 <sup>a</sup>	6.22 <sup>a</sup>	5.98 <sup>a</sup>	0.204	0.0001
Faecal nitrogen (g/day)	9.15 <sup>b</sup>	26.01 <sup>a</sup>	26.97 <sup>a</sup>	28.31 <sup>a</sup>	1.622	0.0005
Total nitrogen output (g/day)	12.22 <sup>b</sup>	32.07 <sup>a</sup>	33.19 <sup>a</sup>	34.29 <sup>a</sup>	1.649	0.0002
Nitrogen retained (g/day)	26.73 <sup>b</sup>	81.87 <sup>a</sup>	86.61 <sup>a</sup>	86.03 <sup>a</sup>	2.852	0.0001
% Nitrogen Intake	67.74	71.65	72.20	71.46	2.317	0.2954

<sup>abc</sup> Values having different superscripts in the same row are significantly different at  $p < 0.05$ , SEM=Standard error mean; Nap0<sub>Conc</sub> = Napier grass only, Nap1.5<sub>Conc</sub> = Napier grass + 1.5% concentrate per kg body weight, Nap2.0<sub>Conc</sub> = Napier grass + 2.0% concentrate per kg body weight and Nap2.5<sub>Conc</sub> = Napier grass + 2.5% concentrate per kg body weight

According to Mohamed et al. (2001), the nitrogen content of the feed and intake of dry matter both have an influence on nitrogen intake. Nitrogen retained of 81.87 g/day – 86.61 g/day by the animals on concentrate supplement in this study is higher than 48.50g/day – 54.85 g/day reported by Sani et al. (2017) and 72.01 g/day –79.48 g/day reported by Yusuf (2016). These differences could be as a results of a higher nitrogen concentration in the supplementary diets fed to the animals. In contrast, Lamidi (2005) reported a higher value of 130 g/day – 180 g/day and 146.67 g/day – 206.6g/day when Bunaji bulls were fed sundried layer and broiler litters respectively. This could be as a result of differences in the age of the animal and feed composition.

The results obtained in this experiment also revealed that both the concentrate supplemented calves and the control group had positive nitrogen balance. This suggest that the nitrogen was well absorbed and utilized by the animals for better performance. Abdu et al. (2012) noted that nitrogen retention is an indicator used to evaluate the protein nutrition status of ruminants. Likewise, Sarwar et al. (2003) reported that nitrogen retention in ruminant livestock depends on good digestibility of nutrients and utilization by the animals. It was also observed that nitrogen intake increased with concentrate supplementation of the basal diet. This observation agrees with the findings made by McDonald et al. (2002) who reported that dietary nitrogen intake is directly correlated to the proportion of nitrogen concentration in the diet. The results of also showed increased faecal nitrogen and reduced urinary nitrogen with increasing levels of concentrate supplement. This agree with the findings of Al-Asfoor (2010) who noted that the concentration of nitrogen in the faeces is strongly dependent on the nitrogen concentration of the diet.

## **5.7 Conclusion and Recommendation**

### **5.7.1 Conclusion**

Providing quality feed during the dry season ensures the optimum performance of ruminants and profitability to smallholder farmers. Feeding protein concentrate as a supplement to Napier grass basal diet improved total and average dry matter intake in N'dama bull calves. Furthermore, increased digestibility of DM, CP, OM, Ash, NDF, and Hemicellulose in N'dama bull calves implies that there was improved rumen function and feed digestibility from cattle fed the supplemented diets. In addition, water intake improved as dry matter intake increased but declined when the concentrate level was increased from 2.0% to 2.5%. Protein concentrates as a supplement to Napier grass basal diet again improved both the nitrogen intake and nitrogen balance in N'dama bull calves and thus could be used to enhance the quality of poor forages, especially during the dry season.

### **5.7.2 Recommendation**

1. It is recommended that concentrate supplement should be used by the cattle farmers as a good source of feed supplement especially during the driest season of the year to maintain live weights of bull calves for improved performance.
2. It is also recommended that concentrate supplement should be fed at 2.0% per kilogram body weight of the animal since it gives higher dry matter digestibility.
3. It is also recommended that further studies should be conducted to assess the effect of concentrate supplement on the growth performance and blood

parameters of N'dama bull calves fed Napier grass. Hence animal experiment two (2) was carried out.

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## CHAPTER SIX

### **6.0 EFFECTS OF SUPPLEMENTING NAPIER GRASS WITH VARYING LEVELS OF A CONCENTRATE SUPPLEMENT ON FEED INTAKE, GROWTH PERFORMANCE AND BLOOD PARAMETERS AND ECONOMIC BENEFITS OF N'DAMA CALVES FED NAPIER GRASS BASAL DIET**

#### **6.1 INTRODUCTION**

According to FAO (2014), livestock plays an important role in the supply of animal protein, farmyard manure (dung) for soil fertility improvement, farm power and traction and income for livelihood improvement. This helps to reduce poverty and enhance food security. Currently in Ghana, due to rapid urbanization, increasing income and fast population growth, animal products like meat and milk are in high demand (SRID, 2016). Conversely, homegrown production of livestock and its related product is unable to meet the increasing demand resulting in high importation of livestock and livestock products from neighbouring countries and abroad to supplement for the deficit. According to SRID report (2016), Ghana imported 42, 536 metric tons of frozen meat as well as dairy products to meet the local demands. Animal breeding, feeding, care and management of animals for the production of food and other services to meet the demand for human consumption thus becomes very important. According to Thornton (2010), improvements in animal health, nutrition, and breeding will increase livestock productivity through increased genetic diversity, increased efficiency, and increased potential production.

In Ghana, cattle intensification in an established pasture is uncommon because the majority of cattle are fed on natural pasture in an extensive system of production, with or without concentrate supplementation. This method of production is severely

constrained by availability of forage of good quality particularly during the dry season.

According to Akbar et al. (2000), farmers generally do not prepare farm lands for the production of fodder for feeding ruminant livestock due to the high demand for crop production to meet human needs. Cattle mainly thrive on poor quality forages with partial supplementation of crop residues and limited or without concentrate. These challenges have a negative impact on cattle performance in general, making it highly unsatisfactory compared to developed nations. Nutritive value of these poor forages can be improved with concentrate supplementation for increase production in cattle. Hills *et al.* (2015) reported that supplementary feeds increase dry matter intake and general performance of animals. On an extensive production system, young cattle grow at 0.1–0.2 kg/day, but with improved feeding, that rate increases to 0.3–0.4 kg/day (Akbar et al., 2000). The growth rate of cattle is greatly influenced by high plane of nutrition.

According to Banerjee (1998), the amount of protein in the diet and its source affects the growth rate of ruminant animals. Similar to concentrate supplements, increased nutritional intake is necessary for animals to increase productivity. In the dry season, tropical grasses reduce significantly in energy and protein content reducing forage intake and animal performance as a result of ineffective protein synthesis by rumen microbial activities (Pulido *et al.*, 2009., Hills *et al.*, 2015). Supplementation of concentrate after grazing is rarely practiced in Ghana for feeding cattle. Therefore, cattle are inept to meet their nutritional requirements for optimum growth and reproductive performance hence supplementary feeding becomes necessary to meet the nutritional requirement of the animal. This problem can be resolved by feeding

cattle with high yield pasture with concentrate supplementation for optimal performance. One of these high-yielding forages is Napier grass.

Napier grass (*Pennisetum purpureum*) also known as "Elephant grass" is one of the most promising forages in livestock production worldwide. It is widely used in cut-and-carry cattle feeding systems. It has several qualities that make it a preferred feed, including a high yield per unit area, resistance to intermittent drought, and excellent water use efficiency (Kabirizi et al., 2015). It can resist repeated cutting and will regrow back quickly, yielding highly palatable leafy leaves (Lowe et al. 2003). In areas with fertile soil and high humidity, Napier grass produces a lot of herbage. According to Wangchuk et al. (2015), it accounts for up to 80% of forage grown and is the preferred forage for smallholder livestock farmers in East Africa. Napier's wide range of adaptability, vigorous growth, high biomass productivity, and deep root system that allows it to survive in dry conditions have all been linked to the widespread cultivation of this plant in the area (Lowe et al. 2003).

Herbage of forages consist mostly of leaves in their early stages of growth and the stems makes a greater percentage of the forages with age. Herbage yield of Napier grass may be affected by harvesting date. Herbage yield increases with age due to the rapid growth of plant tissues (Minson, 1990). Yield of 22,489 kg/h DM at 60 days of harvesting and a record high yield of 46,013 kg/h DM at 120 days of harvesting respectively, have been reported (Ansah et al., 2010). With the application of 1320 kg/ha of nitrogen fertilizer, Boonman (1993) recorded a significant high yield of 130 t/h. Furthermore, Nutritional quality of feed is directly influenced by management practices and age at harvest. According to Wadi et al. (2004), the age at harvest affects the crude protein content of Napier grass. Dry matter yield of Napier grass increases

with age but crude protein declines. Humphreys (1991) reported that fluctuation of crude protein content of forages is generally attributed to dilution of crude protein by rapid accumulation of cell wall carbohydrates at the advanced stage of growth. The range of crude protein content of Napier grass varies from 4.4 to 20.4% with the mean of 12% as suggested by Rusdy (2016). Ansah et al. (2010) recorded highest crude protein (CP) of 109.9 g/kg DM at 60 days of harvesting and lowest crude protein content of 79.9 g/kg DM at 120 days of harvesting. This characteristic of the Napier grass makes it suitable for pasture establishment for feeding livestock in the cut-and-carry system as well as conserving it in the form of hay and/or silage for feeding ruminants.

Sani et al. (2014) reported that biochemical tests are vital in evaluating the animal's internal body condition and the course of metabolic changes in the body. Blood is used as a pathological indicator of an animal's health after exposure to toxins and other conditions (Sani et al., 2014). Furthermore, Etim *et al.*, (2014) stated that blood examination gives the opportunity to clinically assess the occurrence of metabolites and other constituents in the body of animals. Blood also plays an important role in the nutritional, physiological as well as pathological status of an animal (Etim *et al.*, 2014). Blood constituents change in relation to the physiological status of an animal (Sani et al., 2014). These changes are important in evaluating the response of farm animals to various physiological changes.

A number of animal feeding trials have been conducted using small ruminants to determine the effect of feeding concentrate on feed intake, growth performance and blood parameters in Ghana. However, little emphasis was given to the effect of supplementation of concentrate on feed intake and growth performance of calves.

With this perspective in mind, the current studies were undertaken with the following objectives:

1. To assess the effects of a concentrate supplement on feed intake and growth performance of N'dama calves fed Napier grass.
2. To assess the effects of concentrate supplement on blood parameters of N'dama calves fed Napier grass.
3. To assess the economic benefits of concentrate supplement on fattening of N'dama calves fed Napier grass.



## **6.2 MATERIAL AND METHODS**

### **6.2.1 Experimental Site, animals and housing**

The experiment was carried out at the University of Cape Coast Teaching and Research Farm of the School of Agriculture, Cape Coast, Ghana from May to September 2020. Details of the experimental location has been described in Chapter 5.

Sixteen N'dama bull calves, all male and weighing 99.06kg, were used in a twelve-week experiment at the University of Cape Coast Teaching and Research Farm in Cape Coast, Ghana. The animals were individually housed and kept in a well-ventilated and well-managed shed pen. The animals' ears were tagged to ease identification and management and were allowed 14 days adaptation period, during which time they were fed the basal diet plus 1.0 kg DM of the concentrate supplement. The body weight of the bull calves was measured with a weighing scale at the start of the experiment and then every two weeks after that. Weighing was done early in the morning before the calves were given access to feed and water. All animals were treated for both internal and external parasite as described in Chapter 5.

### **6.2.2 Experimental design and dietary treatment**

Sixteen N'dama calves were randomly assigned to one of four dietary treatments in a Completely Randomized Design (CRD) according to their body weight. The treatment was as follows:

- T1 – Napier grass only (Nap0<sub>Conc</sub>).
- T2 – Open grazing + concentrate fed at 1.0% of LW (OG1.0<sub>Conc</sub>)
- T3 – Napier grass + concentrate fed at 1.5% of LW (Nap1.5<sub>Conc</sub>)
- T4 – Napier grass + concentrate fed at 2.0% of LW (Nap2.0<sub>Conc</sub>)

There were 4 animals per treatment.

### 6.2.3 Animal feeding and management

Elephant grass was used in the experiment as a basal diet. After 60 days of regrowth, the grass was harvested and chopped to a length of 10cm to 15cm, and fed to the calves individually. For Nap0<sub>Conc</sub>, Napier grass only was offered at 3% BW without concentrate supplementation. The composition of the concentrate was described in chapter 5. For Nap1.5<sub>Conc</sub> and Nap2.0<sub>Conc</sub>, the supplement was fed at 1.5% BW and 2.0% BW, respectively each morning at 7:30 am. The animals generally consumed the entire supplement within 20 min after which a basal Napier grass diet was offered at 3% BW. For calves in OG1.0<sub>Conc</sub>, after morning concentrate supplementation at 1.0% BW, they were allowed to graze on the paddocks within the research farm every morning from 8:00 a.m. to 4:00 p.m. A quadrant was randomly thrown on a pasture field on average 15 times. The enclosed grasses within the square of the quadrant were cut and thereafter weeds were separated. The collected grasses were then weighed and recorded the same day, and thereafter oven-dried between 60 and 80 °C for 48 hours. The dried pasture was afterwards weighed to determine the water loss and dry matter content. In order to achieve a homogeneous consistency and nutritional properties for the best rumen functions, the concentrate ingredients were thoroughly mixed. Weekly adjustments were made to the quantity of concentrate and fresh grass provided to each animal. Each animal had free access to a mineral block<sup>5</sup> and water. Each animal was offered 12 liters of water from a plastic 25 liters gallon with one side cut open within each pen. Water intake was recorded per calf.

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<sup>5</sup> Selena mineral block: Sodium Chloride 95.5%, Calcium Carbonate 2.7% and Calcined Magnesita 1.0%

## 6.2.4 Parameters measured

### 6.2.4.1 Feed and water intake

The feed offered each morning was weighed with a weighing scale before being offered to the bull calves. The differences between feed offered (basal and concentrate) and feed refused was measured and recorded daily as feed intake. Furthermore, fresh clean water was measured and offered each day to individual animals and the differences between offered and water refused was recorded as water intake. The average feed and water intake per day was calculated by dividing the total intake by the number of days in the experiment.

### 6.2.4.2 Live weight gain (LWG)

The animals' body weight was recorded at the start of the experiment and then every two weeks for the entire period of the experiment. The weight gain (WG) was calculated as the difference between the animal's initial and final weight.

