

**SCHOOL OF PUBLIC HEALTH,
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA, LEGON**

**FACTORS ASSOCIATED WITH BOVINE FASCIOSIS IN KPONE-
KANTAMANSO DISTRICT, GREATER-ACCRA REGION, 2015-2016.**

BY

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**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN
PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF
MPHIL APPLIED EPIDEMIOLOGY AND DISEASE CONTROL DEGREE**

JULY, 2016.

DECLARATION

I, Bai Janneh, declare that under the guidance of my supervisor, Dr. Nathaniel Yebuah, part-time lecturer, School of Public Health, University of Ghana, Legon, this thesis is my original work except for related works that have been duly referenced and that no form of it has been presented elsewhere for another degree.

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DEDICATION

This work is dedicated to Almighty Allah for taking me through the course successfully. I also dedicated the work to my beloved parents and children for their support.



ACKNOWLEDGEMENT

My sincere gratitude goes to Almighty God for his grace and mercy in seeing me through my study.

I would also like to express my deepest appreciation to West Africa Health Organisation (WAHO) for fully sponsoring my two year MPhil in Applied Epidemiology and Disease Control.

I wish to thank the Director General, Dr. Duto Sainey Fofana and the entire staff of the Department of Livestock Services for their support.

I would like express my deepest appreciation to my academic supervisor Dr. Nathaniel Yebuah, part-time Lecturer, School of Public Health, Legon, without his guidance and persistent help this thesis would not have been possible. Special thanks and appreciation goes to Dr. Samuel O Sackey, School of Public Health and Professor Aning, School of Veterinary Medicine, Legon whose support and suggestion enabled me to complete this work.

Furthermore, I would like to acknowledge with much appreciation the crucial role of the Director and staff of Veterinary Services Directorate for allowing me to use all required equipment and the necessary material to complete my sample collection and laboratory analysis.

My profound gratitude also goes to Miss Florence Akuffo, Bamba Janneh, Foday Bojang, Mr. Lamin and Mrs Zainab Jawara for their support during my two years stay in Ghana.

Last but not the least, I have to appreciate the support and guidance given by Dr. Kenu, the Director, Professor Edwin Afari, the Coordinator, Dr. Wurapa and the entire staff of Ghana Field Epidemiology and Laboratory Training Program.

ABSTRACT

Background

Fasciolosis is one of the most important helminth infection of ruminant livestock and caused by *Fasciola hepatica* and *Fasciola gigantica*. Clinically, disease is usually characterized by weight loss, anaemia and hypoproteinaemia. Fascioliasis has also been recognized as re-emerging and widespread zoonotic disease affecting millions of people worldwide and many more are at the risk of infestation.

Methods

A cross-sectional study was conducted from December 2015 to March 2016 at Kpone-Katamanso district. Gbetsileh and Katamanso settlements participated in the study. 384 faecal samples of cattle sampled from 20 herds were examined using the sedimentation technique. Similarly husbandry practices and aspect of herd owners' education in the same settlements were capture using a standard questionnaire.

Result

The prevalence of bovine fasciolosis in this study was 16.93% and was higher in Gbetsileh than in Katamanso. The age group 7 -12 months and sex were identified as potential risk factors. On the contrary deworming and training on husbandry practices reduces (protective factors) risk of bovine fasciolosis. Both of them were not statistically significant ($P > 0.052$ and $P > 0, 81$ respectively).

Conclusion

The prevalence of bovine fasciolosis for this study was 16.93%. Age group 7 – 12 months of cattle increases the risk of bovine fasciolosis. Deworming and training on improved husbandry/management practices lower bovine fasciolosis prevalence in cattle

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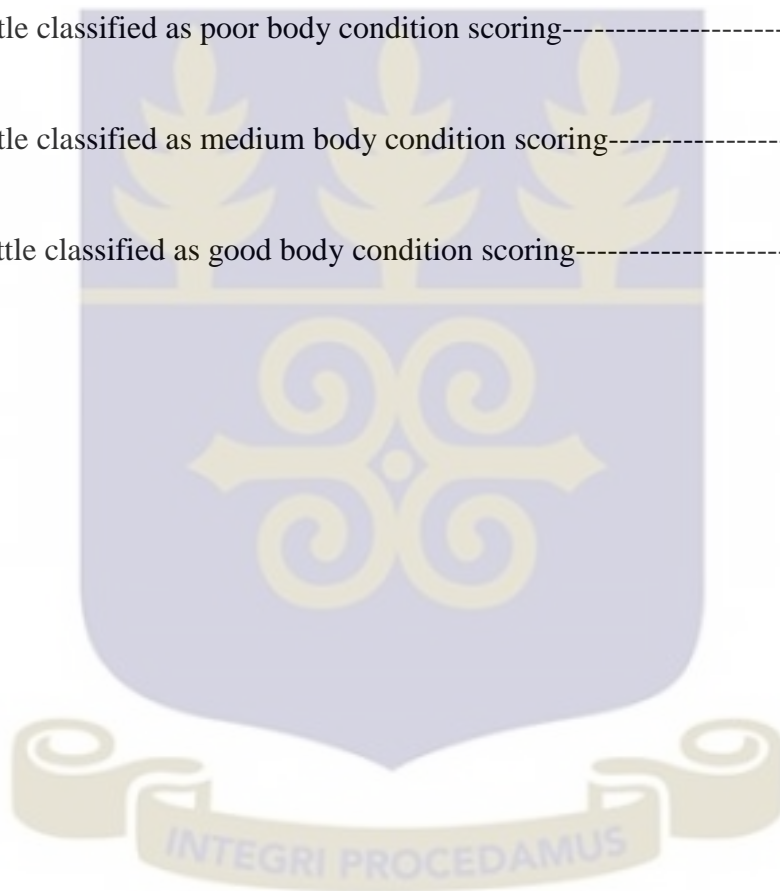
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LIST OF ABBREVIATIONS

CSIR -	Centre for Scientific and Industrial Research
DALY -	Disability Adjusted Life Years
FAO -	Food and Agriculture Organisation
FBT –	Food-borne trematodiasis
GDP -	Gross Domestic Product
HF –	Human fasciolosis
ICT –	Information communication technology
KKD -	Kpone-Katamanso District
LCDs –	least develop countries
NTD -	Neglected Tropical Disease
WHO -	World Health Organisation



CHAPTER ONE

INTRODUCTION

1.1 Background

Fasciolosis, commonly called liver fluke, is an economically important helminth disease mainly of cattle and sheep caused by trematode worms of the genus *Fasciola*. The two species of veterinary importance are *Fasciola hepatica* and *Fasciola gigantica*. Clinically, disease is usually characterized by weight loss, anaemia and hypoproteinaemia.

The life cycle of these trematode involves amphibious snail as an intermediate host (Walker et al., 2005). *Fasciola hepatica* has a worldwide distribution and is commonly found in temperate climate zones (Mas-Coma et al., 2005). On the other hand, *Fasciola gigantica* is an important parasite for the tropics where it is endemic (Keiser et al., 2005). The intermediate host of *Fasciola gigantica* is the *lymnaeid* snail *Radix natalensis* while that of *Fasciola hepatica* is *Galde truncatula*.

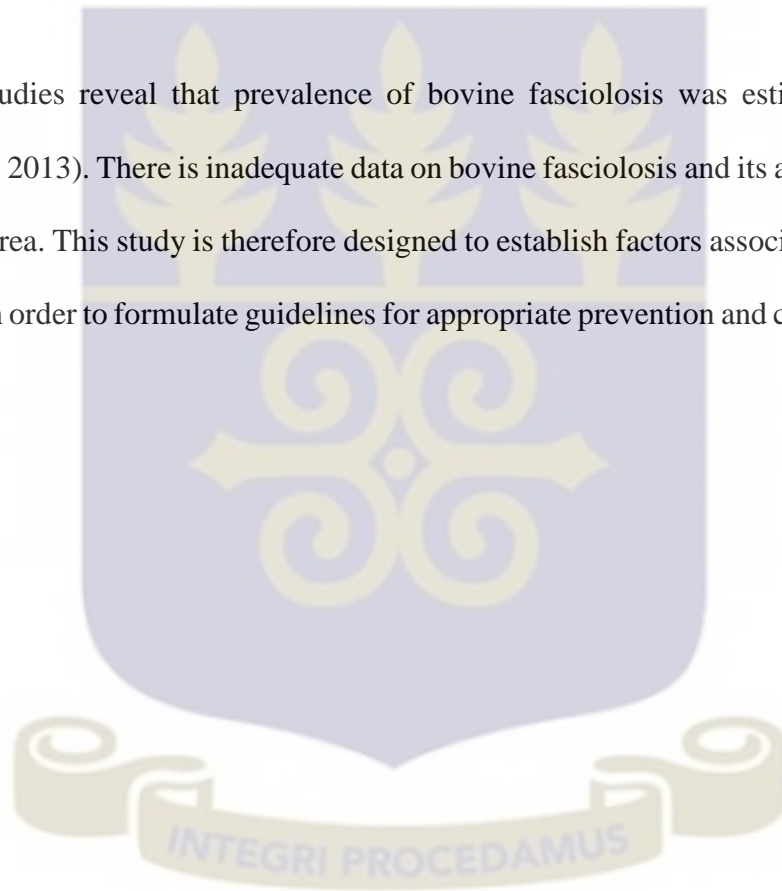
The parasite causes major challenges to livestock development leading to poor meat and milk production, liver condemnation in slaughter houses, reproductive failure, high mortality and a public health problem (Boray, 1994). Globally, economic losses associated with Fasciolosis can be estimated at over 200 million US Dollars, with 600 million animals infected annually (Ramajo, 2001). In Kenya, financial losses due to the infection caused by *Fasciola hepatica* and *Fasciola gigantica* on livestock was estimated at 0.26 million US Dollars per annum (Khan, 2009).

Human fasciolosis has recently been recognized as an emerging and widespread zoonosis. Globally, between 2.4 and 17 million people are currently infected and 91.1 million people are at risk of infection (Chhabra et al., 2009).

A number of control measures against fasciolosis exist and can be used independently or as a combination of two or more of them. These methods included reduction in the number of

intermediate snail hosts by chemical or biological means, strategic application of anthelmintics, reduction in the number of snails by drainage, fencing and other management practices as well as reduction in the risk of infection by planned grazing management (FAO 2005). However, anthelmintics drugs are the most preferred due to the ease, individual, non-concerted use of such treatments. The development of resistance against the commonly used anthelmintics caused a serious threat that rendered majority of the commonly used anthelmintics ineffective in the control of fasciolosis (Waruiru *et al.*, 2000).

In Ghana, studies reveal that prevalence of bovine fasciolosis was estimated at 51.1% (Squire *et al.*, 2013). There is inadequate data on bovine fasciolosis and its associated factors in the study area. This study is therefore designed to establish factors associated with bovine Fasciolosis in order to formulate guidelines for appropriate prevention and control strategies.



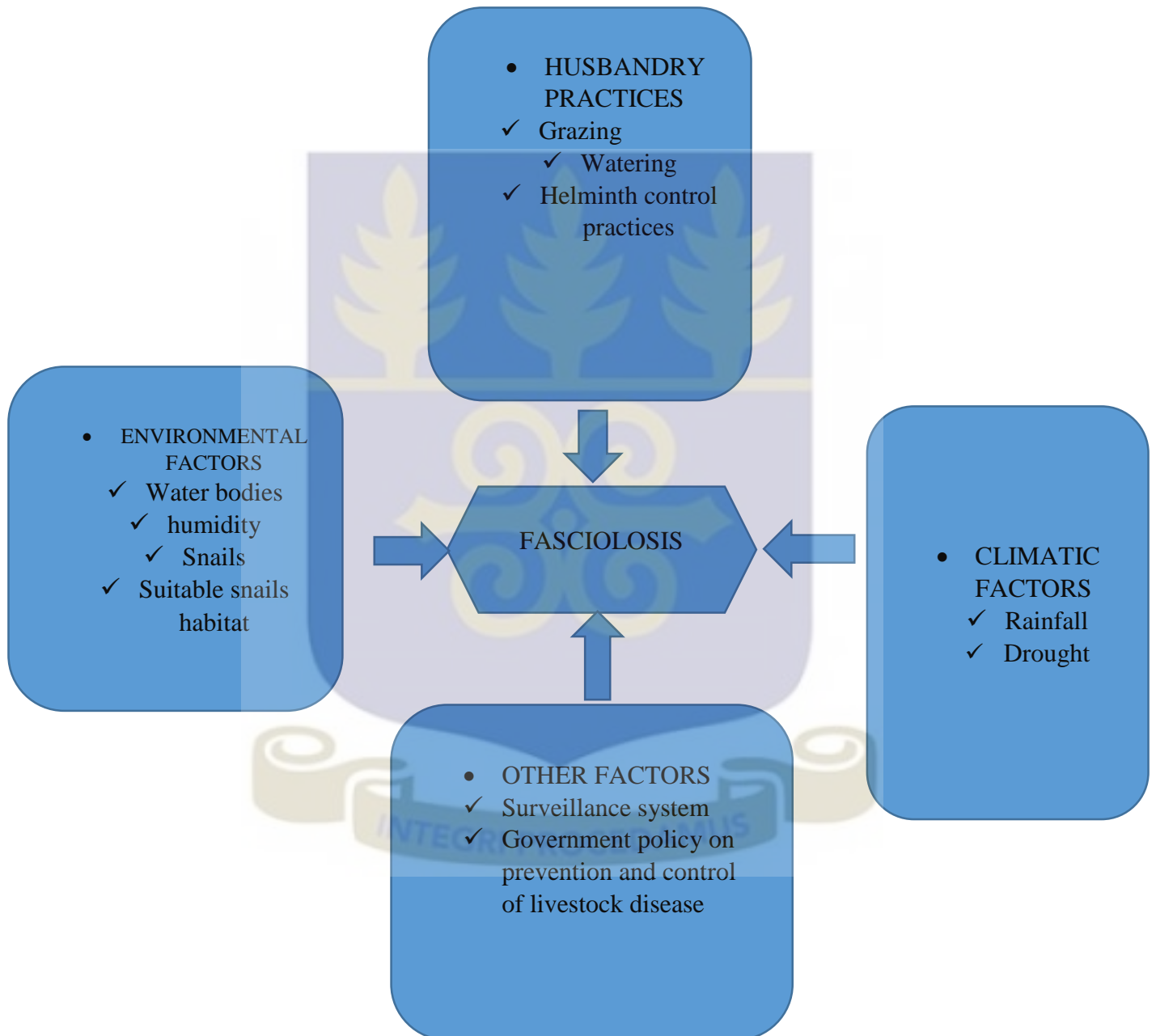
1.2 Problem Statement

Fasciolosis is one of the most important Neglected Tropical Diseases (NTDs) and found in more than 70 countries worldwide. In Ghana, review of abattoir records from Kumasi Central Abattoirs revealed that out of 91,286 cattle slaughtered, 710 were diagnosed with bovine Fasciolosis (Veterinary Services Directorate 2010). Availability of moisture, optimal temperature and suitable snail habitat are among factors that influence the occurrence of bovine fasciolosis in a particular area (Urquhart *et al.*, 1996). Increase in the number of dams and irrigation canals built to boost energy and food production, especially in sub-Saharan Africa are considered as factors contributing to the high incidence of the disease (Chandi *et al.*, 2009). Irrigated agriculture increases the number of potential snail habitats and hence increased incidence of fasciolosis (ESTEBAN *et al.*, 2003). Weak surveillance system and lack of government policy on prevention and control of livestock disease also contributed to emerging and re-emerging of animal disease Worldwide.

Appropriate control measures gear toward control the intermediate host snail and parasites should be prioritise by the governments and non-government agencies. Failure of which could affect the sector's contribution to national Gross Domestic Product (GDP).



1.3 Conceptual framework of bovine fasciolosis



Availability of Suitable Snails Habitat: This factor influences the occurrence of Fasciolosis in both animals and human in an area. Since snails are the intermediate host of liver fluke and they play an important role in the development of the parasite.

Temperature: An optimal temperature of 10 °C and 16°C are necessary for snail vectors and for development of the parasite in the intermediate snail hosts. Moreover, such conditions are required for completion of the life cycle such as development of fluke eggs, free-living miracidia in water looking for intermediate snails host for the completion of its life cycle and dispersal of cercaria. (Urquhart *et al.*, (1996).

Rainfall/Moisture: - Moisture is key in both breeding and development of the parasite. It is also necessary for the development of parasite eggs, for miracidium to penetrate a snail and dispersal of cercariae shed from the snails.

Husbandry practices: This is management practice used by cattle farmers. This play an important role in the infestation of fasciolosis. For instance indiscriminate grazing (feeding) or watering (drinking) can directly or indirectly increase fasciolosis infestation for human and cattle.



1.4 Justification

The study aims at determining the factors associated with the occurrence of fasciolosis in cattle at the study site. The study findings will fill the knowledge gaps and update existing information on disease condition in the study area. This study will stimulate the interest to carry out further studies in different parts of the country. It will also increase efforts geared toward its monitoring and surveillance for the control and possible eradication of the disease in the study area and other parts of the country.

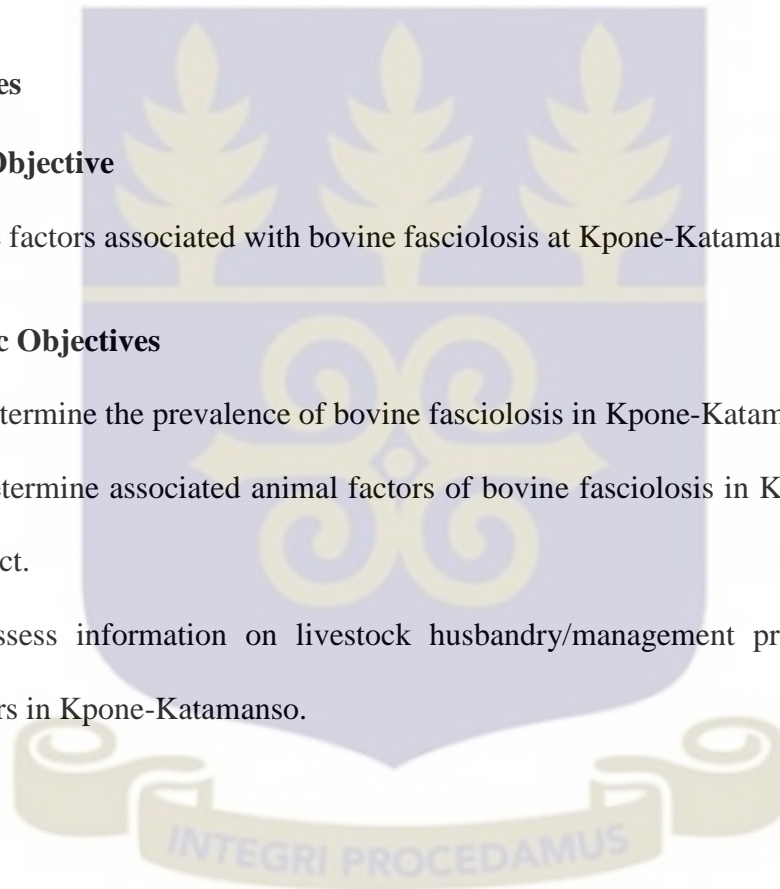
1.5 Objectives

1.5.1 Main Objective

To determine factors associated with bovine fasciolosis at Kpone-Katamanso District.

1.5.2 Specific Objectives

1. To determine the prevalence of bovine fasciolosis in Kpone-Katamanso District.
2. To determine associated animal factors of bovine fasciolosis in Kpone-Katamanso District.
3. To assess information on livestock husbandry/management practices of cattle owners in Kpone-Katamanso.



CHAPTER TWO

LITERATURE REVIEW

Fasciolosis is one of the most important parasitic infections in tropical and subtropical countries which hinder livestock production. The two most important trematodes commonly reported to cause fasciolosis are *Fasciola hepatica* and *Fasciola gigantica* (Kithuha *et al.*, 2002). The disease affects the liver parenchyma, bile ducts of animals including humans and causes significant economic losses as well as threatens public health (FAO, 2005). Fasciolosis also cause wide spread morbidity and mortality in ruminant livestock and usually characterized by weight loss, anaemia and hypoproteinaemia.

2.1 Etiology of *Fasciolosis*

These parasites belong to class trematode and a phylum of *Platyhelminthes* which can be divided into subclasses; *Digenea* and *Aspidogastrea* (Urquhart *et al.*, 1996). *Digenea* have a complex life cycle that involves one or more intermediate host. Many variation exist on the life cycle, but each of which include a snails as either a primary or intermediate host. Members of the family *Fasciolidae* are hermaphroditic and self-fertilization can also occur, although sexual reproduction is normally by cross-fertilization in the final host (Magona *et al.*, 2002).

2.2 Morphology of *Fasciola hepatica* and *Fasciola gigantica*

Fasciola hepatica is leaf shaped, with broad and cone shaped anterior projection. It is usually grayish-brown in colour but changes to gray when preserved. The tegument is armed with sharp spines. The young fluke measures 1-2 millimeter (mm) in length at the time of entry into the liver and lancet like when become mature in the bile ducts.

An adult *Fasciola hepatica* measured around 3.5cm in length and 1cm in width. The eggs are oval in shape, brownish or yellowish brown in colour, have an indistinct operculum and develop after been laid. *Fasciola* eggs can be distinguished from the eggs of other flukes, especially from that of paramphistomum. Eggs of fasciola have yellowish-brown shell with an indistinct operculum and embryonic cells where as paramphistomum eggs have transparent shell, distinct operculum with embryonic clear cells and possess a small knob at their posterior ends (Urquhart *et al.*, 1996).

On the other hand, *Fasciola gigantica* is larger than *Fasciola hepatica* and measure up to 7.5cm length. The shape is more of leaf like, with a very short conical anterior end and has similar characteristic with *Fasciola hepatica*. The eggs are larger than those of *Fasciola hepatica*, measuring 190 x100 micrometer (μm) (Magona *et al.*, 2002).

2.3 Public Health Importance of Fasciolosis

The incidence of fasciolosis/fascioliasis in human is on the increase and has been reported in 51 countries of the 5 continents. The fasciolosis is a major constraint to livestock production leading to reduction of meat and milk production, condemnation of liver of slaughtered animals, reproductive failure and mortality as well as public health concerns.

Among the zoonotic parasitic diseases, human fascioliasis is currently classified as a plant/food-borne trematode infection, with higher prevalence seen among farming communities in low income countries (Soliman, 2008).

Despite the recent developments in diagnostic and surveillance techniques, some countries are still completely lacking in data on human fascioliasis. This may be because the disease is not endemic but is more likely due to underreporting/diagnosis especially in the resource limited settings. The underestimated global burden of the disease to date is approximated to be between 35 and 72 million people, with an additional 180 million at risk of infection

(McDaniel *et al.*, 2014). However, there is enough data supporting animal Fasciolosis in many tropical developing countries and regions, with the corresponding presence of snail species responsible for transmission. Therefore, the possibility of transmission of animal fascioliasis to humans is high especially where close proximity of humans with domestic animals is common (y Sierra *et al.*, 2011).