The ADG was calculated by dividing the weight gained by the period of the experiment.

Mathematically;

$$ADG = \frac{\text{Weight gain}}{\text{number of days}}$$

### 6.2.4.3 Feed conversion Efficiency (FCE)

The feed conversion efficiency was calculated by dividing each animal's average daily gain by the average daily intake.

$$FCE = \frac{\text{Average daily gain}}{\text{average daily intake}}$$

#### **6.2.4.4 Blood Samples**

At the end of the experiment, blood samples were collected from each animal via jugular vein puncture. To prevent contamination and infection, 70% alcohol was used to clean the vein site. 5ml of blood were drawn from each animal, with 2.5 ml transferred into ethylenediaminetetraacetic acid (EDTA) tubes to prevent clotting. To induce clotting, the remaining 2.5 ml was put into a simple tube that did not contain EDTA. The blood samples were then kept in an ice chest and transferred 152 kilometers away to the Noguchi Memorial Institute for Medical Research in Accra, Ghana, for analysis.

#### **6.2.4.5 Haematological parameters**

The Sysmex analyser<sup>6</sup> was used to analyze blood samples transferred into EDTA tubes for the determination of haemoglobin (Hb), white blood cell (WBC), red blood cell (RBC), haematocrite (HCT), mean cell volume (MCV), mean cell haemoglobin (MCH), mean cell haemoglobin concentration (MCHC), red cell distribution width (RCDW), neutrophils, lymphocytes, and platelets. The procedures employed were those described by Gernsten (2009).

#### **6.2.4.6 Blood chemistry**

To separate the serum from the whole blood, the clotted blood was centrifuged at 2,000 rpm for 10 minutes at 40°C. Using a Selectra E analyzer<sup>7</sup>, the serum was analyzed for blood glucose and total protein.

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<sup>6</sup> Sysmex Haematology Analyzer. Made in China.

<sup>7</sup> Selectra E Chemistry Analyser. Made in Netherland

### 6.2.5 Chemical Analysis

Napier grass and concentrate supplement samples were collected and dried at 60°C for 48 hours. The dried samples were then grounded using a laboratory mill (Wiley mill) and allowed to pass through 1mm sieve screens for analyses. Chemical analysis of the samples was carried out to determine the dry matter (DM), crude protein (CP), ash, ether extract, neutral detergent fibre (NDF) and acid detergent fibre (ADF). The Proximate analysis was performed according to the Association of Official Analytical Chemists (A.O.A.C., 1990). The NDF and the ADF fractions were determined following the technique described by Goering and Van Soest (1970).

### 6.2.6 Economic analysis

The prevailing market price of the various feed ingredients, price of water per liter and the price of basal diet (Napier grass) during the experimental period was used to evaluate the total cost of feed intake, feed cost per kilogram weight gain, value of gain and net benefit using the procedure suggested by Alimi and Manyong (2000). This was used to determine the profitability or otherwise of the fattening enterprise. The formula used were as follows;

Value of gain (VG) was calculated as;

$$VG = \text{total weight gain} * \text{price of beef per kg}$$

The net benefit (NB) was calculated as;

$$NB = \text{value of gain} - \text{total cost of feed and water}$$

Return on investment (RI) was also calculated as;

$$RI = \frac{\text{Net benefit}}{\text{Cost of feed and water}}$$

### 6.2.7 Statistical Analysis

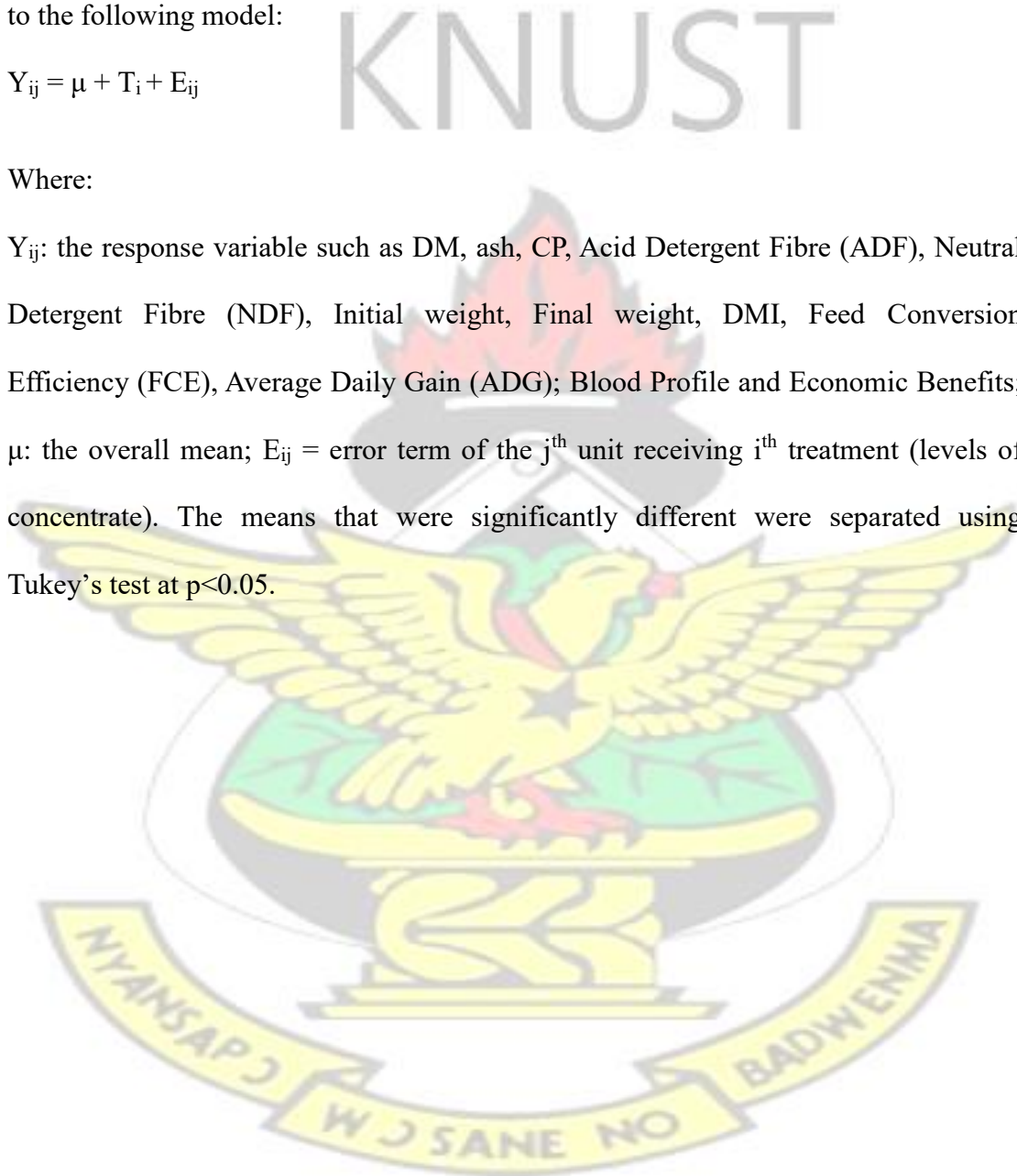
All data on chemical composition, growth performance, blood parameters and economic benefits were analysed as completely randomized design (CRD) using Statistical Analysis System (SAS, 2012, SAS Institute Inc. Cary, NC, USA) according to the following model:

$$Y_{ij} = \mu + T_i + E_{ij}$$

Where:

$Y_{ij}$ : the response variable such as DM, ash, CP, Acid Detergent Fibre (ADF), Neutral Detergent Fibre (NDF), Initial weight, Final weight, DMI, Feed Conversion Efficiency (FCE), Average Daily Gain (ADG); Blood Profile and Economic Benefits;

$\mu$ : the overall mean;  $E_{ij}$  = error term of the  $j^{\text{th}}$  unit receiving  $i^{\text{th}}$  treatment (levels of concentrate). The means that were significantly different were separated using Tukey's test at  $p < 0.05$ .



## **6.3 RESULTS AND DISCUSSION**

### **6.3.1 Chemical composition of Napier grass**

The chemical composition of the Napier grass (local) basal diet, ingredients composition of the concentrate supplement and the chemical composition of the concentrate supplement used in the experiment have been presented in Chapter 5 Table 5.1, 5.2 and 5.3 respectively.

### **6.3.2 Effects of concentrate supplement on growth performance**

The effect of concentrate supplement on live weight gain (LWG), average daily gain (ADG), dry matter intake (DMI), total water intake (TWI) and feed conversion ratio (FCR) are shown in Table 6.1.

### **6.3.3 Final body weight (FBW)**

The Initial body weights of the bull calves were similar ( $P > 0.05$ ) at the start of the experiment and was averaged 99.05 kg BW. The average initial live weight of the animals ranged from 99.55 kg (Nap2.0<sub>Conc</sub>) to 100.25 kg (OG1.0<sub>Conc</sub>) (Table 6.1).

The results showed significant differences ( $p < 0.0001$ ) in final weight due to treatment effect. Table 6.1 showed that calves on OG1.0<sub>Conc</sub> had the least final weight. Groups supplemented with concentrate at 1.5%BW and 2.0BW (Nap1.5<sub>Conc</sub> and Nap2.0<sub>Conc</sub>) had higher final weight than openly grazed animals supplemented at 1.0%BW concentrate (OG1.0<sub>Conc</sub>). This indicate that as the concentrate level increases beyond 1.5% BW, weight gain depreciated at marginal level. This could be that at level 1.5% BW, the concentrate supplement was able to combine with a low-quality roughage to yield the highest daily weight gain as reported by Kartcher (1980). The results in Table 6.1 further showed that, comparing calves on Nap2.0<sub>Conc</sub> with

Nap1.5<sub>Conc</sub>, there was a negative influence on the weight gain of the animals. This observation is contrary to normal. Also, OG1.0<sub>Conc</sub> with higher initial body weight performed poorly at the end of the experiment with final body weight of 123.13 kg (Table 6.1). This shows that, giving concentrate supplement to the animals on OG1.0<sub>Conc</sub> after grazing had no influence on their weight gain. This could be attributed to negative energy balance due to grazing by the animals on the field.

**Table 6.1: Effect of concentrate supplement on the growth performance of N'dama bull calves fed Napier grass basal diet**

Parameters	Treatments				SEM	p
	Nap0 <sub>Conc</sub>	OG1.0 <sub>Conc</sub>	Nap1.5 <sub>Conc</sub>	Nap2.0 <sub>Conc</sub>		
Initial weight	97.75	100.25	98.7	99.55	1.32	0.59
Final weight	133.38 <sup>b</sup>	123.13 <sup>c</sup>	147.05 <sup>a</sup>	146.83 <sup>a</sup>	0.94	0.0001
Live weight gain (kg)	35.63 <sup>b</sup>	22.88 <sup>c</sup>	48.35 <sup>a</sup>	47.28 <sup>a</sup>	0.89	0.0001
Average daily gain (kg/day)	0.47 <sup>b</sup>	0.27 <sup>c</sup>	0.58 <sup>a</sup>	0.56 <sup>a</sup>	0.01	0.0001
DM intake from grass (kg)	258.93 <sup>b</sup>	239.10 <sup>c</sup>	266.40 <sup>a</sup>	263.75 <sup>ab</sup>	2.44	0.0001
DM intake from concentrate (kg)	0.00	103.60 <sup>c</sup>	145.60 <sup>b</sup>	187.60 <sup>a</sup>	0.50	0.0001
Total DMI (kg)	258.93 <sup>d</sup>	342.70 <sup>c</sup>	412.00 <sup>b</sup>	451.35 <sup>a</sup>	1.43	0.0001
Average DMI (kg/day)	2.88 <sup>d</sup>	4.08 <sup>c</sup>	4.91 <sup>b</sup>	5.38 <sup>a</sup>	0.03	0.0001
Average water intake (L/day)	8.35 <sup>c</sup>	9.08 <sup>b</sup>	9.22 <sup>b</sup>	9.71 <sup>a</sup>	0.08	0.0001
FCE	0.16 <sup>a</sup>	0.06 <sup>c</sup>	0.12 <sup>b</sup>	0.11 <sup>b</sup>	0.003	0.0001

<sup>abc</sup> Values having different superscripts in the same row are significantly different at  $p < 0.05$ , DMI= Dry matter intake, LWG= Live weight gain, SEM=Standard error mean; FCE= Feed conversion efficiency, Nap0<sub>Conc</sub> = Napier grass only, OG1.0<sub>Conc</sub> = Open grazing+1.0% concentrate, Nap1.5<sub>Conc</sub> = Napier grass+1.5% concentrate, Nap2.0<sub>Conc</sub> = Napier grass+2.0% concentrate

#### 6.3.4 Live weight gain (LWG)

The live weight gain (LWG) of the bull calves at the end of the experiment is shown in Table 6.1 above. The concentrate had a significant ( $p < 0.0001$ ) effect on LWG (Table 6.1). There were significant differences in LWG between OG1.0<sub>Conc</sub> (22.88 kg)

and Nap0<sub>Conc</sub> (35.63 kg) but no difference in LWG was observed between Nap1.5<sub>Conc</sub> (48.35 kg) and Nap2.0<sub>Conc</sub> (47.28 kg) (Table 6.1). The improved LWG for these animals is likely to be due to the increased DM intake resulting from intake of concentrate as suggested by Quang et al. (2015). A number of studies reported that LWG increased as the concentrate intake increased. In contrast, animals supplemented with concentrate at 1.5% BW (Nap1.5<sub>Conc</sub>) performed better than the rest. The result could suggest that concentrate supplementation up to 1.5% BW was optimum for rumen function. This current result is in agreement with the result of Dung et al. (2015), Doyle (1987), Paeng-Koum and Tatsapong (2009) and Manni et al. (2013) who reported significant difference in live weight gain among the supplemented animals and the control. Surprisingly, OG1.0<sub>Conc</sub> recorded the least LWG (22.86 kg) compared to the control animal (Nap0<sub>Conc</sub>). Grazing of the animals could have contributed to the results observed in OG1.0<sub>Conc</sub> as much energy is being used for maintenance instead of converting to muscles.