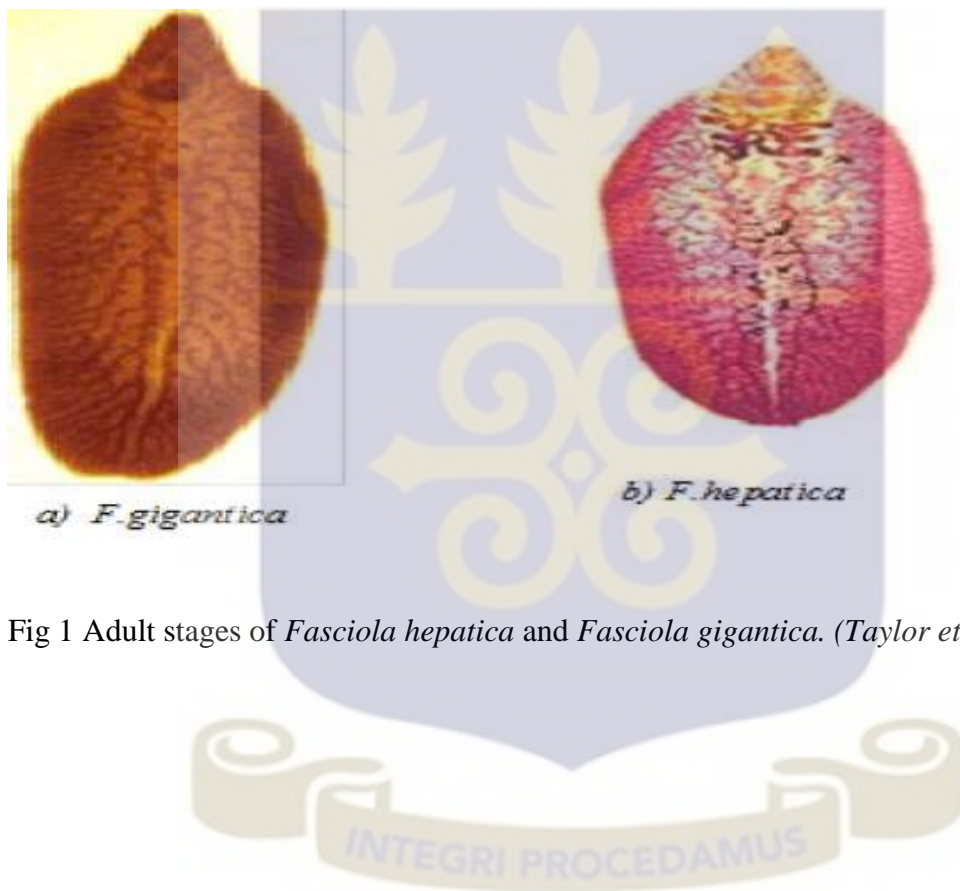


Fig 1 Adult stages of *Fasciola hepatica* and *Fasciola gigantica*. (Taylor *et al.*, 2007)

2.4 Economic importance of animal and human fasciolosis

Fasciolosis causes significant economic loss to livestock especially in cattle and sheep (Bowman, 2014). The economic losses include indirect cost such as costs of anthelmintics, labor, and liver condemnation at meat inspection. Direct economic losses included the following: losses in production due to mortality, reduction in meat and milk production, reduction in growth rate, and decreased feed intake (Assefa, 2005). Globally, economic losses associated with Fasciolosis can be estimated at over 200 million US Dollars, with 600 million animals infected annually

Human infection with fascioliasis was very sporadic until the last three decades when clinical cases and outbreaks were reported. According to a World Health Organization (WHO) report in 2007, the infection was limited in the past to specific and typical geographical areas, but is now widespread throughout the world, with human cases being increasingly reported from Europe, the Americas and Oceania (where only *Fasciola hepatica* is transmitted), and from Africa and Asia (where the two species overlap).

2.5 Epidemiology of animal and human fasciolosis

Fasciolosis is a food or water-borne parasitic infection caused by *Fasciola hepatica* and *Fasciola gigantica*. *Fasciola hepatica* is found in all continents except Antarctica and have the widest latitudinal, longitudinal, and altitudinal distribution than other food-borne trematodiasis (FBT), other parasitic and vector-borne diseases (Martins *et al.*, 2014). On the other hand, *Fasciola gigantica* is more geographically constricted in the tropical regions of Africa, the Middle East, and Asia, where infection due to either species may also occur (Keyyu *et al.*, 2005). Contrary to early thinking, prevalence of veterinary disease is not predictive of prevalence of human disease in endemic regions (Martins *et al.*, 2014).

Recent investigations at molecular and pathophysiology levels gave thorough understanding of the interaction between the parasite and its accidental human host (Scott *et al.*, 1977).

Unlike the other Food or water borne trematodiasis (FBT), in which consumption of raw or undercooked seafood is necessary for infection, humans most often become accidental hosts of fasciola when they ingest aquatic vegetation on which the metacercariae have encysted. Another source of infection is drinking water contaminated with free-living (non-encysted) metacercariae. The least common mode of transmission is the consumption of raw or undercooked liver infected with immature or adult forms of the worm. Climatic factors such as rainfall and temperature plays a very important role in the epidemiology of fasciolosis (MICHAEL 2004).

2.6 Risk Factors for animals and human

The development of fasciola involves the presence of an intermediate host *Lymnaea* species, suitable habitats for snails and environmental factors such as high humidity, adequate temperature and rainfall. Furthermore, when infecting the definitive host, mature flukes lay eggs that spread in the environment and cause pasture recontamination. There are three most important factors that influence the occurrence of fasciolosis.

2.6.1 Availability of suitable snail habitat:

One of the most important factors that influence the occurrence of fasciolosis in an area is the availability of suitable snails' habitat. The snail habitat may be permanent or temporary. The availability of these intermediate host depends largely on climatic conditions. For example *Lymnaea truncatuala* prefers wet mud to free water but its permanent habitat includes the bank of ditches, streams and edges of small ponds. A slightly acid pH environment is optimal for *Lymnaea* species than high pH levels (Wakuma, 2009).

2.6.2 Temperature:

Temperature is another important factor that affects the rate of development of snails and the stages of the parasite's development outside the final host. For instance, at a temperature

of 0°C or above is necessary for the snails to breed and the parasite development within the snail. But all activity cease at a temperature of 5°C (Urquhart et al., 1996). *Fasciola cercaria* and *Lymnaea* snails have been found to survive better at a temperature of 25-30°C which explains that higher prevalence occur in autumn compared to other seasons (kithuka *et al.*, 2002).

2.6.3 Moisture:

The ideal moisture conditions for breeding and development of parasite within snails are attained when rainfall exceeds transpiration and field saturation. Such conditions are also essential for the development of fluke eggs, for miracidium to search for snails and also for the dispersal of cercariae shed from the snails (Wakuma, 2009).

2.6.4 Host Range

2.6.4.1 Definitive host

Fasciola hepatica can infect a wide range of mammals including rabbits and occasionally these hosts may act as reservoirs of infection. *Fasciola gigantica* infect only ruminant livestock (Wakuma, 2009).

2.6.4.2 Intermediate host

Intermediate hosts of *Fasciola* include molluscs of the family *Lymnaeidae* such as *Lymnaea*. Among the snails of the genus *Lymnaea*, *Lymnaea truncatula* the amphibious snail are more common and have a worldwide distribution. Other important *Lymnaea* vectors of *Fasciola hepatica* outside Europe are *Lymnaea tomentosa*, *Lymnaea cumella*, *Lymnaea bulimoidis* and *Lymnaea humilis*. On the other hand, snails of the genus *Lymnaea*, *Lymnaea auricularia* and other snails like *Lymnaea natalensis*, *Lymnaea rufescens* as well as *Lymnaea rubiginas* are intermediate hosts of *Fasciola gigantica*. They are primarily aquatic and mainly found in streams, irrigation channels and marshy swamps (Wakuma, 2009).

2.7 Life Cycle

An adult fasciola shed its eggs into the bile that goes into the intestine and finally excreted through faeces. The undeveloped eggs require a minimum of 10 days to reach miracidial stage. The eggs develop and hatch releasing motile, ciliated miracidium in 9 days at optimum temperature of 22-26°C while little or no development occurs below temperature of 10°C (Urquhart *et al.*, 1996).

The miracidium has a short life span and must locate a suitable snail within 3 hours for successful penetration of the snail's tissue. In infected snails, development proceeds through the sporocyst and redial stage to the final stage called cercaria. These cercaria are shed from the snail as motile forms which attach themselves to frame surface, such as grass blades and encyst to form the infective metacercariae. It takes a minimum of 6-7 weeks for completion of the development from miracidium to metacercariae.

Metacercariae are ingested by the final host and encyst in the small intestine. They migrate through the gut wall cross the peritoneum and penetrate the liver capsule. The young flukes tunnel through the liver parenchyma for 6-8 weeks and then enter into the bile ducts where they migrate to the large ducts and occasionally the gall bladder. The prepatent period is 10-12 weeks. The minimal period for the completion of one entire life cycle of *Fasciola hepatica* is 17-18 weeks. The longevity of *Fasciola hepatica* in untreated cattle is usually less than one year (Urquhart *et al.*, 1996).

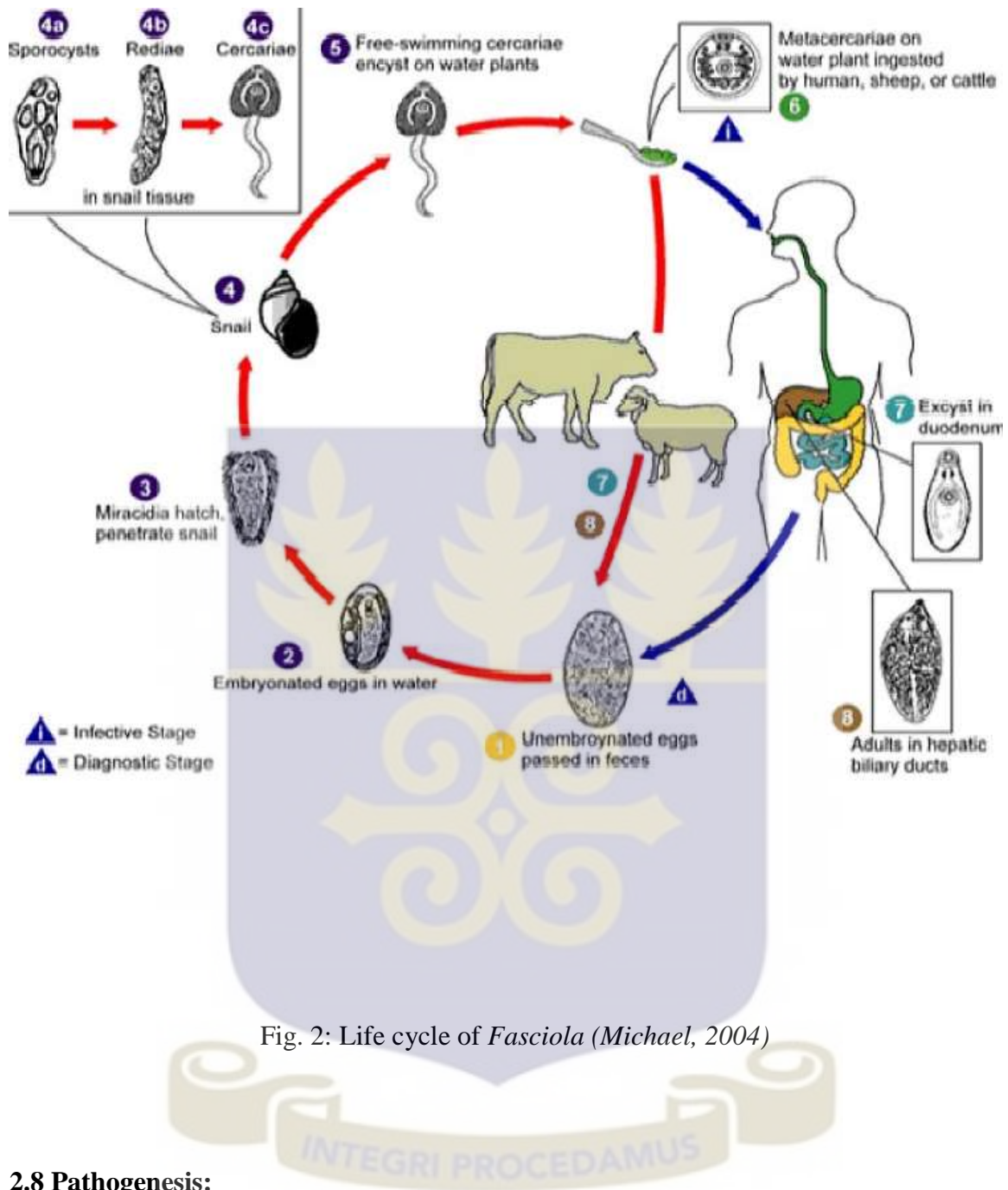


Fig. 2: Life cycle of *Fasciola* (Michael, 2004)

2.8 Pathogenesis:

The pathogenesis of fasciolosis varies according to the phase of parasite development in the liver and species of host involved. Essentially it has two phases. The first phase occurs during migration of the parasite in the liver parenchyma and is usually associated with liver damage as well as hemorrhage. The second phase occurs when the parasite is in the bile duct, result of its haematophagic activity and also from damage on the biliary mucosa by their tegumental spines (Wakuma, 2009).

Pathogenesis as a direct result of the fluke's activity may be either acute or chronic. Acute fasciolosis occurs during the pre-adult migration of the parasite in the liver parenchyma. In chronic fasciolosis, the damage is primarily to the liver. Unlike the acute phase of the disease, the damage occurs from the fibrosis (scar tissue), blockage of the bile duct and inflammation of the bile ducts (Wakuma, 2009).

The pathogenesis of bovine fasciolosis is similar to that of sheep but in sheep, it involved calcification of the bile ducts and enlargement of gall bladder. Acute and Sub-acute disease occasionally occur under condition of heavy challenges especially in young calves while Chronic form of the disease is most commonly seen in sheep during the late winter or early spring (Urquhart et al., 1996).

Aberrant migration of the flukes is more common in cattle and encapsulated parasites are often seen in the lungs (Urquhart *et al.*, 1996). Migrating *Fasciola hepatica* through hepatic tissue containing inactive spores of *Clostridium nobyi* may cause the development of infectious necrotic hepatitis in sheep and cattle. This migration has been thought to stimulate the development of occasional causes of bacillary haemoglobinuria in cattle. Immature flukes are tissue feeders, but may accidentally ingest some blood and the minor degree anaemia that develops in the tracts 4-5 weeks of ingestion probably reflects the loss of blood into migratory tracts of young flukes (Urquhart *et al.*, 1996).

2.9 Effect of fasciolosis on animal and human

Fasciolosis causes three main adverse effects in livestock and humans (Kassai, 1999).

1. Mechanically, fasciolosis causes obstruction of parenchyma and blood vessels of the liver by immature flukes burrowing bile ducts.
2. The parasite secret/excrete some chemical substances that are toxic to the definite host

3. Loss of blood resulting from haemorrhage in the liver (acute form) and haematophagous feeding habits of the flukes.

Light infection due to *Fasciola hepatica* may be asymptomatic. However, fascioliasis in human shows the following signs and symptoms:- hepatic colic with coughing and vomiting, generalized abdominal rigidity, head ache and sweating, irregular fever, diarrhoea, pipe clay and anaemia (Kithuka *et al.*, 2002).

2.10 Clinical signs of fasciolosis

The clinical features of fasciolosis may vary depending on forms of the disease (acute, sub-acute and chronic).

2.10.1 Acute phase

Acute fasciolosis rarely occurs in cattle and it occurs 2-6 weeks after the ingestion of large number of metacercariae (usually >2,000). In sheep, acute infection occurs seasonally and is manifest by a distended, painful abdomen, anaemia and sudden death occurring 2-6 weeks after infection (Assefa, 2005). It is responsible for wide spread morbidity and mortality in cattle characterized by weight loss, anaemia and hypoproteinaemia.

2.10.2 Sub-Acute Phase

Sub-acute fasciolosis is caused by ingestion of a moderate number (usually 500 – 1500) of metacercaria over longer period of time. This condition is characterized by anaemia, jaundice and ill-thrift (Boray *et al.*, 1994). Even in case with significant hepatica damage, but death occur due to haemorrhage and anaemia.

2.10.3 Chronic Phase

Chronic fasciolosis is the most common form of the disease in cattle. It occurs as a result of ingesting moderate number (200 – 500) of metacercariae and also when the parasite reaches the hepatic bile duct (Mullen *et al.*, 2009). Animal becomes emaciated with pale eye, gums and typically develop “bottle-jaw” due to oedema under the jaw (FAO, 2005). Depending on the severity of the disease, death in untreated animals follows in about two to three months although many survive longer than this and may eventually recover if not re infected. Cattle with chronic fasciolosis may develop diarrhoea but tend to lose most of their infections after six months (Kanyari *et al.*, 2010).

2.11 Diagnosis

Diagnosis of fascioliasis is important for its control. Fasciolosis can be diagnosed of using clinical sign, grazing history, seasonal occurrence, faecal examination by laboratory tests and post mortem examination (Wakuma, 2009).

2.11.1 History and Clinical Sign:

Fasciola hepatica infection is normally associated with herds and flocks grazing from wet land with marshy pasture. While infection due to *Fasciola gigantica* occurs when livestock drink from snail infected watering places and also grazing from wet land (Price *et al.*, 1993). In acute fasciolosis, sudden death and severe anaemia occur due to the migration of young flukes through the liver but no fluke’s eggs are passed in the faeces. Sub-acute form causes signs of rapid loss of condition, severe anaemia, high fluke egg count and death occurs 12-30 weeks after infection. In chronic fasciolosis, gradual wasting, severe anaemia with ascites, bottle-jaw and very high fluke egg count which may lead to death more than 20 weeks after infection (Wakuma, 2009).

2.11.2 Faecal Examination:

Fasciolosis in animal and human is mainly diagnosed by faecal examination using sedimentation technique in the laboratory. However, they must be distinguished from the eggs of *Paramphistomum*. Since *Fasciola* eggs have high specific gravity therefore faecal examination using sedimentation technique is preferred to floatation technique (Smith, 1981). The oval operculated golden eggs of *Fasciola hepatica* appear in the faeces 10 weeks after infection while *F. gigantica* eggs only appear 15 weeks after infection. Excretion of fluke eggs shows considerable day-to-day and within day variation. The distribution of eggs in faeces are irregular and single faecal egg count may lead to incorrect conclusion (Kassai, 1999).

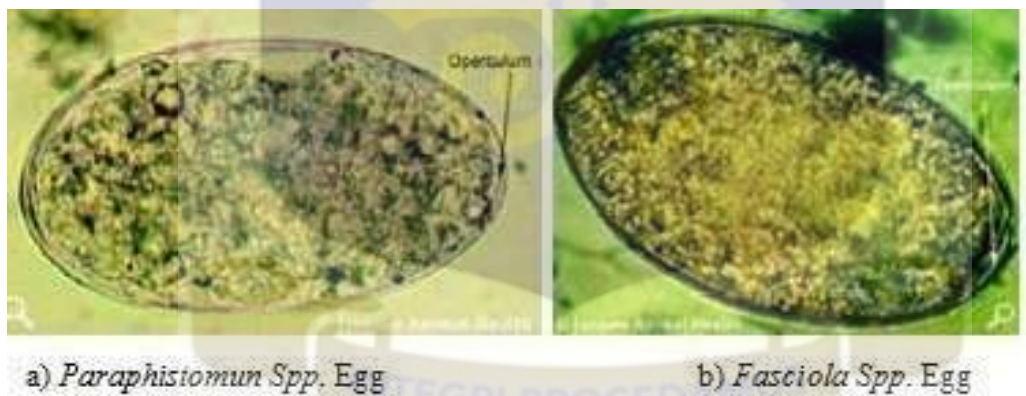


Fig. 3: A Paraphistomum and Fasciola Eggs (Sloss et al., 1994).

2.11.3 Serological diagnosis:

In vivo diagnosis of mild and pre-patent infection is possible serologically. For example, detection of antibodies by ELISA in serum or milk is available and particularly useful for diagnosis of infection in cattle in an individual or herd basis. A rise in antibodies can be detected by two weeks after infection and keeps rising until week six (Payne, 1990).

2.11.4 Necropsy:

The detection of adult flukes in the liver at necropsy is the most reliable method to confirm fasciolosis. Prevalence studies should be based on abattoir survey other than coproscopic investigation (Asseta, 2005). Acute fasciolosis is characterized by a badly damaged swollen liver. The peritoneal cavity may contain an excess of blood-stained serum. The liver capsule shows many small perforations, sub-capsular haemorrhage and the parenchyma shows tracts of damaged tissue and much more friable than the normal (Robinson *et al.*, 2009).

Chronic fasciolosis is associated with the presence of leaf-like flukes in grossly enlarged and thickened bile ducts particularly in the ventral lobe of the liver. Calcification of bile duct walls is a common in cattle. The hepatic parenchyma is extensively fibrosed and the hepatic lymph nodes are dark brown in color (Robinson *et al.*, 2009).



2.12 Treatment

Not all chemical compounds are equally effective against all stages of development of the parasite in the body. For the treatment of acute fasciolosis, it is essential to choose a product which is highly effective against the juveniles that damage the liver parenchyma. For chronic disease a compound active against adult fluke is required (Robinson *et al.*, 2009).

Triclabendazole (12 mg/kg) is considered as the most common drug due to its high efficacy against adult as well juvenile flukes. It is effective against adult *Fasciola hepatica* at a dose of 10mg/kg in cattle. It is ovicidal and will kill any *Fasciola hepatica* eggs present in the bile duct or the alimentary tract at the time of treatment. Clorsulon is supplied in combination with ivermectin for combined fluke and round worm control in cattle. Nitroxylin is given subcutaneously at 10mg/kg and has good efficacy against the adult fluke but the dose has to be increased up to 50% to obtain adequate control of acute disease (Robinson *et al.*, 2009).

Until recently, treatment was not very successful due to inefficiency of the older drugs against the early parenchymal stages. However, efficient drugs are now available and the best drugs of choice is triclabendazole which effective against all the developing stages of the parasites from one week old. Other drugs are Rafoxanide (7.5 mg/kg), Closantel and Nitroxylin, which can kill the parasite at four weeks old (Wakuma, 2009).

2.13 Prevention and Control

Program charts for fasciolosis control can be produced based on average rainfall and temperature records of any geographic region (Wakuma, 2009). Reduction of snail population and use of anthelmintics are the two major control and prevention strategies against fasciolosis (Robinson *et al.*, 2009)

2.13.1 Reduction of snail population:

Before any snail control program takes place, it is important to conduct a survey of the snail habitat to determine whether they are localized or wide spread. The best and sustainable method of reducing snail population is to ensure permanent destruction of their habitat. The snail habitat is limited by simple method of fencing or treat annually with a molluscicide (Melendez *et al.*, 1983). The snail control using chemical such as niclosamide and copper sulphate is possible seasonally. But usually, these control methods not are practicable due to labour, high cost, environmental consideration and rapid re-colonization of snail habitats (Melendez *et al.*, 1983).