### **6.3.5 Average daily gain (ADG)**

There were significant differences in ADG between OG1.0<sub>Conc</sub> (0.27 kg/d) and Nap0<sub>Conc</sub> (0.42 kg/day) ( $p < 0.0001$ ) but not between Nap1.5<sub>Conc</sub> (0.58 kg/day) and Nap2.0<sub>Conc</sub> (0.56 kg/day) (Table 6.1). Similarly, comparing ADG between the control (Nap0<sub>Conc</sub>) OG1.0<sub>Conc</sub>, Nap0<sub>Conc</sub> animals performed better. The significant difference in OG1.0<sub>Conc</sub> under extensive system could be because the basal diet is of relatively high quality. Because of the relatively high CP content of the Napier grass at 60 days regrowth (Table 5.1, Chapter 5), the animals were able to meet their nutrient requirements for normal body weight gain by feeding only Napier grass. The current study's findings are consistent with those of Budmaska and Kalinka (1994), who

reported 0.71 kg/day, 0.73 kg/day, 0.75 kg/day, and 0.81 kg/day weight gain in bulls. Dolberg and Finlayson (1995) observed a curvilinear response ranging from 0.24 kg/day to 0.86 kg/day when urea-treated straw was fed with cottonseed cake at rates ranging from 0 to 4 kg/head/day. According to Anuez et al. (1991), when Holstein steers were given concentrates, the average daily gains were 0.88, 1.00 kg/day, 0.91 kg/day, and 1.08 kg/day. According to Brzoska et al. (1999), Simmental bulls given grass silage or wet grass silage with supplementary concentrate 45 and 65 g/kg BW had daily weight gains of 0.91 and 0.95 kg on average, respectively. When Rahman (2001) fed bull calves a 1 kg concentrate mix containing green grass and urea molasses straw (UMS), the calves' body weight increased on average by 0.49 kg per day. This result corresponds to the findings of Muia et al. (2001) who also reported a positive effect of supplementing Napier grass (*Pennisetum purpureum*) with poultry litter and sunflower meal-based concentrates on feed intake and rumen fermentation in Friesian steers.

### **6.3.6 Feed intake (FI)**

Daily average DM intake of the animals was 3.08, 4.08, 4.91 and 5.38 kg for Nap0<sub>Conc</sub>, OG1.0<sub>Conc</sub>, Nap1.5<sub>Conc</sub> and Nap2.0<sub>Conc</sub>, respectively as shown in Table 6.1 above. The lowest DM intake was observed in animals fed Napier grass only (Nap0<sub>Conc</sub>) and the highest was recorded for Napier plus 2.0% BW concentrate supplement (Nap2.0<sub>Conc</sub>). The total daily DM intake increased ( $p < 0.0001$ ) as the level of concentrate supplementation increased. In general, DM intake of Napier grass was significantly ( $p < 0.0001$ ) higher in Nap1.5<sub>Conc</sub> (266.4 kg) and Nap2.0<sub>Conc</sub> (263.75 kg) as compared to OG1.0<sub>Conc</sub> (239.10). There were significant differences in grass DM intake between OG1.0<sub>Conc</sub> and Nap0<sub>Conc</sub> (258.93 kg) (Table 6.1). The highest grass

DM intake was recorded for diet containing 1.5% concentrate supplement and decreased non-significantly as the level of concentrate supplementation was increased to 2.0%. The results of the study suggest that 1.5% concentrate supplementation may be suitable for optimum fermentation of Napier grass-based diets in ruminants for optimum growth. On the other hand, Napier grass intake decreased at the higher levels of concentrate supplementation. These results correspond to those of Ba et al. (2008), who studied Vietnamese native yellow cattle production, and Manni et al. (2013), who studied dairy bull production. Sairanen et al. (2005) and Arriola et al. (2011) found that increasing concentrate levels enhanced daily feed intake in dairy cows. Consistently with the results of other experiments, Chowdhury (2001), who reported that total DM intake increased by 1 g/kg BW/day but straw DM intake decreased by 0.54 g/kg BW/day as the levels of cotton seed cake (CSC) with UMS increased in adult cannulated bulls fed rice straw-based diet.

### **6.3.7 Feed conversion efficiency (FCE)**

Feed conversion efficiency was different ( $p < 0.0001$ ) between OG1.0<sub>Conc</sub> (0.06) and Nap0<sub>Conc</sub> (0.16) but the differences between Nap1.5<sub>Conc</sub> (0.12) and Nap2.0<sub>Conc</sub> (0.11) was not significant (Table 6.1). The animals in Nap0<sub>Conc</sub> had the best FCE followed by Nap1.5<sub>Conc</sub>, Nap2.0<sub>Conc</sub> and OG1.0<sub>Conc</sub> had the least FCE. Differences in FCE depends on the growth rate and feed intake and both are affected by the quality of the diet. A good FCE is obtained when feed intake is low and growth rate is high as was observed in Nap0<sub>Conc</sub>, Nap1.5<sub>Conc</sub> and Nap2.0<sub>Conc</sub> signifying that animals were effective in converting the feed consumed into weight gain. Generally, intake and digestibility of the diet is affected by FCE. Higher FCE indicates more efficient feed utilization for body weight gain. The low FCE (0.06) observed in OG1.0<sub>Conc</sub> in this

current study could be as a result of insufficient nutrient utilization by the grazing animals. The results of this study are consistent with that of Loerch and Fluharthy (1998) who reported that feed efficiency was highest ( $p < 0.05$ ) for steers continually fed concentrate supplement. Values of FCE observed in the current study are within the range (0.04 to 0.11) reported by Mwilawa (2012) and Umunna et al. (1980) on Zebu steers fed concentrate *ad libitum* and by Araba and Byers (2002) for bulls and heifers of Holstein x Friesian fed on cereal/molasses diets.

### **6.3.8 Water intake (TWI)**

The effect of concentrate on water intake is presented in Table 6.1. The result showed that there was significant difference ( $p < 0.0001$ ) between Nap0<sub>Conc</sub> and Nap2.0<sub>Conc</sub> but no differences was observed in between OG1.0<sub>Conc</sub> and Nap1.5<sub>Conc</sub>. Average daily water intake increased with increasing in concentrate supplementation. Bull calves fed basal diet plus concentrate at 2.0% BW, 1.5%BW and 1.0% BW had higher average daily water intake 9.71 L, 9.22 L and 9.08 L, respectively than Nap0<sub>Conc</sub> bull calves fed basal diet only which recorded the least water intake (8.35L) (Table 6.1). The water intake may be influenced by the amount of dry matter consumed and the quality of the water offered. Water quality is vital for cattle to sustain the water intake (NRC, 2001). Beede (2006) reported that water intake by cattle is influenced by smell and taste. Unpalatable or obnoxious odour can affect water intake negatively and hence cattle are unable to meet the water requirement for increase production (Beede, 2006). There is a positive correlation between water intake and dietary concentrate intake regardless of ration as opined by (Kume et al., 2010; Meyer et al., 2004). Normally, cattle drink less water when fed on feed with high water content. The low water intake recorded in Nap0<sub>Conc</sub> could be as a result of the nature of the grass fed. This current

study agrees with the findings of Hicks et al. (1998) who reported that water consumption increases with increase in dry matter intake.

#### **6.4 Effects of concentrate supplement on haematological parameters of N'dama bull calves**

Table 6.2 shows the effects of the concentrate supplement on haematological parameters of N'dama bull calves. There were significant differences ( $P < 0.05$ ) observed in WBC count among the treatment and the control groups (Table 6.2). The study showed a higher WBC value for OG1.0<sub>Conc</sub> (16.35 K $\mu$ L). The results could be as a results of tick infestation resulting from grazing pasture by the animals. Ahamefule et al. (2006) reported that high WBC counts are usually associated with microbial infection or the presence of foreign bodies or antigens in the circulatory system. Valencia (2012) also reported that high WBC value could be caused by infection, immune system disorders, and stress. This assertion agrees with the current finding. Merck Veterinary Manual (2012) reported that the normal values for WBC, NEUT, LYP, and MXD for cattle are 4 - 12 (K/L), 0 - 5, 2.5 - 7.5, and 5 - 10%, respectively.

There was no significant difference ( $p > 0.05$ ) between the supplemented animals and the control group in the proportion of blood volume constituted of RBC, MCV, MCH, and MCHC (Table 6.2). Red blood cells (RBCs) containing haemoglobin (iron-rich protein) pick up oxygen and transport it to various organs and tissues throughout the body as blood flows through the lungs. Aderemi (2004) reported that red blood cells are produced in the bone marrow and they live for almost 120 days in the circulatory system and are eventually removed by the spleen. Anaemia is a deficiency of red blood cells and can cause weakness, shortness of breath and irritability in animals.

The current study supports the findings of Adams et al. (2008), who found no differences in total haematocrit between supplemented animals and the control calves. The haematological values obtained are within the reference ranges reported for RBC (M/ $\mu$ L) 5– 10, HGB (g/dL) 10 –15, HCT (%) 26 – 46, MCV (fL) 39 –55, MCH (ps) 13 –17, and MCHC (g/dL) 30 – 36, respectively (Merck Veterinary Manual, 2012).

**Table 6.2: Blood profile of N'dama bull calves fed Napier grass and supplemented with a concentrate**

Parameters	Treatments				SEM	p
	Nap0 <sub>Conc</sub>	OG1.0 <sub>Conc</sub>	Nap1.5 <sub>Conc</sub>	Nap2.0 <sub>Conc</sub>		
WBC (K/ $\mu$ L)	12.80 <sup>b</sup>	16.35 <sup>a</sup>	13.30 <sup>b</sup>	11.75 <sup>b</sup>	0.93	0.0243
RBC (M/ $\mu$ L)	9.04	9.23	7.92	7.73	0.75	0.1447
HGB (g/dL)	12.65	13.38	11.78	10.35	0.95	0.1903
HCT (%)	37.68	38.13	39.25	36.25	3.49	0.9427
MCV (fL)	42.43	40.95	44.9	45.33	1.36	0.1248
MCH (ps)	13.13	13.23	12.68	13.05	0.46	0.8477
MCHC (g/dL)	31.73	30.63	31.85	31.68	0.63	0.5162
NEUT (%)	5.4	4.35	6.33	3.95	0.57	0.0488
LYM (K/ $\mu$ L)	13.48 <sup>a</sup>	8.60 <sup>b</sup>	11.50 <sup>b</sup>	9.83 <sup>b</sup>	0.92	0.0152
MXD (%)	66.8	67	76.18	72.78	2.12	0.0215

<sup>abc</sup> Values having different superscripts in the same row are different at  $p < 0.05$ , SEM = Standard Error Mean, Nap0<sub>Conc</sub> = Napier grass only, OG1.0<sub>Conc</sub> = Open grazing+1.0% concentrate, Nap1.5<sub>Conc</sub> = Napier grass+1.5% concentrate, Nap2.0<sub>Conc</sub> = Napier grass+2.0% concentrate

RBC = Red blood cell, HGB = Haemoglobin, HCT = Haematocrit, MCV = Mean cell volume, MCH = Mean cell haemoglobin, MCHC = Mean cell haemoglobin WBC = White blood cell concentration, LYM = Lymphocyte, NEUT = Neutrophiles, MXD = Mixed cell count.

### 6.5 Effects of concentrate supplement on blood Glucose and Total Protein

Table 6.3 shows the effects of concentrate supplement on blood glucose and total protein of N'dama bull calves. The results showed that dietary treatment did not significantly ( $p > 0.05$ ) influence the blood glucose measured. The glucose concentration is a sign of physiological state of an animal. Glucose represents the synthesis of carbohydrates and is in the form in which carbohydrates is supplied to cell from body fluids. The values obtained in this study were within the normal

reference values for cattle (59 – 105 mg/dl and 61 – 81g/l), respectively as recognized in Merck Veterinary Manual (2012) which shows better health condition of the animals.

## 6.6 Total Protein

There were significant differences ( $p < 0.05$ ) observed in total protein level across dietary treatments (Table 6.3). It was observed that Nap1.5<sub>Conc</sub> recorded the highest value of total protein (64.13 g/l). Proteins are important building blocks of all cells and tissues and are needed for growth, development, and health of animals. Aderemi (2004) also reported that humoral and cell mediated immunity is impaired by protein deficiency hence predispose animals to diseases. According to Aderemi (2004), low total protein in animals is a sign of malnutrition and organ problems including kidney and liver disease, whereas excessive total protein in animals may be a sign of inflammation or infections and bone marrow disorders. However, the result fell within the range of normal standards for cattle (58 to 81g/l), as noted in Merck Veterinary Manual (2012) which suggests that the animals are in better health conditions.

**Table 6.3: Effect of concentrate supplement on blood glucose and total protein of N'dama bull calves**

Parameters	Treatments				SEM	<i>p</i>
	Nap0 <sub>Conc</sub>	OG1.0 <sub>Conc</sub>	Nap1.5 <sub>Conc</sub>	Nap2.0 <sub>Conc</sub>		
Blood glucose (mg/dl)	64.13	73.18	72.5	77.08	3.26	0.0858
Total Protein (g/l)	61.65 <sup>ab</sup>	61.03 <sup>ab</sup>	64.13 <sup>a</sup>	58.58 <sup>b</sup>	1.03	0.0191

<sup>abc</sup> Values having different superscripts in the same row are different at  $p < 0.05$

SEM = Standard Error Mean, Nap0<sub>Conc</sub> = Napier grass only, OG1.0<sub>Conc</sub> = Open grazing+1.0% concentrate, Nap1.5<sub>Conc</sub> = Napier grass+1.5% concentrate, Nap2.0<sub>Conc</sub> = Napier grass+2.0% concentrate

## **6.7 Partial budget analyses of N'dama bull calves fed Napier grass basal diet with or without concentrate supplement**

The partial budget analyses of N'dama bulls fed Napier grass basal diet with or without concentrate supplement is presented in Table 6. There was significant difference ( $p < 0.0001$ ) in all the parameters measured. The feed cost per kg gain was significantly different ( $p < 0.01$ ) and higher in OG1.0<sub>Conc</sub> (GHS 16.23/Kg gain) and lowest for the Nap0<sub>Conc</sub> diet (GHS 7.34/Kg gain). The results obtained is not surprising as OG1.0<sub>Conc</sub> animals were fed only the basal diet without concentrate supplement. However, no significant differences were observed between Nap1.5<sub>Conc</sub> (GHS 9.23/Kg gain) and Nap2.0<sub>Conc</sub> (GHS 10.47/Kg gain). The result of this study agrees with the findings of Yusuf (2016) and Sani (2014) who fed graded level of brewer dried grains and raw and parboiled rice offal to yearling and fattened Bunaji bulls respectively. The total cost of feed and water increases with increasing level of concentrate supplementation. There was Significant differences ( $p < 0.0001$ ) in total feed and water cost and the least cost was recorded in Nap0<sub>Conc</sub> (GHS 261.07) followed by OG1.0<sub>Conc</sub> (GHS 370), Nap1.5<sub>Conc</sub> (GHS 445.44) and the highest in Nap2.0<sub>Conc</sub> (GHS 495.12) respectively (Table 6). The most important economic factor for the farmers is the net benefit (income over feed). The highest net benefit was recorded in Nap1.5<sub>Conc</sub> (GHS 424.86) and then followed by Nap0<sub>Conc</sub> (GHS 380.18) and Nap2.0<sub>Conc</sub> (GHS 355.84).

Furthermore, OG1.0<sub>Conc</sub> recorded the least net benefit (GHS 41.7) indicating that grazing animals with concentrate supplement is not economically feasible as less benefit is recoup after investment. Net benefit and rate of return to feed investment observed at the levels of inclusion were all positive. The result from this study agreed with the findings of Ehoche et al. (2002) who reported that supplementation with

either concentrate or legume forages may improve animal performance thereby increased smallholder cattle farmers income.

**Table 6.4: Partial budget analysis of N'dama bull calves fed Napier grass basal diet with or without concentrate supplement**

Parameters	Treatments				SEM	p
	Nap0 <sub>Conc</sub>	OG1.0 <sub>Conc</sub>	Nap1.5 <sub>Conc</sub>	Nap2.0 <sub>Conc</sub>		
Live weight gain (kg)	35.63 <sup>b</sup>	22.88 <sup>c</sup>	48.35 <sup>a</sup>	47.28 <sup>a</sup>	0.89	<0.0001
DM intake of grass (kg)	258.93 <sup>b</sup>	239.10 <sup>c</sup>	266.40 <sup>a</sup>	263.75 <sup>ab</sup>	2.44	<0.0001
DM intake from concentrate (kg)	0.00	103.60 <sup>c</sup>	145.60 <sup>b</sup>	187.60 <sup>a</sup>	0.50	<0.0001
Total DMI (kg)	258.93 <sup>d</sup>	342.70 <sup>c</sup>	412.00 <sup>b</sup>	451.35 <sup>a</sup>	1.43	<0.0001
Total water intake (L)	701.00 <sup>c</sup>	762.25 <sup>b</sup>	774.00 <sup>b</sup>	815.50 <sup>a</sup>	6.99	<0.0001
Cost of basal diet (GHS)	233.03 <sup>b</sup>	215.19 <sup>c</sup>	239.76 <sup>a</sup>	237.38 <sup>ab</sup>	1.28	<0.0001
Cost of concentrate (GHS)	0.00	124.35 <sup>c</sup>	174.72 <sup>b</sup>	225.12 <sup>a</sup>	0.01	<0.0001
Cost of water (GHS)	28.04 <sup>c</sup>	30.49 <sup>b</sup>	30.96 <sup>b</sup>	32.62 <sup>a</sup>	0.28	<0.0001
Total cost of feed and water (GHS)	261.07 <sup>d</sup>	370.00 <sup>c</sup>	445.44 <sup>b</sup>	495.12 <sup>a</sup>	1.40	<0.0001
Value of gain (GHS)	641.25 <sup>b</sup>	411.75 <sup>c</sup>	870.30 <sup>a</sup>	850.95 <sup>a</sup>	16.08	<0.0001
Cost/kg gain (GHS/kg gain)	7.34 <sup>c</sup>	16.23 <sup>a</sup>	9.23 <sup>b</sup>	10.47 <sup>b</sup>	0.31	<0.0001
Net benefit (GHS)	380.18 <sup>ab</sup>	41.7 <sup>c</sup>	424.86 <sup>a</sup>	355.84 <sup>b</sup>	15.83	<0.0001
Return on investment	1.46 <sup>a</sup>	0.11 <sup>d</sup>	0.95 <sup>b</sup>	0.72 <sup>c</sup>	0.05	<0.0001

*abc* Values having different superscripts in the same row are significantly different at  $p < 0.05$ , DMI= Dry matter intake, SEM=Standard error mean, Nap0<sub>Conc</sub> = Napier grass only, OG1.0<sub>Conc</sub> = Open grazing+1.0% concentrate, Nap1.5<sub>Conc</sub> = Napier grass+1.5% concentrate, Nap2.0<sub>Conc</sub> = Napier grass+2.0% concentrate, price of concentrate/kg = GHS1.2, price of Napier grass/kg DM = GHS0.9, price of water = 0.04GHS/l, Price of bull/live weight = GHS18/kg. value of gain = total weight gain\*GHS18, Net benefit = value of gain - total cost of feed and water intake, Return to investment on feed = net benefit/cost of feed and water

## **6.8 CONCLUSION AND RECOMMENDATION**

### **6.8.1 Conclusion**

Supplementation of concentrate to Napier grass basal diet significantly improved dry matter intake, water intake, average daily gain and final body weight of N'dama bull calves under intensive management system compared with the control animal with bulls on 1.5% BW concentrate supplement having the highest performance. However, when bulls on Napier grass basal only under intensive system were compared with bull calves on concentrate supplement under grazing system, the former performed better in all of the parameters measured. Furthermore, concentrate supplementation did not adversely affect the levels of blood haematological and biochemical indices of N'dama bull calves. There were also economic advantages in feeding concentrate supplement at 1.5%BW under intensive management for higher net benefit and return to investment on feed.

### **6.8.2 Recommendation**

This study recommends that small holder farmers and large-scale farmers could include concentrate at 1.5% BW in the diets of bull calves for improved growth performance. It is also recommended that further studies should be conducted to assess the effect of concentrate supplement on milk production and carcass trait of N'dama cattle. Again, further studies should be carried out using large number of animals to assess the effect of concentrate supplement on growth performance of calves fed *Brachiaria mulato* basal diet.

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## CHAPTER SEVEN

### 7.0 GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

#### 7.1 INTRODUCTION

The protagonist (crop farmers and cattle farmers) perspectives of crop farmer-herder conflict and sustainable cattle production in Ghana was investigated in two surveys and two animal experiments.

The first survey study evaluated the root causes of farmer-herder conflict and proposed possible solutions. The respondents of this study were selected using a multi-staged sampling technique. The first stage involved the purposive sampling technique that helped in the selection of six farming communities or villages in the Agogo traditional area. This decision was made based on how frequent farmer-herder conflicts that occurred in those localities (Baidoo, 2014). These areas are Mankaila, Nyamebkyere, Kowereso, Aberewapong, Bebuoso and Brahabebome. Sixty (60) crop farmers were interviewed in total, ten (10) from each of the six villages. In the case of cattle herders, the data were collected during a training workshop titled 'Basic Animal Feed Production and Preservation' under the auspices of Ghana National Association of Cattle Farmers (GNACAF) in Tamale in the year 2022. The workshop brought together cattle owners and herders involved in cattle business from Agogo (Ashanti Region), Kintampo (Bono East Region) Dambai (Oti Region) and Gusheigu (Northern Region). The stakeholders were invited in the wake up of increasing clashes between cattle herders and crop farmers in those selected regions. One hundred and forty (140) cattle herders were interviewed in total, thirty-five (35) from each of the selected region. In total, two hundred (200) respondents were interviewed in this study.

The second survey sought to assess the awareness and willingness of urban and peri-urban cattle farmers on improve forage and to cultivate pasture in some selected communities in the Ashanti Region of Ghana as a result of the influx of cattle from the conflict areas into Kumasi Metropolis. A total of 105 individuals involved in cattle value chain from four urban communities namely Aboabo, Asawasi, Sawaba, Bouban and three peri-urban communities namely Parkoso, Achiase and Abrem were selected randomly and interviewed independently. These communities were selected because smallholder cattle production is most common among the dwellers. The information was gathered by questioning various farmers at their farm gates using a pre-tested questionnaire. There were both single- and multiple-response items in the created questionnaire.

Animal experiment one evaluated the effects of concentrate supplement on dry matter and water intake, nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet. Animal experiment two evaluated effects of concentrate supplement on feed intake, growth performance and blood parameters and economic benefits of N'dama calves fed Napier grass basal diet. All the above-mentioned experiments were systematically and separately discussed and subsequent conclusions were made.

## **7.2 GENERAL DISCUSSION**

### **7.2.1 The protagonist perspectives of crop farmer-herder conflict**

Primary and secondary data were collected for this study. Primary data were collected using 200 structured interviewed. The structured questionnaires consisted of both open ended and close ended questions. By the use of the questionnaires, the selected farmers were interviewed and asked questions relating to the set objectives. Focus

Group Discussion (FCD) were conducted to validate the findings from the quantitative result. The results indicated that, out of 60 crop farmers interviewed, 37 were males representing 61.7% whilst 23 were females representing 38.3% of the respondent. In the case of the cattle herders, 110 of the respondents were male constituting 78.6% whereas 30 were females constituting 21.4% of the respondents. The results suggest that both crop and cattle farming is a male dominated activity in the study area. A cross tabulation from the results indicated that majority (43.2%) of the crop farmers chose to retaliate or revenge to any disorder when their crops or any other properties are damaged by grazing cattle or herder as compared to their female counterpart to which majority (52.2%) preferred the herders are relocated to a different environment with only 2.7% of the male cattle herders agreed to relocate to different community. None of the female cattle herder agreed to relocate to different community as they find their means of livelihood in the current location. Similarly, majority (30.0%) of the cattle herders preferred open confrontation or hit back their opponent when their cattle are harmed as compared to their colleague females of which majority (56.7%) preferred to report any damages to their cattle. However, only 26.1% of the female crop farmers agreed to report their case to authorities for compensation or any other action.

The results also indicated that majority of the crop farmers interviewed were within the age bracket of 30 – 39 years (40%) whereas 8.3% of them fell below 30 years and 5% were beyond 60 years. This suggest that youth in the study area are more into crop farming than those above 40 years. It was observed that majority of the respondent from both the crop farmers and the cattle herders aged between 21 – 39 wanted retaliation to reporting or relocation or amicable resolution. However, the respondents aged above 40 preferred other settlements apart from open confrontations.

A cross tabulation of respondents' educational level and their response to disturbance showed that majority of crop farmers (68.0%) and the cattle herders (66.6%) who had basic education preferred other method of responding to disturbances than retaliation. However, 32.0% and 33.3% of them preferred retaliation.

On the causes of the conflict, the results from the study showed that majority (83.3%) and (68.6%) of both the crop farmers and the cattle herders agreed that damage to food crops is one of the factors that causes conflict between them. Similarly, (75%) of the crop farmers and 67.9% of the cattle herders agreed that encroachment of farm land also leads to conflict while 23.4% and 27.2% of crop farmers and the cattle herders respectively disagree, 1.7% and 5.0% were undecided. It was again observed that more of the respondent from the crop farmers (85.0%) and the cattle herders (70.0) agreed that contamination of water bodies by the grazing animals also leads to reprisal. The results implies that crop farmers differed in their opinion with the cattle herders on the possibility of pasture poisoning as a cause of the conflict. Majority (68.3%) and (69.3%) of crop farmers and the cattle herders agreed that bush burning causes conflict between them.

The results showed that majority (43.3%) of the crop farmers preferred the matter to be settled by the community leaders. About 26.7% considered religious leaders as preferred authority to mediate, 13.3% and 6.7% favored crop farmers and cattle farmers association respectively, 5.0% preferred the Police Department, 3.3% and 1.7% also decided to go to the District Assembly and the law court to seek redress. The results also showed that majority (41.7%) of the crop farmers believed that farmer-herder conflict can be resolved through establishment of cattle ranch. None of

the cattle herders supported 'Operation Cowleg' as alternative solution to farmer-herder conflict.

### **7.2.2 The urban and peri-urban cattle farmers awareness of improved forages and their willingness to cultivate pasture in some selected communities in the Ashanti Region of Ghana.**

The study targeted some chosen cattle farmers in the selected districts which were purposively selected to reflect cattle producing areas in the region. Thereafter seven cattle producing communities from each district were selected by purposive sampling technique. Finally, the snowball technique was employed in the selection of cattle producers from each community.

In this survey about 99% of respondent engaged in cattle production were male and only 1% were female. This shows that cattle production unlike small ruminants (sheep and goat) in Ghana is male dominant enterprise because of the huge task involved in keeping cattle. In the cattle value chain, the females are mostly involved in milking and milk processing into various dairy products like 'Wagashe' to local consumers. The study revealed that out of the total respondent, 28.6% had no formal education and the rest (73.3%) have at least basic education (Table 4.3), with 3.8 % having tertiary education, 14.3% had secondary school education, 21.9% had Arabic and secular education, 11.4% had junior high school education and 21.9% had primary school education. Furthermore, majority of the respondents (50.5%) practices extensive system of cattle management, followed by semi-intensive system (28.6%) and the least was intensive system of management represented by 20.9%. The results suggest that, cattle production in the study area is dependent on natural pasture as feed source for the animals. Majority of the respondents interviewed (75.7%) are not aware

of improved forage (Table 4.7). According to the respondents, lack of access to extension officers and adequate training and workshops is the major factor contributing to their unawareness of improved forages and its adoption in their livestock feed. Again, from the survey results (Table 4.7), majority of the respondent (52.4%) were willing to purchase a planting material for pasture establishment at a cost beyond GHC 21. This was followed by GHC 11 – 15 (19%), GHC 16 – 20 (18.1%), GHC 6 – 10 (8.6%) and the least was GHC 1 – 5 (1.9%).

### **7.2.3 Effects of concentrate supplement on dry matter and water intake, nutrient digestibility and nitrogen balance of N'dama bull calves fed Napier grass basal diet**

Four N'dama bull calves averagely six months of age and weighing 61.63 kg were used in a 10-week (70 days) experiment of which 14 days were used for adaptation period and 56 days for data collection.

The Napier grass crude protein (CP) value recorded was 9.82% which is in agreement to the result of Ansah et al. (2010) who reported a CP level of 9.7% in the local variety after 60 days of harvesting. The CP level reported is higher than the critical CP level (7%) needed for voluntary feed intake in ruminant livestock as suggested by Nori et al. (2009). The compounded concentrate supplement diet consists of maize (30%), rice bran (50%), palm kernel cake (19.5), oyster shells (0.3%), common salt (0.1%) and vitamin premix (0.1%) and had 85% DM, 15% moisture, 14.30 % CP, 8.94% ash, 6.15% EE, 32.8% CF, 82.61% NDF, 62.37% ADF, 0.21% Ca, 1.0% P and 1813.33 Kcal/kg ME. The CP level of the concentrate supplement recorded was higher than the critical CP level (7%) needed for voluntary feed intake in ruminant livestock as suggested by Nori et al. (2009).