2.13.2 Use of Anthelmintics:

Seasonal strategic application of effective anthelmintics specific for trematode, timely prophylactic and curative treatment play an important role in the control of fasciolosis (Hansen *et al.*, 1994). The prophylactic use of anthelmintic is aimed at reducing pasture contamination by fluke eggs. This method is sometimes most suitable for development of fluke from April to August and reducing fluke population at times of heavy burdens or at periods of nutritional stress of animal. Prophylactic treatment in cattle is therefore directed at reducing the fluke burdens in the dry season at a time when the nutritional status of the animal is at its lowest level (Wakuma, 2009). Other control methods include environmental sanitation and manipulation such as draining, swamps, building sewage system and providing clean water supplies. In addition, rotational grazing and avoiding mixed grazing of animals of different age groups are also used as control measures (Hansen *et al.*, 1994).

A great number of chemicals have been used as molluscicides in the past, but recently, Niclosamide and Copper sulphate are mostly used in different countries in Africa (Cywinska, 2005).

Host range, longevity and egg production of liver fluke in definitive host have implication for control. It is estimated that in sheep, one liver fluke produces about 20,000 eggs per day. On the other hand, cattle are relatively poor hosts because infection usually is retained only for months. Egg production by *Fasciola hepatica* in cattle is also poorer than in sheep. Pasture contamination by cattle therefore increase more slowly and ends sooner than with sheep (Melendez *et al.*, 1983).

2.14 Immunity and Immunization:

Natural immunity is expressed both during the migratory parenchymal and bile duct stages of the infection. This is considered to be related to the distribution and amount of connective tissue in the hosts liver parenchyma. Cattles are more resistance due to presence of significant number of connective tissue in their liver and these connective tissue helps to trap young flukes during migration. Immunity of *Fasciola hepatica* has been demonstrated and antibodies can be found in the blood of infected animal. Field observation indicated that older animals are usually more resistant to the infection (Wakuma, 2009). Fasciola has a number of survival mechanisms for evading host immune responses such as changing its surface antigen during migration, releasing a proteolytic enzyme that can cleave immunoglobins and modulating the host immune response (Robinson *et al.*, 2009).

Vaccine against fasciolosis is under development. One of these which use recombinant fluke cathepsin L proteinase has given up to 79% protection against infection in cattle and sheep. Successful vaccination strategies elicit Th1 rather than Th2 immune response induced by natural infection (Robinson *et al.*, 2009).

Issues of Immediate Concern about Fasciolosis in the Least Developed Countries

Although fascioliasis has been established as a disease of human importance, it is still considered primarily an animal disease, particularly of sheep and cattle. Lack of awareness presents a major obstacle in the effective management of human fascioliasis. Unfortunately in many of the least developed countries burdened by poverty and infectious diseases, human fascioliasis is not a recognized and reportable disease. Awareness and sensitization are key first steps to any planned intervention strategies.

Fortunately to date there have been no reported deaths directly associated with human fascioliasis infection. This inevitably attributes a low emergency health priority to the disease, making it one of the most neglected tropical diseases. The disease has also been reported to have a much higher prevalence among the female children of school going age. The associated morbidity and Disability Adjusted Life Years (DALY) impact of the disease are thus of more significant concern (Hotez *et al.*, 2012). The consequent morbidities of chronic disease significantly contribute to poor quality of life, expectancy, and productive output since the adult worm can live for over 10 years in a suitable host (Mekky *et al.*, 2015).

There have been only scattered reports of outbreaks of fascioliasis in irrigated agricultural areas free from domestic animals (Mekky *et al.*, 2015). The highest proportions of reported cases are zoonotic in nature, and so any intervention strategies should ideally address the problem at the veterinary level as well. Human fascioliasis is hardly reported in those countries where animal fascioliasis is highly prevalent (Swai *et al.*, 2009) Vigilant surveillance and screening programs should be implemented in such areas, with an emphasis on interdisciplinary involvement across various professions (Carrique *et al.*, 2013)

The global awareness and one health approach to zoonosis are by far the most comprehensive approach to fascioliasis (Ashrafi *et al.*, 2014). Sustained efforts are still

required including control measures for trade and travel to curb the spread of infected animals from one country to another. Improved water and food hygiene programs are further important components of control programs. Stakeholder involvement and the political will to back such strategies are crucial to the effective uptake of these interventions.

Definitive reports of drug resistance to triclabendazole should be rigorously investigated and alternative treatment options sought. Vaccine development should also be an area of future research. Mixed infections with other trematode or intestinal parasites confound early detection of fascioliasis. Delayed and missed diagnoses especially among the young key population magnify the DALY impact of the disease (Lopez *et al.*, 2012).

Future Challenges of fascioliasis

The 21st century has seen a dawning in the knowledge on human fascioliasis evidenced by the number of publications on the subject over the last 10 years. The complete implementation of this new knowledge and its translation into tangible results remain a challenge in the least developed countries (LDCs). Populations in LDCs are the highest at risk of disease because of the following reasons:

- (i) Poor access to this new body of knowledge,
- (ii) Limited resources to put it into practical use, or
- (iii) Having these limited resources dedicated to “more threatening” problems than fascioliasis. The poverty-disease cycle is indeed a vicious, autocatalytic cascade.

A typical complicating infection control scenario of zoonotic infections including fascioliasis in sub-Saharan Africa includes:

- (a) Global warming and civil unrest,

(b) Close proximity to domestic animals,

(c) rural-urban migration with poor personal, water, and food hygiene, and

(d) lax biosafety and surveillance systems. Therefore, control programs of human fascioliasis should have an integrated approach whereby all factors that contribute to the presence of the disease are considered (Bidaisee *et al.*, 2014).

Cutting edge advances in diagnostic, surveillance, and management techniques of fascioliasis have been made. Yet the developing countries and particularly the lowest income communities are not able to access these advances because of poverty. Heavily burdened by diseases, civil unrest, and competition for scarce resources, it is not surprising that there are hardly any reports on human fascioliasis from these regions (Soliman, 2008). Control programs should first consider rigorous awareness campaigns and sensitization on both the magnitude and impact of human fascioliasis in humans and animals.

The current “One Health Integrated Global Approach to Disease” presents by far the most comprehensive and participatory solution, not only to human fascioliasis but also to the bulk of zoonotic diseases at large (Standley *et al.*, 2012). A classic example of the problems it tackles can best be elaborated in the recent drive to “Go Green,” as a healthy approach to the modern artificial lifestyle.

Compartmentalized to specific sections like nutrition and preventive medicine, agriculture, and industry, this has seen an unprecedented increase in the consumption of fresh, raw/green fruit and vegetables (Broglia *et al.*, 2011). This is however poorly backed by water safety, fertilizer-pesticide use control, and waste management. The consumption of poorly monitored, produced, and stored fresh green vegetables has contributed to the increased spread of plant/food-borne trematodiasis including fascioliasis, among many other health problems (Lev., et al 2014).

Controlled clinical trials to investigate reported cases of triclabendazole and bithionol resistance of *Fasciola* are areas of immediate research interest. Further development of chemotherapeutic options like the Myrrh-derived Mirazid and nitazoxanide, as well as other novel interventions aimed at the intermediate snail hosts, may provide much needed alternative chemotherapy. Control strategies aimed at the animal reservoirs and active surveillance for disease hotspots allow early intervention while improved food and water safety combined with possible vaccine development is vital to prevention strategies of human fascioliasis. In order to succeed, all this needs to be backed by rigorous awareness, sensitization campaigns and political will to maximize uptake.

Human fascioliasis is perceived as a low significance “Neglected Tropical Disease of Poverty”. As interventions and solutions to the disease are developed in the more developed countries/communities, support structures, basic amenities, and simple interdisciplinary collaborations degenerate equally fast in the lowest income communities at particularly high risk of infection (Molyneux *et al.*, 2011)

A case in point is observed in the abundance of veterinary reports on animal fascioliasis out of sub-Saharan African countries, countered by an almost total disregard for the human zoonosis among the medical and public health community. It is surprising that human fascioliasis is still not a reportable disease in many of these countries.

However, because of easy and fast global travel currently prevailing, open markets and free trade, cultural tourism, and massive cultural and national integration, the problems of the developing countries may spill to more developed countries. The dawn of unpredictable climate changes and their effect on exobiology, civil unrest, and the simple natural laws of evolution are factors that have altered the patterns of spread of zoonosis. For example, the recent global threat from the West African Ebola outbreak is a fresh reminder of the far

reaching ramifications of unexpected disease outbreaks on the continent. Human fascioliasis is still nonfatal and results from interventions used in most hyper endemic regions prove that it can be effectively controlled, if not eradicated. As an NTD, this should be a tangible target.



CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study was conducted in Kpone-Katamanso District (KKD) of the Greater-Accra Region. It was carved from the Tema Metropolitan Assembly in 2012. KKD is located along the coastal part of Tema and lies in the coastal savannah zone of Ghana. The district is 38 kilometers drive from Accra, the capital city of Ghana. It shares boundaries with Tema to the west, Dangme West to the east, the Gulf of Guinea to the south and Akuapem South to the north.

The topography of the land is generally flat and forms part of the coastal plain. It enjoys a dry equatorial climate and has two rainy seasons with a mean annual rainfall ranging between 730mm to 790mm. The major rainy season is usually from April to July and from September to November is the minor rainy season. Temperatures are high all year round with significant daily and seasonal variation. The annual average temperature ranges from 25°C to 30°C. The population of the district, according to the 2010 Population and Housing census is 109,864 representing 2.7 percent of the total regional population.

Agricultural activities in the district are prominent and they can be grouped into crop and livestock production, fishing and agro-processing. Livestock production is commonly practiced in the district mostly in the Katamanso and Gbetsilleh area. The types of animal reared include cattle, sheep, goats, pigs, rabbits and grass cutter. These animals are produced on both subsistence and commercial basis. Also, a number of livestock and poultry farms are in the district.