The results of concentrate supplement on Napier grass basal diet intake of N'dama bull calves is presented in Table 5.4. There was significant ( $P < 0.05$ ) difference in all the parameters measured except the average daily water intake ( $P > 0.05$ ). The total DM intake of the animals was 36.92 kg, 42.37 kg, 44.55 kg and 44.74 kg for Nap0<sub>Conc</sub>, Nap1.5<sub>Conc</sub>, Nap2.0<sub>Conc</sub> and Nap2.5<sub>Conc</sub> respectively as shown in Table 5.4. The lowest DM intake was observed in animals fed Napier grass only (Nap0<sub>Conc</sub>) and the highest was recorded for Napier plus 2.5% BW concentrate supplement (Nap2.5<sub>Conc</sub>).

The average daily water intake was highest in T3 (9.47 L/day) and the least recorded in T1 (7.99 L/day) but the differences were not statistically significant ( $P > 0.05$ ). It was observed that as the dry matter intake increases, water intake also increases (fig. 1). However, water intake decreased non-significantly as the level of concentrate was increased from 2.0% to 2.5%. The result suggest that concentrate supplement had influenced in the water intake of the animal in this study which agrees with the findings of Hicks et al (1998) who reported that water consumption increase with increase in dry matter intake.

There was significant difference ( $p < 0.05$ ) in dry matter digestibility between the treatments and the control animals. The least dry matter digestibility was recorded in Nap0<sub>Conc</sub> (512.8 g/kg) followed by Nap2.5<sub>Conc</sub> (611.4 g/kg), Nap1.5<sub>Conc</sub> (629.0 g/kg) and Nap2.0<sub>Conc</sub> (638.1 g/kg). The highest DM digestibility was recorded for diet Nap2.0<sub>Conc</sub> (638.1 g/kg) containing 2.0% concentrate supplement and decreased non-significantly as the level of concentrate supplementation was increased to 2.5% (Nap2.5<sub>Conc</sub>, 611.4 g/kg).

There was significant difference ( $p < 0.05$ ) in crude protein digestibility as shown in Table 5.5. The highest crude protein digestibility was recorded in Nap2.0Conc (739.7 g/kg) followed by Nap2.5Conc (733.3 g/kg) and Nap1.5Conc (723.8 g/kg) but the differences were not statistically significant ( $p > 0.05$ ). The least crude protein digestibility was recorded in Nap0Conc (564.0 g/kg). The higher crude protein digestibility values observed in the supplemented treatment groups could be attributed to the higher crude protein intake compared to the control group.

There was a significant ( $p < 0.05$ ) difference in nitrogen intake between the treatment animals and the control group. There were however no significant ( $p > 0.05$ ) differences in nitrogen intake among the treatment animals with highest numerical value recorded in Nap2.5Conc (120.32 g/day) followed by Nap2.0Conc (119.79 g/day) and Nap1.5Conc (113.94 g/day). The control animal recorded the least nitrogen intake (Nap0Conc, 38.94 g/day). Nitrogen intake and faecal nitrogen excreted increases as the level of concentrate supplementation increases. There were significant ( $p < 0.05$ ) differences in urinary nitrogen excreted among the treatment animals and the control. Animals receiving 2.5% concentrate supplement recorded the least urinary nitrogen (Nap2.5Conc, 5.98 g/day) among the treatment groups but the differences observed was not statistically significant. Similar observation was made in the total nitrogen output.

The results obtained in this experiment also revealed that both the concentrate supplemented calves and the control group had positive nitrogen balance. This suggest that the nitrogen was well absorbed and utilized by the animals for better performance.

#### **7.2.4 Effects of concentrate supplement on feed intake, growth performance and blood parameters and economic benefits of N'dama calves fed Napier grass basal diet**

Elephant grass was used in the experiment as basal diet to feed sixteen N'dama bull calves. After 60 days of regrowth, the grass was harvested and chopped into 10cm to 15cm length and fed individually to the calves. For Nap0<sub>Conc</sub>, Napier grass only was offered to the animal at 3% BW without concentrate supplementation. The composition of the concentrate was described in chapter 5. For Nap1.5<sub>Conc</sub> and Nap2.0<sub>Conc</sub>, the supplement was fed at 1.5% BW and 2.0% BW respectively each morning at 7:30 am. The animals generally consumed the entire supplement within 20 min after which a basal Napier grass diet was offered at 3% BW. There were significant differences in the final body weight (FBW) between OG1.0<sub>Conc</sub> (123.13 kg) and Nap0<sub>Conc</sub> (133.38 kg) ( $p < 0.0001$ ) but no difference in FBW between Nap1.5<sub>Conc</sub> (147.05 kg) and Nap2.0<sub>Conc</sub> (146.83 kg) (Table 6.1). Furthermore, bull calves in Nap1.5<sub>Conc</sub> had a higher final body weight at than Nap2.0<sub>Conc</sub> although differences in gain were not generally significant. The least final body weight was recorded in OG1.0<sub>Conc</sub> at 1.0% BW concentrate level. This indicate that as the concentrate level increases beyond 1.5% BW, weight gain depreciated at marginal level hence it could be that at level 1.5% BW, the quantity of concentrate supplement was able to combine with a low-quality roughage to yield the highest daily weight gain as reported by Kartcher (1980).

The concentrate treatments had a significant ( $p < 0.0001$ ) effect on LWG of the animals (Table 6.1). There were significant differences in LWG between OG1.0<sub>Conc</sub> (22.88 kg) and Nap0<sub>Conc</sub> (35.63 kg) but no difference in LWG was observed between Nap1.5<sub>Conc</sub> (48.35 kg) and Nap2.0<sub>Conc</sub> (47.28 kg) though Nap2.0<sub>Conc</sub> have lower

numerical value than Nap1.5Conc at the end of the experiment (Table 6.1). There were significant differences in ADG between OG1.0Conc (272.32 g/d) and Nap0<sub>Conc</sub> (421.11 g/day) ( $p < 0.0001$ ) but no difference in ADG between Nap1.5Conc (575.6 g/day) and Nap2.0Conc (562.8 g/day) (Table 6.1). ADG in Nap1.5Conc was superior in numerical advantage than Nap2.0Conc yet the bull calves in Nap2.0Conc received more concentrate supplement per live body weight (LBW).

The lowest DM intake was observed in animals fed Napier grass only (Nap0<sub>Conc</sub>) and the highest was recorded for Napier plus 2.0% BW concentrate supplement (Nap2.0Conc). The total daily DM intake increased ( $p < 0.0001$ ) linearly as the level of concentrate supplementation increased. In general, DM intake of Napier grass was significantly ( $p < 0.0001$ ) higher in concentrate supplemented diets Nap1.5Conc (266.4 kg) and Nap2.0Conc (263.75 kg) as compared to OG1.0Conc (239.10). There were significant differences in grass DM intake between OG1.0Conc under grazing system with supplement and Nap0<sub>Conc</sub> (258.93 kg) under intensive management without supplement (Table 6.1). The highest grass DM intake was recorded for diet containing 1.5% concentrate supplement and decreased non-significantly as the level of concentrate supplementation was increased to 2.0%. The results of the study suggest that 1.5% concentrate supplementation may be suitable for optimum fermentation of Napier grass-based diets in ruminants for optimum growth.

There were significant ( $p < 0.0001$ ) differences among the diets OG1.0Conc (15.03) and Nap0<sub>Conc</sub> (7.28) but no significant differences were observed in Nap1.5Conc (8.54) and Nap2.0Conc (9.55) for FCE (Table 6.1). The animals in Nap0<sub>Conc</sub> had 7.28 which was the best FCR followed by Nap1.5Conc, Nap2.0Conc and OG1.0Conc had the least FCR. Differences in FCR depends on the growth rate and feed intake and

both are affected by the quality of the diet. A good FCR is obtained when feed intake is low and growth rate is high as was observed in Nap0<sub>Conc</sub>, Nap1.5<sub>Conc</sub> and Nap2.0<sub>Conc</sub> signifying that animals were effective in converting the feed consumed into weight gain.

The result showed that there was significant difference ( $p < 0.0001$ ) between Nap0<sub>Conc</sub> and Nap2.0<sub>Conc</sub> but no differences was observed in OG1.0<sub>Conc</sub> and Nap1.5<sub>Conc</sub>. Average daily water intake increases with increase in concentrate supplementation. Bull calves fed basal diet plus concentrate at 2.0% BW, 1.5%BW and 1.0% BW had higher average daily water intake 9.71L, 9.22L and 9.08L respectively than Nap0<sub>Conc</sub> bull calves fed basal diet only which recorded the least water intake (8.35L) (Table 6.1).

There were significant differences ( $p < 0.05$ ) observed in WBC count among the treatment and the control groups (Table 6.2). The study showed a higher WBC value for OG1.0<sub>Conc</sub> (16.35 K $\mu$ L). The results could be as a results of tick infestation resulting from grazing pasture by the animals. Generally, concentrate supplementation had no significant effect on any of the haematological traits measured ( $p > 0.05$ ).

From table 6.3, the highest glucose level was recorded in Nap2.0<sub>Conc</sub> (77.08 mg/dl) followed by OG1.0<sub>Conc</sub> (73.18 mg/dl) whilst the least value was recorded in Nap1.5<sub>Conc</sub> (72.50 mg/dl) and Nap0<sub>Conc</sub> (64.13 mg/dl) but the difference observed was not statistically significant ( $P > 0.05$ ). There were significant differences ( $p < 0.05$ ) observed in total protein level for Nap2.0<sub>Conc</sub> and the rest (Nap0<sub>Conc</sub>, OG1.0<sub>Conc</sub> and Nap1.5<sub>Conc</sub>) (Table 6.3). It was also observed that Nap1.5<sub>Conc</sub> recorded the highest value of total protein (64.13 g/l).

There was significant difference ( $p < 0.0001$ ) in all the parameters measured. The feed cost per kg gain was significantly different ( $p < 0.01$ ) and higher in OG1.0Conc (GHS 16.23/Kg gain) and lowest at Nap0Conc diet (GHS 7.34/Kg gain). The results obtained is not surprising as OG1.0Conc animals were fed only the basal diet without concentrate supplement.

### 7.3 GENERAL CONCLUSIONS

The findings from the first survey study indicates that gender and age have a significant effect on the conflict between crop farmer and the cattle herder. This is due to the fact that crop cultivation and herding animals are largely carried out by the male and youth in the age bracket between 31 – 39 years, who are more active and hence more prepared to join in violent conflict than the elderly persons who preferred to live peacefully with their counterparts. Furthermore, educated people have better understanding to issue pertaining to conflict than those without education. However, educational attainment from this finding had no direct effect on the choices of the respondents regarding conflict. Among the factors that causes conflict between the farmer and the herder was found to be crop damages, land encroachment, pasture poisoning, killing of stray animals and cattle rustling. Furthermore, the respondents preferred community leaders and the religious leaders as mediators of the conflict between them. Only few preferred government institutions such as the Police department and the law court as dispute settlers. It can also be concluded that the respondents more especially the cattle herders preferred to secure land for pasture establishment and ranching as the solution to farmer-herder conflict than other methods specifically the ‘Operation Cowleg’ which led to loss of properties.

It was also concluded from the second survey that, in the study area, cattle production is one of main agricultural activity which plays a major role in improving the farmers' livelihood. Nonetheless, animal feed shortage and lack of fodder conservation techniques is one of leading constraint that impede productivity of this sector. Farmers in the study area have less access to grazing land for their animal as they trek with the animals to far distances to search for grazing pastures. Available feed also does not meet the requirement of the animals both in quality and quantity. Lack of supplementary feed to support the energy requirement of the animals is also a challenge in the study area. Farmers' unawareness of improved forages and inadequate training is also a challenge faced by the farmers although they are willing to cooperate in adopting the technology of improved forages and pasture establishment.

The performance of N'dama bull calves under intensive management system in the first animal experiment was significantly improved by supplementing concentrate with Napier grass basal diet when compared to the control animals. Bull calves on a 2.0% BW concentrate supplement have the best performance in terms of dry matter intake and water intake.

The concentrate supplementation had an overall effect on Napier grass intake and digestibility. Concentrate supplement had a significant effect on digestibility of DM, CP, OM, Ash, ADF, NDF and Hemicellulose among the treatment groups as compared to the control group. The highest nutrient digestibility was recorded in animals on 2.0% BW concentrate supplement.

From the results of this study, it was also concluded that concentrate supplement had a significant effect on nitrogen balance among the treatment animals and the control group. Calves on 2.0% BW concentrate supplement again recorded the highest nitrogen retention value and this could be the reason for higher performance observed in that group.

Supplementation of concentrate with Napier grass basal diet significantly in the animal experiment two improved dry matter intake, water intake, average daily gain and final body weight of N'dama bull calves under intensive management system compared with the control animal with bulls on 1.5% BW concentrate supplement having the highest performance. However, when bulls on Napier grass basal only under intensive system were compared with bull calves on concentrate supplement under grazing system, the former performed better in all of the parameters measured. Furthermore, concentrate supplementation did not adversely affect the levels of blood haematological and biochemical indices of N'dama bull calves. There were also economic advantages in feeding concentrate supplement at 1.5%BW to N'dama bull calves under intensive management for higher net benefit and return to investment on feed.

#### **7.4 RECOMMENDATIONS AND FUTURE WORK**

Sensitization of both the farmer and the herder on the need to peacefully coexist must be strengthened through education with the help of extension officers and research institution. Similarly, more training workshops on the pasture development and conservation should be organized for the cattle farmers and encouraged to participate. Cattle farmers should be encouraged to own land to establish pastures for cattle intensification in order to prevent recurring conflict. The government policy of

‘Operation Cowleg’ should be discouraged and more and sustainable method of conflict resolution should be employed. Furthermore, Farmers should be educated on the improved method of animal production particularly intensification so as to increase productivity. Intensive training on fodder production and pasture establishment should be organized periodically for cattle farmers so as to ensure all year-round feed availability.

It is again recommended that concentrate supplement should be used by the cattle farmers as a good source of feed supplement especially during the peak of the dry season to maintain live weights of bull calves for improved performance. Likewise, it is recommended that concentrate supplement should be fed at 2.0% per kilogram body weight of the animal since it gives higher dry matter digestibility.

This study recommends that small holder Farmers and large-scale Farmers could include concentrate at 1.5% BW in the diets of bull calves for improved performance. It is also recommended that further studies should be conducted to assess the effect of concentrate supplement on milk production and carcass trait of N’dama cattle. Again, further studies should be carried out using large number of animals to assess the effect of concentrate supplement on growth performance of calves fed *Brachiaria mulato* basal diet.

## APPENDICES

### APPENDIX I: QUESTIONNAIRE FOR CROP FARMERS AND FULANI HERDSMEN

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY  
COLLEGE OF AGRICULTURE AND RENEWABLE NATURAL RESOURCES  
FACULTY OF AGRICULTURE  
DEPARTMENT OF ANIMAL SCIENCE**

This research/questionnaire is in partial fulfilment for the award of a PhD degree in animal nutrition on the topic “**Cattle ranching as an alternative solution to crop farmers and cattle herders conflict in Asante-Akim North District of Ghana**”.

This is purely for academic purpose and your confidentiality is greatly assured. Please, note that this study does not constitute an investigation aimed at reprimanding or stirring your emotions as participants and/or victims of conflict. Kindly respond truthfully.

Thank you.

*Please tick where applicable.*

*Date...../2022*

#### SECTION A: BIO DATA

1. Sex: a. Male [ ] b. Female [ ]
2. Age (Years): a. 10 – 19 [ ] b. 20 – 29 [ ] c. 30– 39 [ ] d. 40– 49 [ ]  
e. 50 – 59 [ ] f. 60+ [ ]
3. Marital Status: a. Single [ ] b. Married [ ] c. Divorced [ ] d. Separated [ ]  
f. Widowed [ ]
4. Family Size: a. 1-5 [ ] b. 6-10 [ ] c. 11-15 [ ] d. 16+ [ ]
5. Level of Education: a. Basic [ ] b. Secondary [ ] c. Tertiary [ ] d. Arabic  
e. Non-formal [ ] f. None [ ]
6. Ethnic group: a. Hausa [ ] b. Fulani [ ] c. Akan [ ] d. Ewe [ ]  
e. Others [specify].....
7. Citizenship: a. Ghanaian [ ] b. Non-Ghanaian
8. Years of Residence: a. 1– 5 [ ] b. 6 – 10 [ ] c. 11 – 15 [ ] d. 16+ [ ]
9. Town/Village: .....
10. Occupation: a. Crop Farming [ ] b. Cattle herder [ ] c. Cattle owner and  
herder [ ] d. Others [specify] .....
11. Herd size: a. 1 – 50 [ ] b. 51 - 100 [ ] c. 101 – 150 [ ] d. 151 – 200 [ ]  
e. 200+ [ ]
12. Farm size (acres): a. 1-15 [ ] b.16-30 [ ] c. 31-45 [ ] d.46-60 [ ] e. 61+ [ ]
13. How did you acquire the land? a. Bequeath to me [ ] b. Bought it [ ]  
c. Long term leasehold [ ] d. Hired it [ ]  
e. Other [specify].....

## SECTION B: CAUSES OF FARMER-HERDER CONFLICTS

Kindly choose either 1, 2, 3, 4 or 5 from the followings which best indicate your opinion regarding the causes of the conflict. Please remember to tick only once for each of the listed items.

1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, 5 = strongly Agree

The followings are the likely causes of the conflict in your area?

S/N	Causes	1	2	3	4	5
14.	Damage of food crops by cattle					
15.	Encroachment of farmland/grazing lands					
16.	Contamination of water bodies by cattle					
17.	Poisoning of pasture by the farmer					
18.	Killing of stray animals					
19.	Cattle rustling					
20.	Indiscriminate bush burning					
21.	Sexual harassment of women					
22.	Drug abuse					
23.	Activities of under-aged herders					
24.	Others [specify]					

## SECTION C: INSTITUTIONS INVOLVED IN MANAGING FARMER-HERDER CONFLICTS

25. Which of the following institutions are involved in managing the conflicts in your community? You can tick multiple answer. a. Traditional rulers [  ] b. Police [  ] c. Law court [  ] d. Cattle Farmers Association [  ] e. Crop Farmers Association [  ] f. District Assembly [  ]

Kindly choose either 1, 2, 3, 4 or 5 from the followings which best indicate your opinion regarding the institutions involved in managing the conflict. Please remember to tick only once for each of the listed items.

1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, 5 = strongly Agree

The following institutions are efficient in their role of managing the conflict in your area?

S/N	Institution	1	2	3	4	5
26.	Traditional rulers					
27.	Police Department					
28.	Law court					
29.	Cattle Farmers Association					
30.	Crop Farmers Association					
31.	Opinion leaders (Imam/Pastors)					
32.	District Assembly					

33. How was the conflict between the farmer and the herder resolved?  
a. Payment of compensation [  ] b. Verbal warning [  ] c. Amicable resolution [  ]  
d. Relocation [  ] e. Others [specify].....

34. Was the settlement satisfactory? a. Yes [  ] b. No [  ]

35. If no, why? a. There was no justice [ ] b. Payment was inadequate [ ] c. Payment was beyond damage [ ] d. Others [specify].....

**SECTION D: EFFECTS OF FARMER-HERDER CONFLICTS**

36. Does the conflict have a negative effect on the economic growth of the area? a. Yes [ ] b. No [ ]
37. How many cattle have you lost in the event of the conflict? a. 10 – 29 [ ] b. 30 – 59 [ ] c. 60 – 99 [ ] d. 100+ [ ]
38. What is the degree of the damage to your farm in the event of the conflict? a. Severe [ ] b. Very severe c. No damage d. Others [specify].....
39. Were there any loss of properties in the conflict? a. Yes [ ] b. No [ ]
40. What property were mostly lost in the conflict? a. Burning of houses [ ] b. Stealing of cattle [ ] c. Killing of cattle [ ] d. Burning of farms [ ] e. Others [specify].....
41. Were there any injuries in the conflict? a. Yes [ ] b. No [ ]
42. If yes, what was the degree of the injury? a. Severe [ ] b. Very severe [ ] c. Mild [ ] d. others [specify]
43. Were there any loss of life in the conflict? a. Yes [ ] b. No [ ]
44. How many lives were lost per your estimation in the conflict for the past 10 years?

Casualty	Farmer	Herder
Number of death		
Number of injuries		

45. Who suffered the most when there is conflict? a. Children [ ] b. Women [ ] c. Old age [ ] d. Others [specify].....

**SECTION E: SOLUTIONS TO FARMER-HERDER CONFLICTS**

46. Do your animals have enough fodder to graze on? a. Yes [ ] b. No [ ]
47. State reason for your answer to question 46
48. What is the status of the grazing area? a. Increasing [ ] b. Decreasing [ ] c. No change [ ] d. No Idea [ ]
49. What is the status of the graze fodder in terms of quality? a. High [ ] b. moderate [ ] c. Low [ ] d. No idea [ ]
50. During the last dry season, did you moved your herd to another location? a. Yes [ ] b. No [ ]
51. State reason for your answer to question 50  
.....
52. Was the herd moved with one or more household members? a. Yes [ ] b. No [ ]
53. If yes, which member of the household were moved? a. Wives [ ] b. Children [ ] c. Siblings [ ] d. Others [specify].....
54. For how long did you stay in the different locality? a. Weeks [ ] b. Month [ ] c. Year [ ] d. Others [specify]

Kindly choose either 1, 2, 3, 4 or 5 from the followings which best indicate your opinion regarding the possible solution to the conflict. Please remember to tick only once for each of the listed items.

1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, 5 = strongly Agree

S/N	Solution	1	2	3	4	5
55.	Operation cow leg					
56.	Establishment of cattle ranch					
57.	Relocation of herders/farmers					
58.	Secure grazing land for herders					
59.	Lease of lands to herders					

60. There will be advantage prioritizing cattle ranching over open grazing in cattle production.

a. Strongly Agree [ ] b. Agree [ ] c. Disagree [ ] d. Strongly disagree [ ]  
e. Undecided [ ]

61. Are you aware of government established cattle ranch at Wawase in the Afram plains and other places? a. Yes [ ] b. No [ ]

62. What do you know about the ranch?

63. Are you willing to send your herd to any government established ranch? a. Yes [ ] b. No [ ]

64. What is the reason for your choice of answer? a. Very secured [ ]  
b. Availability of feed [ ] c. Lack of feed [ ] d. Availability of technical personnel [ ]  
e. Others [specify].....

65. Are you willing to acquire your own land and establish a pasture for your animals? a. Yes [ ] b. No [ ]

66. State reason for your answer to question 65

.....

Thank You



**APPENDIX II: QUESTIONNAIRE FOR CROP FARMERS AND FULANI  
HERDSMEN**

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY  
COLLEGE OF AGRICULTURE AND RENEWABLE NATURAL RESOURCES  
FACULTY OF AGRICULTURE  
DEPARTMENT OF ANIMAL SCIENCE**

**THIS IS PURELY FOR ACADEMIC PURPOSE AND YOUR  
CONFIDENTIALITY IS GREATLY ASSURED.**

***PLEASE RESPOND WHERE APPLICABLE. Date...../2021***

**PART I: INFORMATION ABOUT THE RESPONDENTS**

1. Gender
  - a. Male ( )
  - b. Female ( )
2. What is your age?
  - a. 15-24 ( )
  - b. 25-34 ( )
  - c. 35-44 ( )
  - d. 45-54 ( )
  - e. 55+ ( )
3. What is your religious inclination?
  - a. Islamic ( )
  - b. Christianity ( )
  - c. Traditionalist ( )
4. What is your marital status?
  - a. Married ( )
  - b. Single ( )
  - c. Widowed ( )
  - d. Divorced ( )
5. What is your educational status?
  - a. No formal education ( )
  - b. Arabic ( )
  - c. Basic ( )
  - d. Secondary ( )
  - e. tertiary ( )
6. What is your ethnicity?
  - a. Fulani ( )
  - b. Hausa ( )
  - c. Zarma ( )
  - d. Akan ( )
  - e. Others (specify)
7. What is your hometown and region? .....
8. Where do you currently live? .....
9. What is your household size?
  - a. 1-5 [ ]
  - b. 6-10 [ ]
  - c. 11-15 [ ]
  - d. 16+ [ ]
10. Other than yourself, how many persons on your household are in these age groups?
  - a. 1-5 [ ]
  - b. 6-10 [ ]
  - c. 11-15 [ ]
  - d. 16+ [ ]

**PART II: INFORMATION ABOUT THE RESPONDENTS FARM OPERATION**

11. What is your primary occupation?.....
12. What category of stakeholder are you in the industry? You can tick more than one option.
  - a. Cattle owner
  - b. Herdsman
  - c. Butcher
  - d. Middleman
  - e. Milk processor
13. How many years have you been operating?
  - a. 1-5 [ ]
  - b. 6-10 [ ]
  - c. 11-15 [ ]
  - d. 16-20 [ ]
  - e. 21-25 [ ]
  - f. 26+ [ ]
14. Did you received any training on cattle production?
  - a. Yes
  - b. No
15. If yes, from who?
  - a. Family member
  - b. Friend
  - c. Local Fulani
  - d. Nomad
  - e. Other (specify)
16. How did you acquired your herd?
  - a. Inheritance
  - b. Self-acquisition
  - c. Gift
  - d. Other (specify)

17. Do you plan to pass on your herd?
  - a. Yes [ ]
  - b. No [ ]
18. Do you live on or close to your farm?
  - a. Yes [ ]
  - b. No [ ]
19. What type of farming system do you practice?
  - a. Small scale
  - b. Middle scale
  - c. Large scale
20. What method of identification do you use on your farm?
  - a. Branding
  - b. Tagging
  - c. Tattooing
  - d. Not necessary
  - e. Others (specify)
21. What is the size of your herd?
  - a. 1-10 [ ]
  - b. 11-20 [ ]
  - c. 21-30 [ ]
  - d. 31-40 [ ]
  - e. 41-50 [ ]
  - f. 51+ [ ]
22. Do you keep record in your farm?
  - a. Yes
  - b. No
23. If yes, what type of record do you keep?
  - a. Financial record
  - b. Production record
  - c. Feed record
  - d. Others (specify)
24. Do you keep birth record on your farm?
  - a. Yes
  - b. No
25. Do you keep death record on your farm?
  - a. Yes
  - b. No
26. How many cattle have you sold over the past two years?
  - a. 1-5 [ ]
  - b. 6 - 10 [ ]
  - c. 11-15 [ ]
  - d. 16+ [ ]
27. What was the approximate weight of the animals sold?
  - a. 100 – 150 kg
  - b. 160 – 200 kg
  - c. 210 – 250 kg
  - d. 260+ kg
  - e. No idea
28. What breed of cattle do you keep?
  - a. Gudali
  - b. WASH
  - c. White Fulani
  - d. Sanga
  - e. Others [ specify ]
29. How much did you sell your animal based on the animal body weight?
  - a. GHS 1000 – 1500 [ ]
  - b. GHS 1600 – 2000 [ ]
  - c. GHS 2100 -3000 [ ]
  - d. GHS 3100+
30. Who are your target customers? You can tick more than one option
  - a. Cattle owner
  - b. Herdsman
  - c. Butcher
  - d. Middleman
31. What time of the year do you sell your cattle?
  - a. Ramdan season
  - b. Eidul Adha
  - c. Christmas season
  - d. Others (specify)
32. How many cattle have you slaughtered for home consumption over the past two years?
  - a. 1 - 3 [ ]
  - b. 4 - 6 [ ]
  - c. 7 - 10 [ ]
  - d. Others [ specify ]
33. What are your reason for question 24 above?
  - a. Naming ceremony
  - b. Funeral
  - c. Festive season
  - d. Family reunion
  - e. Others (specify)
34. Which category best describe your total annual income from sales of animals or other related animal product?
  - a. GHS 1000-2000 [ ]
  - b. GHS 2100-3000 [ ]
  - c. GHS 3100+ [ ]
35. Do you keep cows on your farm?
  - a. Yes [ ]
  - b. No [ ]
36. How many milking cows do you have on your farm?
  - a. 1-10 [ ]
  - b. 11-20 [ ]
  - c. 21-30 [ ]
  - d. 31-40 [ ]
  - e. 41-50 [ ]
  - f. 51+ [ ]
37. What time do you milk your cow?
  - a. Early morning
  - b. Late afternoon
  - c. evening
38. How many litters of milk do you get per day?
  - a. 1-10 [ ]
  - b. 11-20 [ ]
  - c. 21-30 [ ]
  - d. 31-40 [ ]
  - e. 41-50 [ ]
  - f. 51+ [ ]
39. How many litters of milk do you reserve for house consumption per day?
  - a. 5 L
  - b. 7 L
  - c. 10 L
  - d. 10+ L
  - e. None

40. How many litters of milk do you sell per day?  
 a. 1-10 [ ] b. 11-20 [ ] c. 21-30 [ ] d. 31-40 [ ] e. 41-50 [ ] f. 51+ [ ]
41. Who are your target customers?  
 a. Market women b. Processors c. Household d. Middleman
42. How much do you sell a litter of milk?  
 a. GHS 5 b. GHS 7 c. GHS 8 d. GHS 10+
43. Do you process your milk?  
 a. Yes b. No
44. If yes, what product do you get from milk processing?  
 a. Cheese (wagashe) b. Whey c. Butter d. Yoghurt e. Other (specify)
45. Who does the processing?  
 a. Women b. Female Child

**PART III: RESPONDENTS KNOWLEDGE ABOUT ANIMAL FEED AND FEEDSTUFF**

46. List most commonly used feedstuff for your cattle in order of importance and availability
- a. \_\_\_\_\_  
 b. \_\_\_\_\_  
 c. \_\_\_\_\_  
 d. \_\_\_\_\_
47. How do you feed your animals?  
 a. Zero grazing b. Open grazing d. Tethering in a grazing land  
 d. Other (specify)
48. If zero grazing, what type of feed material do you use?  
 a. Grass b. Concentrate c. Agro-by products d. Kitchen waste  
 e. All the above
49. Where do you get your feed material?  
 a. Cattle market b. Along the road c. Feed processors d. Open market  
 e. Others (specify)
50. How do you transport your feed material? Use of;  
 a. Tricycle b. Motorbike c. Kia truck d. Taxi e. Others (specify)
51. How much does it cost you transporting feed material from the source of collection?  
 a. GHS 10 b. GHS 15 c. GHS 20 d. GHS 20+
52. Do you encounter any feed shortages?  
 a. Yes b. No
53. If yes, what causes feed shortage?  
 a. High demand b. Increased animal population c. Others (specify)
54. If you graze your animals, what time do you graze your animals?  
 a. Early morning b. Afternoon c. Evening
55. What is the status of the grazing land used?  
 a. Decreasing b. Increasing c. No change
56. Do your animals have enough fodder to graze on?  
 a. Yes b. No
57. What is the status of the graze fodder in terms of quality?  
 a. High b. moderate c. Low d. No idea
58. What measures do you take to alleviate feed shortage?