MAP OF KPONE-KATAMANSO DISTRICT SHOWING STUDY SITES

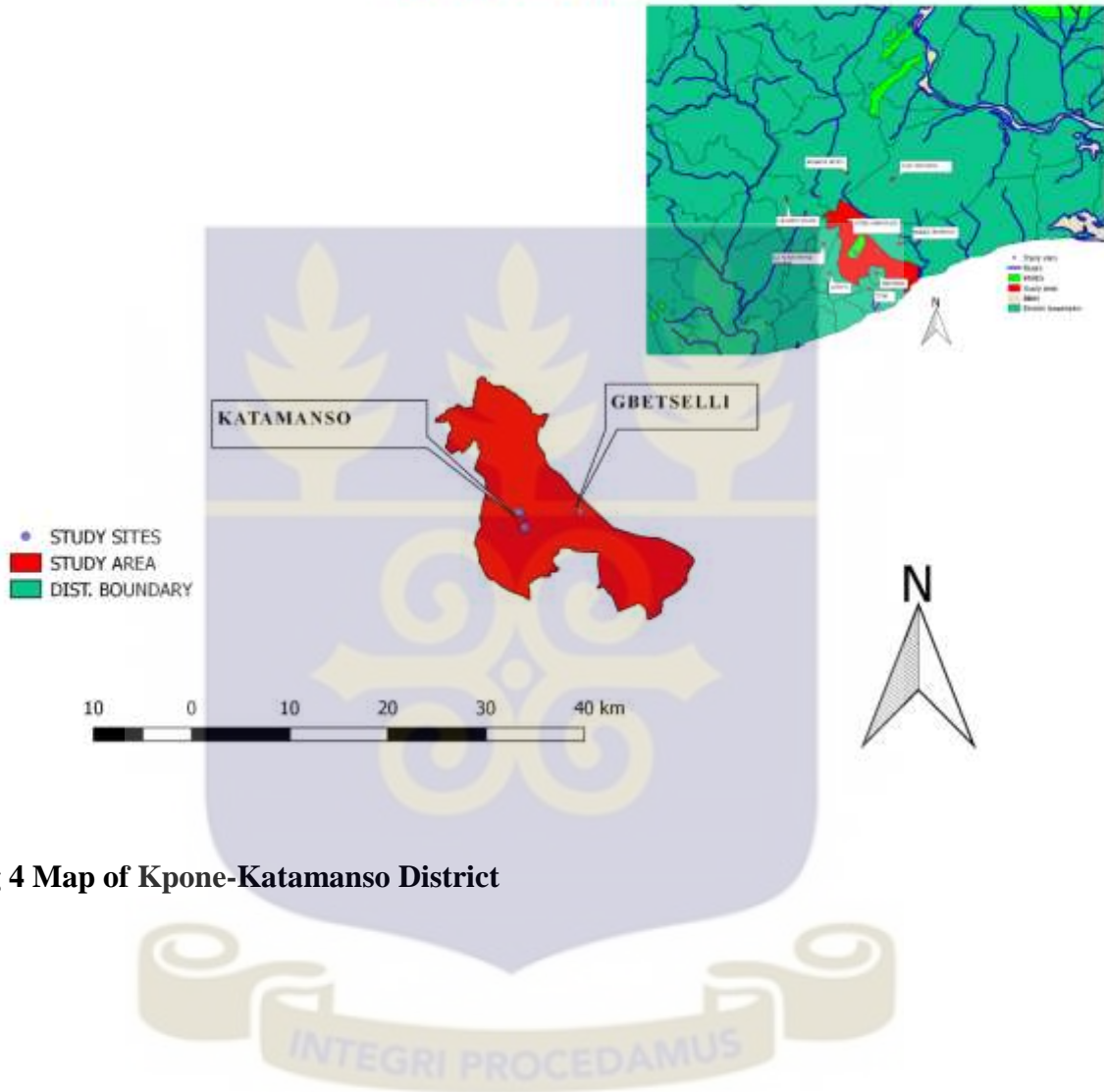


Fig 4 Map of Kpone-Katamanso District

3.2 Study design

A cross-sectional study was used to determine the factors associated with Bovine Fasciolosis in Kpone-Katamanso District from December 2015 to March 2016. The study was conducted in two selected settlement namely Gbetsileh and Katamanso of the studied district. Data were collected on age, sex, breed and body condition scoring of study cattle. Purposive and simple random sampling were used for selecting study herds. Stratified sampling was used to select study animals.

The study also assessed husbandry/management practices of cattle farmers and this was conducted simultaneously with faecal sampling. The dependent variable for the study was the presence of bovine fasciolosis and the independent variable are age, sex, breed, body condition scoring, grazing, watering, deworming and training on husbandry practices.

3.3. Study Animals population

The study animal were local, exotic and cross breeds of all the cattle in the two selected settlement namely Gbetsileh and Katamanso of Kpone-Katamanso district. These animals were managed under extensive (free range) livestock management system. Twenty Cattle farmers were selected from the two study settlements in the study district based on their consent and also their animals were selected for the studied.

3.4 Sample size determination

The sample size was calculated using the formula given by (Thrusfield, 2005) with 95 % Confidence Interval (CI) and 5% absolute level of precision as follows:

$$n = \frac{1.96^2 \times P_{exp}(1-P_{exp})}{d^2}$$

Where

n= required sample size

P exp= expected prevalence (50%)

d = desire level of precision (5%)

$$n = 1.96^2 \times 0.5(1-0.5)/0.05^2 = 3.8416 \times 0.5(0.5)/0.0025 = 3.8416 \times 0.25/0.0025 = 0.9604/0.0025 = 384.16 = 384.$$

The calculated sample size for the study is 384 cattle. Since there was no earlier work done on bovine fasciolosis in the study area, the sample size was determined by using an estimated prevalence of 50% to obtain the maximum sample size.

3.5 Sampling method

A purposive sampling method was used to select study herds in each of the two settlements. The study herds were selected and sampled by generating a random list on all herds in each study settlement. Then the list was followed and picking herds in an increasing order based on having 10 or more cattle.

- The stratified sampling was used to select the study cattle.
- The herds were stratified based on the number of cattle.
- Random numbers were generated using Microsoft excel software and sorted out in increasing order.
- The random numbers generated were used to select the cattle for a particular stratum..

Data was also collected on associated animal factors such as age, sex, breed and body condition scoring. The age was estimated by mean of dentition or with the help of the herdsman. Body condition scoring is useful management tool for distinguishing differences in nutritional status of cattle in the herd. Generally, body condition scoring were made based on the method described by Nicholson *et al.* (1986). According to Nicholson, each scoring were given a number from 1(L- very lean) to 9(F+ very fat and each number has a corresponding parameter used for identification. These numbers were finally included under three body condition scoring namely poor, medium and good as shown in table 1. Accordingly, this study classified study cattle as poor, medium and good body scoring based on the number of ribs shown on the body surface of the animals.

Data on cattle husbandry/management practices such as grazing (feeding), watering (drinking), deworming and training were collected using an Android mobile phone application called Kobocollect. A standard questionnaire are shown in appendix II was created on a laptop computer using the application called Kobocollect on a Kobo Toolbox platform. As you are interviewing farmer, you punch on the answer giving to you by farmer on the mobile phone. After collection, data was edited and later send to particular database. Finally the data was retrieved, copied into Microsoft excel sheet and analysed using STATA software version 13. A standard questionnaires was also created using animal factors such age, sex, breed and body condition scoring. Once a cattle is selected for sampling, age of cattle were captured using dentition or by asking the farmer while sex, breed and body scoring were captured using visual examinations. Grazing (feeding) system was captured by zero and extensive system. Zero grazing is where the pasture is cut and carry for the feeding of the animal while extensive system is where animal go in search of the pasture for feeding. Drinking was captured using Home and outside home. Here home means animals that used water source from home such as wells, taps etc. While outside home means animals

that used other water sources outside home such dams. Lakes etc. Deworming was captured using yes or no. Here yes means farmers practiced deworming while no means those who do not practiced deworming.

Table 1: A table summarising body condition scales and determinants parameter (Nicholson, 1986).

Body condition Score one (BSC 1)	1 L- Marked emaciation (animal would be condemned at ante mortem examination)
	2 L Transverse processes project prominently, neural spines appear sharply.
	3 L+ Individual dorsal spines are pointed to the touch; hips, pins, tail-head and ribs are prominent. Transverse processes visible, usually individually
Body condition two (BSC 2)	4 M- Ribs, hips and pins clearly visible. Muscle mass between hooks and pins slightly concave. Slightly more flesh above the transverse processes than in L+.
	5 M Ribs usually visible, little fat cover, dorsal spines barely visible
	6 M+ Animal smooth and well covered; dorsal spines cannot be seen, but are easily felt
Body Condition three (BSC 3)	7 F- Animal smooth and well covered, but fat deposits are not marked. Dorsal spines can be felt with firm pressure, but feel rounded rather than sharp.
	8 F Fat cover in critical areas can be easily seen and felt; transverse processes cannot be seen or felt.
	9 F+ Heavy deposits of fat clearly visible on tail-head, brisket and cod; dorsal spines, ribs, hooks and pins fully covered and cannot be felt even with firm pressure



Fig 5: Cattle classified under poor body condition scoring



Fig 6 Cattle classified as medium body condition scoring

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Fig 7; Cattle classified as good body condition scoring

3.6.1 Faecal sample collection

Faecal samples for parasitological examination were collected directly from the rectum of cattle using sterile gloves and placed into clean universal bottle with 10% formalin as a preservative. Each containers was clearly labelled with unique identification number, date and place of collection (location). The samples were packed in a cold box with ice packs and transported to the National Veterinary Laboratory of Veterinary Services Directorate at Labadi, Accra for microscopic examination within 24 hours of sample collection.

3.6.2 Coprological (Faecal) examination

Faecal examination for *Fasciola* eggs was carried out using the standard sedimentation technique as described by Hanson et al (1996). Two grams of faeces was weighed and placed in a beaker with 20ml of water. The two were homogenized using a wooden spatula. The mixture was sieved through a tea strainer into another beaker then to centrifuge tubes. The mixture was centrifuged at 1500 rpm for 3-5 minutes. The supernatant was poured off and a drops of methylene blue reagent was added to the sediment. A drop of the sediment was placed on a clean microscopic slide, covered with a cover slip and examined under a microscope using x10 magnification.

Eggs of *Fasciola* were identified by their characteristic yellowish colour against a bluish background while paramphistomes eggs appeared brownish against blue background. faecal sample that have *Fasciola* egg/s were term as positive or presence of Fasciolosis while those that do to have the parasites egg were considered as negative or absence of fasciolosis.

3.7 Ethical consideration

The study proposal was reviewed and approved by animal welfare Ethical Review Board of Centre for Scientific and Industrial Research (CSIR). Permission was also sought from the Veterinary Services Directorate of Ministry of Food and Agriculture. The selected farmers for the study were thoroughly brief on the purpose, method, benefit and risk of the project with the help of a translator. An informed consent were sought to participate in the study through signing or thumb printing depending on the farmer's preference (see appendix III).

3.8 Data Management and Analysis

Data collected during the study period were coded and entered into Microsoft Excel sheet. Data was summarized and statistically analyzed by using Stata version 13 computer program. Data on husbandry/management practices were summarized as percentages. Prevalence of bovine fasciolosis was calculated as number of positive faecal samples from laboratory analysis over total number of cattle examined. Univariant logistic regression was used to assess the association of the prevalence of bovine fasciolosis and associated animal factors such as sex, age, breed and body condition score. The magnitude of the association between the occurrence of fasciolosis and its influencing factors were measured by odds ratio at 95% level of confidence and 0.05 level of significance.

CHAPTER FOUR

RESULT

4.1 Prevalence of fasciolosis

The results showed that the prevalence of bovine fasciolosis in 384 cattle examined in the study areas was 16.93 % which was higher in Gbetsileh (18.18%) than in Katamanso (15.98%) (Table 2).

As shown in Table 2, age group 7 – 12 months (23.46%) was the most affected, followed by age group 0 – 6 months (16.53%) and the least affected age group was greater than 12 months (14.41%). Age of cattle were statistically significantly ($P < 0.00$).

Males had higher prevalence (32.89%) than females (15.89). Analysis indicated that sex was statistically significantly ($P = 0.02$, CI 1.12 – 3.64) (Table 1).

Out of the total of 384 cattle sampled, 8 (2.08%) were West Africa shorthorn, 130 (33.85%) were zebu and 246 (64.06%) were cross-breed cattle. The highest infestation occurred in West African shorthorn (25%) relative to Zebu (20.77%) and cross-breed cattle (14.63%). Breed was not statistically significant ($P = 0.11$, CI 0.41 – 1.09)

Regarding the effect of bovine fasciolosis on body condition scoring as shown in Table 2, no significant ($P = 0.13$, CI 0.49 – 1.09) difference exist. The highest prevalence of bovine fasciolosis was observed in poor body condition scoring (20%) relative to medium (18.57%) and good (11.93%) body condition.

4.2 Livestock husbandry/management practices

The study cattle were managed under extensive (free-range) livestock management system by smallholder's farmers in the two selected settlements of Kpone-Katamanso district. Therefore, 100 % of the respondents in the study area practised extensive (free range) grazing system and used water source outside the home for watering (drinking) of their animals.

Deworming of cattle was practised by 80% of the respondents. None of them practised regular two/three months deworming exercise. Of the 20 cattle farmers interviewed, only 20% received training in improved livestock husbandry/management practices.

Table 4 summarizes the associated factors for Bovine Fasciolosis in Kpone-Katamanso District. The age group 7 -12 months has odds of 199 times more likely to increase risk of bovine fasciolosis than in age group > 0 – 6 months. Being a males has an odds of 161 times more likely to increase risk bovine fasciolosis occurrence than being in female. Both age and sex of cattle increase are significantly associated with the occurrence of the bovine fasciolosis ($P = 0.00$, CI 1.39 – 6.45) and ($P= 0.02$, CI 1.12 – 3.64) respectively.

On the other hand, Deworming with $OR=0.77$ and training on Livestock husbandry/management practice with $OR=0.73$ had tendency to reduce (protective factors) risk of occurrence of bovine fasciolosis. Level Infestation by farm/herds was not done because the herds in each study settlement were stratified by the number cattle and strata were used for selecting study cattle instead of farms/herds.

Table 2 the prevalence of fasciolosis by Age, Sex, Breed and Body condition scoring in Kpone-Katamanso District.

Factors	Factor level	No. examined	No. positive	OR	P-value	95% CI
Age	0 – 6 months	67	12			
	7 – 12 months	81	19			
	>12 months	284	34			
	Total	384		0.57	0.00	0.42 – 0.72
Sex	Female	302	48			
	Male	82	27			
	Total	384		2.02	0.02	1.12 – 3.64
Breed	W/African shorthorn	8	2			
	Zebu	130	27			
	Cross	246	36			
	Total	384		0.67	0.11	0.41 – 1.09
Body Condition score	Poor	65	13			
	Medium	210	39			
	Good	109	13			
	Total	384		0.73	0.13	0.49 – 1.09

Table 3 Livestock husbandry/management practices

Husbandry/Management Practices	Levels	Number of respondents	Percentages
Grazing/feeding	Zero grazing (intensive)	0	0
	Extensive (free-range)	20	100
Watering (drinking)	Home	0	0
	Outside	20	100
Deworming	No	4	20
	yes	16	80
Training on husbandry/management practices	No	16	80
	Yes	4	20



Table 4 Animal factors associated with bovine fasciolosis in Kpone-Katamanso District

Factors	Factor Levels	OR	SE	P-value	95% CI
Deworming	No	Ref			
	Yes	0.77	1.94	0.052	0.01 – 1.02
Training on husbandry/management practices	No	Ref			
	Yes	0.73	0.93	0.81	0.60 – 8.92
Age	0 – 6 months	Ref			
	7 – 12 months	2.99	1.17	0.00	1.39 – 6.45
	>12 months	0.45	0.18	0.04	0.21 – 0.92
Sex	Female	Ref.			
	Male	2.61	0.61	0.02	1.12 – 3.64
Breed	W.A Shorthorn	Ref			
	Zebu	0.79	0.66	0.78	0.15 – 4.12
	Cross	0.51	0.43	0.43	0.10 – 2.64
Body Condition Scoring	Poor	Ref			
	Medium	0.91	0.33	0.80	0.45 – 1.84
	Good	0.54	0.23	0.15	0.23 – 1.25



CHAPTER FIVE

DISCUSSION

5.1 Discussion

The result of this study revealed that bovine fasciolosis is not a problem in the Kpone-Katamanso district with a prevalence of 16.93% when compared to the previous finding of 51.1% in southern Ghana. Prevalence of bovine fasciolosis ranging from 8% (Nuraddis *et al.*, 2010) Ethiopia to 51.1% (Squire *et al.*, 2013) southern Ghana has been reported. However, there is still a need to intensify surveillance to control the disease from further spreading. Prevalence of bovine fasciolosis for the study area varies across settlements. A higher prevalence was recorded in Gbetsileh than in Katamanso. The variation in prevalence among study settlements could be due to the availability of marshy pastures and shallow water bodies in Gbetsileh than in Katamanso where livestock graze and drink. These increased the risk of animals acquiring new fasciolosis infestation in these areas compared to areas with less or no marshy areas in the grazing fields.

The present result revealed a prevalence of bovine fasciolosis in the study area as 16.93%. This finding is not in agreement with previous finding of 51.1% (Squire *et al.*, 2013) in southern Ghana. The present findings is also higher than that of 8% (Nuraddis *et al.*, 2010) in Ethiopia. This finding is similar to that of (Mullen *et al.*, 2009) who reported the prevalence of the disease in cattle, sheep and goats as (16.3%) in Arousha, Tanzania.

Variation of these environmental and ecological factors on different agro-ecological zones leads to changes in the prevalence of bovine fasciolosis from one study area to other. Another possible reason for the variation in prevalence of bovine fasciolosis could be due to

local climatic condition, availability of shallow water bodies and other agricultural and livestock management practices that influence the parasite and/or hosts (Marcos, 2005).

The present study showed significant high prevalence of bovine fasciolosis in age group 7 – 12 months (23.46%) compared to age group 0 -6 month (16.53%) and age group >12months (11.94%). Statistical analysis revealed that there is significant association of bovine fasciolosis with age ($P < 0.00$). The finding of this study is in agreement with (Keiser *et al.*, 2005) who reported that there was an age difference in the prevalence of bovine fasciolosis. Acquired immunity is an important factor that influences the severity of bovine fasciolosis (Spithill *et al.*, 1997). This seems to suggest that young cattle with weak and less developed immunity were more likely to be affected by bovine fasciolosis than older animals in which acquired immunity was well developed.

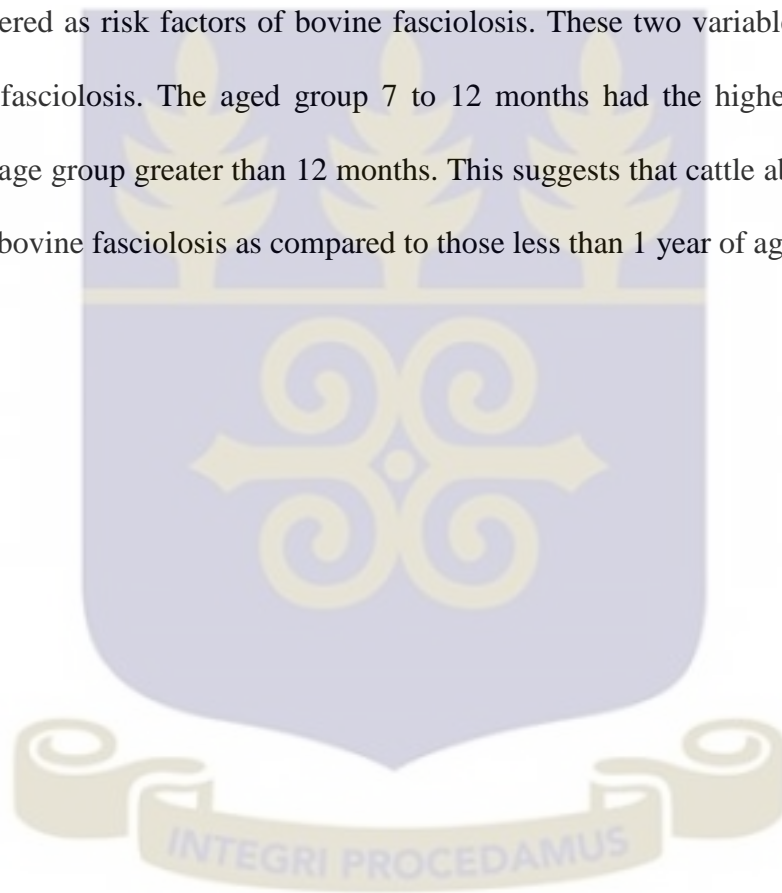
In the present study, sex is statistically significant ($P = 0.02$, CI 1.12 – 3.64). High infestation of the parasite (32.93%) was recorded in males than in females (15.89%). These results in line with (Khan *et al.*, 2009) who also reported higher prevalence in female than males. The reason behind this finding could not be established.

The infestation of bovine fasciolosis on the basis of breed showed no significant difference ($P = 0.11$ CI 0.41 – 1.09). The highest infestation (25%) occurred in West African Shorthorn followed by Zebu (20.77%) and least (14.63%) occurred in cross-breed cattle. This is not in agreement with work done by Mushtag, 2001, who stated that zebu breed are mostly affected than crosses and West African Shorthorn. The possible reason for this could be West African shorthorn cattle are more resistant to parasitic infestation including *Fasciola* than zebu and cross breed cattle.

In the present study, the association between the prevalence of bovine fasciolosis and body condition scoring of cattle was not statistically significant. The highest prevalence of the disease was recorded in poor body condition scoring (20%) than in medium (18.57%) and

good body condition scoring (11.93%). The probable reason could be due to the fact that animals with poor body condition scoring are usually less resistant and are consequently susceptible to various concurrent diseases.

The result of the present study showed that deworming and training on livestock husbandry/management practices reduces (protective) risk of bovine fasciolosis. On the other hand, age group 7 – 12 months and sex increases the risk of bovine fasciolosis and hence considered as risk factors of bovine fasciolosis. These two variables are associated with bovine fasciolosis. The aged group 7 to 12 months had the highest prevalence as compared to age group greater than 12 months. This suggests that cattle above 1 year were resistance to bovine fasciolosis as compared to those less than 1 year of age.



CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The prevalence of bovine fasciolosis was found to be 16.93% in the Kpone-Katamanso District

The age and sex of cattle increase the risk of bovine fasciolosis and are significantly associated with the disease. The age group 7 – 12 months are the most affected.

Herd owners who practice deworming and receive training on improved husbandry/management practices recorded low prevalence of bovine fasciolosis in their cattle.

6.2 Recommendations

The following recommendations are suggested.

- Regular deworming should be carried out mostly targeting young animals.
- There should be an improvement in the husbandry/management care of the males
- All cattle farmers should giving practical refresher course on husbandry/management practices.
- Further studies on this disease with special emphasis on prevalence and risk factors for recommending an effective control program.

REFERENCE

- A. Ashrafi, K., Bargues, M. D., O'Neill, S., & Mas-Coma, S. (2014). Fascioliasis: A worldwide parasitic disease of importance in travel medicine. *Travel medicine and infectious disease*, **12**(6), 636-649.
- Assefa, M. (2005). Parasitic causes of carcass or organ condemnation at Assela municipality abattoir. *DVM thesis, Faculty of veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia*.
- Bidaisee, S., & Macpherson, C. N. (2014). Zoonoses and one health: a review of the literature. *Journal of parasitology research*, 2014.
- Boray, J. C. (1994). Diseases of domestic animals caused by flukes. *Food and Agricultural Organization of the United Nations, Rome*, 49.
- Bowman, D. D. (2014). *Georgis' parasitology for veterinarians*. Elsevier Health Sciences.
- Brogli, A., & Kapel, C. (2011). Changing dietary habits in a changing world: emerging drivers for the transmission of foodborne parasitic zoonoses. *Veterinary parasitology*, **182**(1), 2-13.
- Carrique-Mas, J. J., & Bryant, J. E. (2013). A review of foodborne bacterial and parasitic zoonoses in Vietnam. *EcoHealth*, **10**(4), 465-489.
- Chandi, M. A., Herman, J. S., Partridge, D. G., Hewitt, K., & Chiodini, P. L. (2009). Imported human fascioliasis, United Kingdom. *Emerging infectious diseases*, **15**(11), 1876.
- Chhabra, M. B., and Singla, L. D. (2009). Food-borne parasitic zoonoses in India: review of recent reports of human infections. *Journal of Veterinary Parasitology*, **23**(2), 103
- Cywińska, A. (2005). Epidemiology of fascioliasis in human endemic areas. *Journal of helminthology*, **79**(03), 207-216.
- ESTEBAN, J. G., GONZALEZ, C., CURTALE, F., MUÑOZ-ANTOLI, C. A. R. L. A., VALERO, M. A., BARGUES, M. D., ... and MAS-COMA, S. A. N. T. I. A. G. O. (2003). Hyperendemic fascioliasis associated with schistosomiasis in villages in the Nile Delta of Egypt. *The American journal of tropical medicine and hygiene*, **69**(4), 429-437.
- FAO (2005), FAO Global information and early warning system of Food and Agriculture Organisation World Food Programme.
<http://www.fao.org/docrep/007/J3958e/J3958e00.htm>