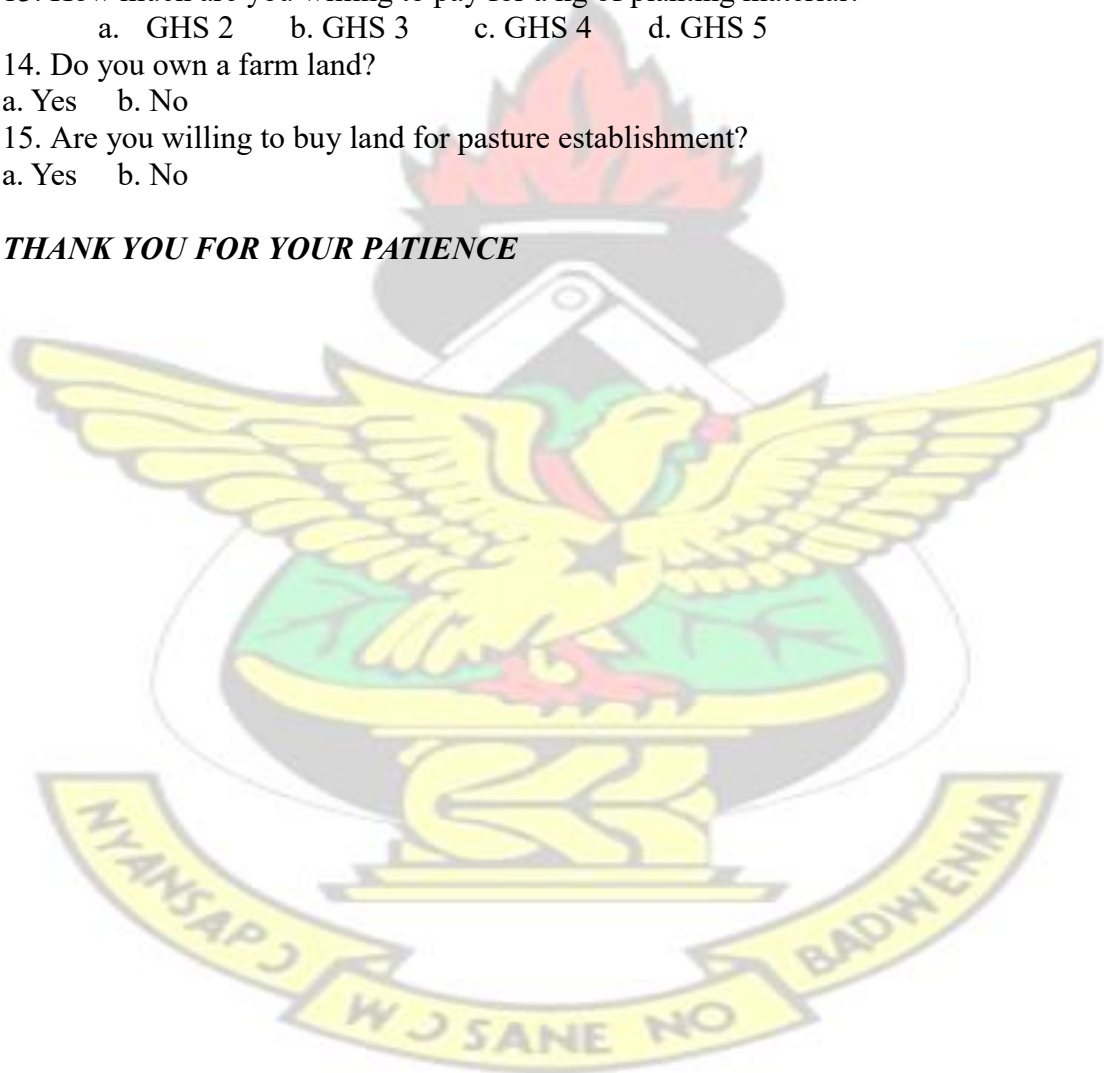
- a. Purchase concentrates      b. Purchase forage      c. Use crop residues
  - d. Preserve any feed during high production season      e. others (specify)
59. In what time of the season do you have enough fodder for your animals?
- a. Wet season      b. Dry season
60. State reason for your answer to question 48
- .....
- .....
- .....
61. During the last dry season, did you moved your herd to another location to look for grazing pasture and/or water?
- a. Yes      b. No
62. What was the reason for moving the herd to another location during the last dry season? a. To look for grazing and water      b. To look for grazing only      c. To look for water only
63. Was the herd moved with one or more household members?
- a. Yes      b. No
64. If yes, which member of the household were moved?
- a. Wives      b. Children      c. Siblings      d. Others (specify)
65. For how long did you stay in the different locality?
- a. Weeks (      )      b. Month (      )      c. Year (      )      d. Others (specify)
66. How many miles did you move with your animals
- a. 10 – 20 miles      b. 21 – 30 miles      c. 31 – 40 miles      d. 41 – 50 miles      d. 51+ miles
67. Do you give supplement/concentrate to your animals after grazing?
- a. Yes      b. No
68. State reason for your answer to question 50
- .....
- .....
- .....
69. What type of feed supplement do you feed your animal with?
- a. Rice bran      b. Cassava peel      c. Others (specify)
70. What is the source of water for your animal?
- a. Stream      b. river      c. well      d. Others (specify)

**PART IV: RESPONDENTS KNOWLEDGE ABOUT IMPROVED FORAGE AND PASTURE CROPS**

1. Are you aware of improved fodder?
    - a. Yes      b. No
  2. Do you have improved forages for your animal feeding?
    - a. Yes      b. No
  3. If yes, is it planted by you or naturally grown?
    - a. Planted by me      b. Existing naturally
  4. If you do not plant improved pasture, what is the reason?
    - a. Shortage of land      b. Unavailability of planting material      c. I am not aware about it
  5. Have you ever attended any training on fodder and pasture establishment?
    - a. Yes      b. No
  6. If yes, state the name of the organizers and duration of the training
- .....
- .....

7. Do you purchase grass for your animals?
  - a. Yes
  - b. No
8. If yes, what time of the season
  - a. Dry season
  - b. wet season
9. What is the quality of the purchased grass?
  - a. High
  - b. Low
  - c. Moderate
  - d. No idea
10. How much does it cost you to purchase a Kg of grass?
  - a. GHS 0.5
  - b. GHS 1
  - c. GHS 1.5
  - d. GHS 2+
11. How many Kg of grass do you buy per day?
  - a. 20 – 30 kg
  - b. 31 – 50 kg
  - c. 51+ kg
  - d. Others (specify)
12. Are you willing to establish a pasture for your animals if planting material is made available to you?
  - a. Yes
  - b. No
13. How much are you willing to pay for a kg of planting material?
  - a. GHS 2
  - b. GHS 3
  - c. GHS 4
  - d. GHS 5
14. Do you own a farm land?
  - a. Yes
  - b. No
15. Are you willing to buy land for pasture establishment?
  - a. Yes
  - b. No

***THANK YOU FOR YOUR PATIENCE***



### APPENDIX III: DIGESTIBILITY TRIAL AND GROWTH TRIAL

Variate: Grass dry matter intake

Source	DF	Type III SS	Mean Square	F Value	Pr > F
animal	3	0.3986000	0.1328667	0.25	0.8554
Period	3	734.0066000	244.6688667	469.25	<.0001
Trt	3	3.2032500	1.0677500	2.05	0.2088

Variate: Concentrate dry matter intake

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	1.17	0.3961
Period	3	6	5.11	0.0433
Trt	3	6	31.52	0.0005

Variate: Total dry matter intake

Source	DF	Type III SS	Mean Square	F Value	Pr > F
animal	3	3.5573188	1.1857729	0.77	0.5502
Period	3	984.5327668	328.1775889	213.83	<.0001
Trt	3	159.5855642	53.1951881	34.66	0.0003

Variate: Total water intake

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	1.73	0.2593
Period	3	6	14.75	0.0036
Trt	3	6	2.25	0.1831

Variate: Average water intake

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	1.73	0.2592
Period	3	6	14.75	0.0036
Trt	3	6	2.25	0.1833

Variate: Dry matter digestibility

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	2.18	0.1914
Period	3	6	11.59	0.0066
Trt	3	6	31.10	0.0005

Variate: Crude protein digestibility

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	0.84	0.5201
Period	3	6	9.73	0.0101
Trt	3	6	206.51	<.0001

Variate: Organic matter digestibility

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	1.14	0.4044
Period	3	6	1.41	0.3297
Trt	3	6	119.61	<.0001

Variate: Ash digestibility

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	1.41	0.3285
Period	3	6	5.33	0.0396
Trt	3	6	37.59	0.0003

Variate: NDF digestibility

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	0.88	0.5037
Period	3	6	3.18	0.1061
Trt	3	6	31.25	0.0005

Variate: ADF digestibility

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	1.74	0.2577
Period	3	6	8.83	0.0128
Trt	3	6	7.87	0.0167

Variate: Total nitrogen intake

	Num DF	Den DF	F Value	Pr > F
animal	3	6	0.98	0.4626
Period	3	6	22.95	0.0011
Trt	3	6	81.35	<.0001

Variate: Urinary nitrogen

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	5.55	0.0363
Period	3	6	5.74	0.0338
Trt	3	6	54.98	<.0001

Variate: Faecal nitrogen

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	0.64	0.6165
Period	3	6	8.01	0.0161
Trt	3	6	30.96	0.0005

Variate: Total nitrogen output

Effect	Num DF	Den DF	F Value	Pr > F
animal	3	6	0.79	0.5421
Period	3	6	9.06	0.0120
Trt	3	6	40.74	0.0002

Variate: Nitrogen retention

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	98.7000	1.3206	12	74.74	<.0001
N+2.0%co	99.5500	1.3206	12	75.38	<.0001
NapierOn	97.7500	1.3206	12	74.02	<.0001
OG+1.0%c	100.25	1.3206	12	75.91	<.0001

Variate: Initial body weight

<b>Effect</b>	<b>Num DF</b>	<b>Den DF</b>	<b>F Value</b>	<b>Pr &gt; F</b>
<b>animal</b>	3	6	1.22	0.3818
<b>Period</b>	3	6	31.94	0.0004
<b>Trt</b>	3	6	104.30	<.0001

Variate: Final body weight

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	147.05	1.0646	12	138.12	<.0001
N+2.0%co	146.83	1.0646	12	137.91	<.0001
NapierOn	137.20	1.0646	12	128.87	<.0001
OG+1.0%c	123.13	1.0646	12	115.65	<.0001

Variate: Live weight gain

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	48.3500	0.8455	12	57.18	<.0001
N+2.0%co	47.2750	0.8455	12	55.91	<.0001
NapierOn	39.4500	0.8455	12	46.66	<.0001
OG+1.0%c	22.8750	0.8455	12	27.05	<.0001

Variate: Average daily gain

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	575.60	10.0659	12	57.18	<.0001
N+2.0%co	562.80	10.0659	12	55.91	<.0001
NapierOn	469.64	10.0659	12	46.66	<.0001
OG+1.0%c	272.32	10.0659	12	27.05	<.0001

Variate: Total grass dry matter intake

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	266.40	2.4354	12	109.39	<.0001
N+2.0%co	263.75	2.4354	12	108.30	<.0001
NapierOn	242.38	2.4354	12	99.52	<.0001
OG+1.0%c	239.10	2.4354	12	98.18	<.0001

Variate: Average grass dry matter intake per day

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	3.1725	0.02905	12	109.22	<.0001
N+2.0%co	3.1425	0.02905	12	108.19	<.0001
NapierOn	2.8825	0.02905	12	99.23	<.0001
OG+1.0%c	2.8475	0.02905	12	98.03	<.0001

Variate: Total dry matter intake

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	412.00	2.4354	12	169.17	<.0001
N+2.0%co	451.35	2.4354	12	185.33	<.0001
NapierOn	242.38	2.4354	12	99.52	<.0001
OG+1.0%c	342.70	2.4354	12	140.72	<.0001

Variate: Average water intake

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	9.2150	0.08253	12	111.65	<.0001
N+2.0%co	9.7075	0.08253	12	117.62	<.0001
NapierOn	8.3450	0.08253	12	101.11	<.0001
OG+1.0%c	9.0750	0.08253	12	109.95	<.0001

Variate: FCR

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	8.5400	0.2944	12	29.01	<.0001
N+2.0%co	9.5500	0.2944	12	32.44	<.0001
NapierOn	6.1550	0.2944	12	20.91	<.0001
OG+1.0%c	15.0300	0.2944	12	51.06	<.0001

Variate: WBC

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	13.3000	0.9292	12	14.31	<.0001
N+20%con	11.7500	0.9292	12	12.65	<.0001
NO	16.3500	0.9292	12	17.60	<.0001
OG	12.8000	0.9292	12	13.78	<.0001

Variate: RBC

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	6.9175	0.7473	12	9.26	<.0001
N+20%con	7.7250	0.7473	12	10.34	<.0001
NO	9.0400	0.7473	12	12.10	<.0001
OG	9.2300	0.7473	12	12.35	<.0001

Variate: HGB

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	11.7750	0.9543	12	12.34	<.0001
N+20%con	10.3500	0.9543	12	10.85	<.0001
NO	12.6500	0.9543	12	13.26	<.0001
OG	13.3750	0.9543	12	14.02	<.0001

Variate: HCT

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	39.2500	3.4924	12	11.24	<.0001
N+20%con	36.2500	3.4924	12	10.38	<.0001
NO	37.6750	3.4924	12	10.79	<.0001
OG	38.1250	3.4924	12	10.92	<.0001

Variate: MCH

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	12.6750	0.4644	12	27.29	<.0001
N+20%con	13.0500	0.4644	12	28.10	<.0001
NO	13.1250	0.4644	12	28.26	<.0001
OG	13.2250	0.4644	12	28.48	<.0001

Variate: MCHC

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	31.8500	0.6333	12	50.29	<.0001
N+20%con	31.6750	0.6333	12	50.01	<.0001
NO	31.7250	0.6333	12	50.09	<.0001
OG	30.6250	0.6333	12	48.36	<.0001

Variate: MXD

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	76.1750	2.1158	12	36.00	<.0001
N+20%con	72.7750	2.1158	12	34.40	<.0001
NO	66.8000	2.1158	12	31.57	<.0001
OG	67.0000	2.1158	12	31.67	<.0001

Variate: LYM

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	76.1750	2.1158	12	36.00	<.0001
N+20%con	72.7750	2.1158	12	34.40	<.0001
NO	66.8000	2.1158	12	31.57	<.0001
OG	67.0000	2.1158	12	31.67	<.0001

Variate: NEUT

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	28.0500	1.2511	12	22.42	<.0001
N+20%con	30.2250	1.2511	12	24.16	<.0001
NO	31.1250	1.2511	12	24.88	<.0001
OG	28.8750	1.2511	12	23.08	<.0001

Variate: Total protein

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	64.1250	1.0319	12	62.14	<.0001
N+20%con	58.5750	1.0319	12	56.76	<.0001
NO	61.6500	1.0319	12	59.74	<.0001
OG	61.0250	1.0319	12	59.14	<.0001

Variate: Blood glucose

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+15%con	72.5000	3.2609	12	22.23	<.0001
N+20%con	77.0750	3.2609	12	23.64	<.0001
NO	64.1250	3.2609	12	19.66	<.0001
OG	73.1750	3.2609	12	22.44	<.0001

Variate: Total cost of feed

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	414.48	1.2840	12	322.80	<.0001
N+2.0%co	462.50	1.2840	12	360.20	<.0001
NapierOn	233.03	1.2840	12	181.49	<.0001
OG+1.0%c	339.51	1.2840	12	264.42	<.0001

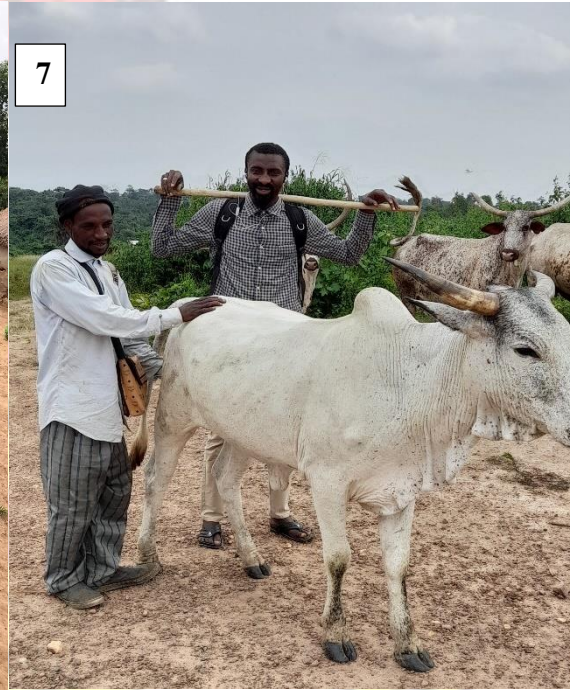
Variate: cost of feed per gain

<b>Treatment Least Squares Means</b>					
<b>Treatment</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>DF</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
N+1.5%co	9.2309	0.3112	12	29.66	<.0001
N+2.0%co	10.4742	0.3112	12	33.65	<.0001
NapierOn	7.3425	0.3112	12	23.59	<.0001
OG+1.0%c	16.2280	0.3112	12	52.14	<.0001

**APPENDIX IV: Pictures taken during the course of the work**



1. Stray animals spotted grazing at Kumasi International Airport
2. Fulani girl child selling soft cheese 'Wagashi'



3. Author with a young Fulani herder
4. Thatched roof homestead of Fulani herder
5. Author with Fulani herder in his homestead
6. Author with Fulani herder on the field



7. Cattle shot dead during ‘Operation Cowleg’ (Citi Fm, 2019).

8. Police engagement with stakeholders in cattle and crop farming (Zuria Fm, 2022)



9. Group picture with the Fulani herders and other stakeholders in cattle business

10. Demonstrating fodder conservation processes to the herders

## APPENDIX V: Pictures during animal trial



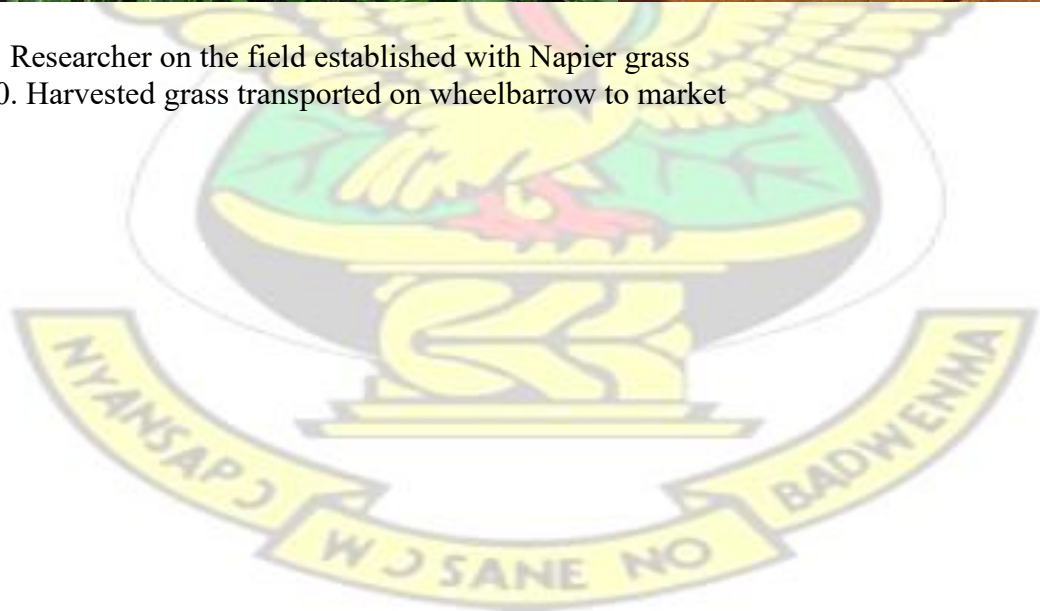
1. Planting material (Napier grass stems) been carried to the field
2. Peri-urban cattle farmer feeding his animals
3. Author working in the laboratory
4. Taking weight of grass at Kumasi abattoir before buying



5. Napier grass on the field
6. Taking weight of Napier grass before feeding
7. Chopping off the grass to smaller length before feeding
8. Feeding animal individually in the pen



9. Researcher on the field established with Napier grass  
10. Harvested grass transported on wheelbarrow to market



**APPENDIX VI: ASOKORE MAMPONG MUNICIPAL ASSEMBLY  
(CONTROL OF SWINE, CATTLE, SHEEP, GOATS AND PIGS) BYE-LAW  
2017**

In exercise of the powers conferred on the Asokore Municipal Assembly by section 181 of the Local Governance Act, 2016 (Act 936) this Bye-law is hereby made.

**1. Swine, Cattle, Sheep, Goats to be kept by Permit**

No person shall keep any swine, cattle sheep or goats within the area of authority of AMMA without permit issued by an authorized officer of AMMA for that purpose upon payment of a fee. The fee shall be determined in accordance with the Fee Fixing Resolution of AMMA.

2. notwithstanding paragraph (1) above, a person may keep animals domestic, religious or customary purpose upon the condition that the animals

(a) Are kept in a pen which is well maintained and always kept clean,

(b) Do not constitute any nuisance by stench or noise to neighbours,

(c) Are attended to by veterinary officer or assistants and that owners are to ensure that sanitary rules specified are maintained.

3. The number of goats and sheep to be kept in any dwelling house shall not exceed Fifteen (15).

Subject to paragraph (2) above, no person shall keep swine and cattle in any premises except at designated places, upon application and approval may by AMMA.

**4. Inspection of Premises**

(a) An officer, servant or agent appointed by AMMA may enter any premises from 6 am to 6 pm and inspect any premises where swine, cattle, sheep or goats are kept.

(b) Any animals found in excess of the permitted number may be impounded by the authorized officer, servant or agent appointed under paragraph 4 (a) above.

**5. Detention of Animals**

(a) Any officer, servant or agent of AMMA appointed under paragraph 4(a) may impound any swine, sheep, cattle or goats found in a public place without any person being in charge of it.

(b) Notwithstanding the provisions of paragraph 5(a) above, any person shall arrest any animal(s) found destroying his/her property. The animals so arrested shall be brought to the AMMA and handed over to the Environmental Health Officer or any Officer designated for safe keeping in the AMMA pond.

**6. Auction Sale**

(a) Animals detained for more than ten (10) days will be auctioned to the public.

(b) Notice of Action shall be posted conspicuously after five days of arrest at place(s) within the community in which the animal(s) were arrested and copy the Police.

(c) GSMA will not be liable for any swine, cattle, sheep or goat that may die after it has been impounded

(d) Any owner of any impounded swine, goat or sheep may retrieve it on conditions as may be determined by AMMA.

## Tano South Municipal Assembly notice for auctioning stray animals

  **TANO SOUTH MUNICIPAL ASSEMBLY**  
Office of the Municipal Administration  
Tano South Municipal Assembly  
Post Office Box 32  
Bechem, Ahafo Region  
Tel: 0208206795/0243205248

Our Ref: TSMA/MEHO/ DATE: 8<sup>TH</sup> SEPTEMBER, 2022

# NOTICE

### AUCTION SALE

It is announced to the general public that the Tano South Municipal Assembly currently has in its pound stray animals **[as specified below]** which are due for auction pursuant to Section 300 Sub-Section 4 of Act 29/60.

Animal	Quantity
Goat	27
Sheep	1
<b>TOTAL</b>	<b>28</b>

The auction sale is scheduled as follows:

**Date:** Thursday, 15<sup>th</sup> September, 2022  
**Time:** 9.00am  
**Venue:** Tano South Municipal Administration Office, Bechem

All are cordially invited.

FOR: MUNICIPAL CHIEF EXECUTIVE  
(AUGUSTINE PEPAH)  
MUNICIPAL COORDINATING DIRECTOR

CC: ALL NOTICE BOARDS, BECHEM  
THE DISTRICT MAGISTRATE  
BECHEM DISTRICT MAGISTRATE COURT, BECHEM  
THE POLICE COMMANDER  
GHANA POLICE SERVICE, BECHEM

Tel: +233 (0) 208206795  
+ 233 (0) 243205248  
Email: tsdoba13@gmail.com  
Website: www.tanosouthdistrict.blogspot.com  
GPS: 83-0073-s736

*READ ME*

## **Appendix VII: ECOWAS Transhumance Protocol (1998) (Decision A/DEC.5/10/98)**

Definition of “transhumance between States”: the seasonal movement between Member States of herds leaving their usual grazing areas in search of water and pasture”. Right to free passage of animals:

Right to free passage of all animals (of the bovine, caprine, cameline, equine and asinine species) across the borders of all Member States. (Article 3)

Introduction of the ECOWAS International Transhumance Certificate: Conditioning of free passage on presentation of the newly introduced ECOWAS International Transhumance Certificate for each herd, providing information on the composition of the herd, the vaccinations given, the itinerary of the herds, the border posts to be crossed, and the final destination. The International Transhumance Certificate is issued by the livestock department and initiated by the local administrative authorities in the country of origin. The International Transhumance Certificate shall enable authorities to monitor the herds before they leave the country of origin, to protect the health of local herds, and to make it possible to inform the host communities of the arrival of transhumant animals. (Article 5) The International Transhumance

Certificate shall be verified and counter-signed by the competent authorities at the entry and exit points in the host country. (Article 6)

Pre-defined itineraries: Transhumant herds have to follow the routes defined by Member States in accordance with the itinerary indicated on the ECOWAS International Transhumance Certificate, enter and leave each country at official border crossings, and may not pass the border at night. (Articles 5, 7, 8)

Supervision of animals: Transhumant livestock has to be under constant guard, both while on the move and during grazing. (Article 10). There must be a minimum of one herdsman for every fifty heads of cattle, while all transhumant herds must be accompanied by a minimum of two herdsmen. (Article 11) Herdsmen must be at least 18 years old and be in possession of identity papers duly issued by the competent authorities in their countries of origin. They must also be able to show proof of the identity and permanent residence of the owner (s) of the herd. (Article 12) The relevant authorities have the right to impound stray animals and apply sanctions against their owner or herdsmen. (Article 13)

Movement within the host country: Each host country fixes the period during which migrating livestock may enter into and depart from its territory, and informs the other States accordingly. (Article 14) Each State defines the areas where transhumant animal may be stocked and determines the maximum capacity of each zone thus identified. The accompanying herdsman must keep his herd in that zone where he has been directed to by officials at the point of entry. (Article 15)

Conflict resolution mechanisms: Herdsmen accompanying transhumant livestock and who are legally admitted into the host country are given protection by the authorities and their fundamental rights are guaranteed by the judicial institutions of the host country. In return, these herdsmen have to observe all laws and regulations of the host country, particularly those concerning the conservation of forest reserves and forest resources and the management of watering points and pastoral land. (Article 16)

Disputes between farmers and nomadic herdsmen are first judged by an arbitration commission. (Article 17). This commission shall be composed of representatives of the herdsmen, farmers, livestock officers and agricultural officers, officials from the ministries of Forest and Water Resources and local political and administrative authorities. (Article 18) In the event that an amicable settlement is not reached, the dispute may be resolved in the law courts in conformity with the rules governing settlement of contentious issues. (Article 19)

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