- Hansen, J., and Perry, B. (1994). The epidemiology, diagnosis and control of helminth parasites of ruminants. 2.
- Hotez, P. J., Savioli, L., & Fenwick, A. (2012). Neglected tropical diseases of the Middle East and North Africa: review of their prevalence, distribution, and opportunities for control. *PLoS Negl Trop Dis*, **6**(2), e1475.
- Kabir, M. H., Eliyas, M., Hashem, M. A., and Miazi, O. F. (2009). Prevalence of zoonotic parasitic diseases of domestic animals in different abattoir of Comilla and Brahman Baria region in Bangladesh. *University Journal of Zoology, Rajshahi University*, **28**, 21-25.
- Kanyari, P. W. N., Kagira, J. M., and Mhoma, R. J. (2010). Prevalence of endoparasites in cattle with zoonotic potential within urban and periurban areas of Lake Victoria Basin, Kenya. *Afri. J. Anim. Biomed. Sci*, **4**(2), 26-33.
- Kassai, T. "Heartworm disease: Cardiovascular dirofilariosis of dog." *Veterinary helminthology* **121** (1999): 4.
- Keiser, J., and Utzinger, J. (2005). Emerging foodborne trematodiasis. *Emerging infectious diseases*, **11**(10), 1507.
- Keyyu, J. D., Monrad, J., Kyvsgaard, N. C., and Kassuku, A. A. (2005). Epidemiology of *Fasciola gigantica* and amphistomes in cattle on traditional, small-scale dairy and large-scale dairy farms in the southern highlands of Tanzania. *Tropical animal health and Production*, **37**(4), 303-314.
- Khan, M. K., Sajid, M. S., Khan, M. N., Iqbal, Z., and Iqbal, M. U. (2009). Bovine fasciolosis: prevalence, effects of treatment on productivity and cost benefit analysis in five districts of Punjab, Pakistan. *Research in veterinary Science*, **87**(1), 70-75.
- Kithuka JM, Mangi N, Njeruh FM and Ombu JN (2002). The prevalence and Economic importance of bovine Fasciolosis in Kenya: - An abattoir data, *J.Vet.Res.* **69** (255-262).
- Lev, O., & Rager-Zisman, B. (2014). Protecting public health in the age of emerging infections. *The Israel Medical Association journal: IMAJ*, **16**(11), 677-682.
- Lopez, M., White, A. C., & Cabada, M. M. (2012). Burden of *Fasciola hepatica* infection among children from Paucartambo in Cusco, Peru. *The American journal of tropical medicine and hygiene*, **86**(3), 481-485.

- Magona, J. W., and Mayende, J. S. P. (2002). Occurrence of concurrent trypanosomosis, theileriosis, anaplasmosis and helminthosis in Friesian, Zebu and Sahiwal cattle in Uganda. *The Onderstepoort journal of veterinary research*, **69**(2), 133.
- Marcos, L., Maco, V., Terashima, A., Samalvides, F., Espinoza, J. R., and Gotuzzo, E. (2005). Fascioliasis in relatives of patients with *Fasciola hepatica* infection in Peru. *Revista do Instituto de Medicina Tropical de São Paulo*, **47**(4), 219-222.
- Martins, I. V. F., Avelar, B. R. D., Bernardo, C. D. C., Leão, A. C. D., & Salim, M. J. (2014). Distribution of bovine fasciolosis and associated factors in south Espírito Santo, Brazil: an update. *Revista Brasileira de Parasitologia Veterinária*, **23**(1), 23-29.
- Mas-Coma S, Bargues M D and Valero M (2005); Fascioliasis and other plant-borne trematode zoonoses. *International Journal for Parasitology* **35**: 1255–1278. zebu cattle. International livestock Centre for Africa, Addis Ababa. ISBN 92-9053-068-5
- McDaniel, C. J., Cardwell, D. M., Moeller, R. B., & Gray, G. C. (2014). Humans and cattle: a review of bovine zoonoses. *Vector-Borne and Zoonotic Diseases*, **14**(1), 1-19.
- Meléndez, R. D., Coronado, A., Díaz, J. J., and Crespo, G. L. (1983). Aspectos epidemiológicos de la fascioliasis bovina en el Centroccidente A possible source for leaf protein lencia del trematode y de su hospedador intermediario. *Acta cient. Venez*, **34**(1), 65-71
- Mellau, L. S. B., Nonga, H. E., and Karimuribo, E. D. (2010). A slaughterhouse survey of liver lesions in slaughtered cattle, sheep and goats at Arusha, Tanzania. *Research Journal of Veterinary Sciences*, **3**(3), 179-188.
- Mekky, M. A., Erqou, S., Gedefaw, M., & Desta, A. (2015). Epidemiology of human fascioliasis and intestinal parasitosis among schoolchildren in Lake Tana Basin, northwest Ethiopia. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **107**(8), 480-486.
- MICHAEL, A. (2004). Infection prevalence of ovine fasciolosis in irrigation schemes along the Upper Awash River Basin and effects of strategic anthelmintic treatment in selected upstream areas (Doctoral dissertation).
- Molyneux, D., Hallaj, Z., Keusch, G. T., McManus, D. P., Ngowi, H., Cleaveland, S., & Garba, A. (2011). Zoonoses and marginalised infectious diseases of poverty: where do we stand? *Parasites & vectors*, **4**(1), 1.

- Mullen, G. R., and Durden, L. A. (Eds.). (2009). *Medical and veterinary entomology*. Academic Press.
- Mushtaq, S. (2011). An Epidemiological Study of Bovine Fasciolosis in Potohar Region, Pakistan.
- Nicholson, M. J., and Butterworth, M. H. (1986). *A guide to condition scoring of zebu cattle*. ILRI (aka ILCA and ILRAD).
- Nuraddis, I., Pawlos, W., and Tadele, T. (2010). Prevalence of bovine fasciolosis and economic importance due to liver condemnation at Kombolcha industrial abattoir, Ethiopia. *Internet Journal of Veterinary Medicine*, **8**(2).
- Payne, W.T.A., (1990). Introduction to Animal Husbandry in the Tropics. 4 ed. Oxford Blackwell science, pp: 47-74.
- Price, T. A., Tuazon, C. U., and Simon, G. L. (1993). Fascioliasis: case reports and review. *Clinical infectious diseases*, **17**(3), 426-430.
- Ramajo V, Oleaga A, Casanueva P, Hillyer GV and Muro A (2001). Vaccination of sheep against *Fasciola hepatica* with homologous fatty acid protein. *Vet Parasitol* **97**(1): 35-46
- Robinson, M. W., Menon, R., Donnelly, S. M., Dalton, J. P., and Ranganathan, S. (2009). An Integrated Transcriptomics and Proteomics Analysis of the Secretome of the Helminth Pathogen *Fasciola hepatica* Proteins associated with invasion and infection of the mammalian host. *Molecular & Cellular Proteomics*, **8**(8), 1891-1907.
- Scott, J. M., and Goll, P. H. (1977). The epidemiology and anthelmintic control of ovine fascioliasis in the Ethiopian central highlands. *British Veterinary Journal (UK)*.
- Smith, G. (1981). A three-year study of *Lymnaea truncatula* habitats, disease foci of fascioliasis. *The British veterinary journal*, **137**(4), 398.
- Soliman KN et al (1964) the present situation concerning liver fluke disease in Egypt. *Bull Epizootic Dis Afr* **12** 455-460.
- Spithill, T. W., Piedrafita, D., and Smooker, P. M. (1997). Immunological approaches for the control of fasciolosis. *International Journal for Parasitology*, **27**(10), 1221-1235.
- Squire, S. A., Amafu-Dey, H., and Beyuo, J. (2013). Epidemiology of gastrointestinal parasites of cattle from selected locations in Southern Ghana. *Livestock Research for Rural Development*, **25**(7).

- Standley, C. J., Dobson, A. P., & Stothard, J. R. (2012). *Out of animals and back again: schistosomiasis as a zoonosis in Africa*. INTECH Open Access Publisher.
- Swai, E. S., & Ulicky, E. (2009). An evaluation of the economic losses resulting from condemnation of cattle livers and loss of carcass weight due to Fasciolosis: a case study from Hai town abattoir, Kilimanjaro region, Tanzania. *Livestock Research for Rural Development*, **21**(11), 186.
- Taylor, M.A., R.L. Coop and R.L. Wall, 2007. *Veterinary parasitology*. 3rd ed. Oxford
- Thrustfield M. (2005). *Veterinary Epidemiology* 3rd edition, Black Well Science Ltd Cambridge, USA PP 225 – 228
- Urquhart, G.M., J.L. Amour, A.M. Dunn and F.W. Jennings, (1996). *Veterinary Parasitology*. 2 ed. Oxford: Blackwell nd publishing, Pp. 103-112. Not clea
- Wakuma, M. (2009). Prevalence and economic significance of bovine fasciolosis at Bedele municipal abattoir. *DVM thesis, Jimma University, Faculty of Veterinary Medicine, Jimma, Ethiopia*.
- Walker SM, Makundi AE, Namud FV, Kassuku AA., Keyyu V, Hoey EM, Prodohi P, Stothard JR and Trudget A (2005). The distribution of *Fasciola hepatic* and *Fasciola gigantica* within southern Tanzania. Constraint associated with intermediate host. *Parasitology* **135**(495-503).
- Waruiru R.M Kyvsgaard N C, Theamsborg S M, Nansen P, Bogh H O, Munyua W K and Gathuma J M (2000). The prevalence and intensity of helminth and coccidal infections in dairy cattle in central kenya. *Veterinary Research Communication* **24**: 39-53
- WHO (2007) Report of the WHO Informal Meeting on use of triclabendazole in fascioliasis control. WHO/CDS/NTD/PCT/2007.1.
- Veterinary Services Directorate Annual repor (2010)
- y Sierra, R. M., Agramunt, V. H., Cuervo, P., & Mas-Coma, S. (2011). Human fascioliasis in Argentina: retrospective overview, critical analysis and baseline for future research. *Parasites & vectors*, **4**(1), 1.

APPENDICES

APPENDIX I: Data extraction tools for age, sex, breed and body condition scoring of study cattle in one study settlement

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age 0 0 – 6 months 1 7 -12 months 2 >12 months	Sex 0 Female 1 Male	Breed 0 W/African short horn 1 Zebu 2 cross	Body Condition Score 0 Poor 1 medium 2 good	Coprology result 0 negative 1 positive
001					
002					
003					
004					
005					
006					
007					
008					
009					
010					
011					
012					
013					
014					
015					
016					
017					
018					
019					
020					

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age	Sex	Breed	Body Condition Score	Coproculture
	0 0 – 6 months 1 7 -12 months 2 >12 months	0 female 1 male	0 W/African short horn 1 Zebu 2 Cross	0 poor 1 medium 2 good	0 Negative 1 Positive
021					
022					
023					
024					
025					
026					
027					
028					
029					
030					
031					
032					
033					
034					
035					
036					
037					
038					
039					
040					

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age	Sex	Breed	Body Condition	Coprology result
	0 0 – 6 months 1 7 -12 months 2 >12 months	0 female 1 male	0 W/African short horn 1 Zebu 2 cross	Score 0 poor 1 medium 2 good	0 negative 1 positive
041					
042					
043					
044					
045					
046					
047					
048					
049					
050					
051					
052					
053					
054					
055					
056					
057					
058					
059					
060					

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age	Sex	Breed	Body Condition Score	Coprology result
	0 0 – 6 months 1 7 -12 months 2 >12 months	0 female 1 male	0 W/African short horn 1 Zebu 2 cross	0 poor 1 medium 2 good	0 negative 1 positive
061					
062					
063					
064					
065					
066					
067					
068					
069					
070					
071					
072					
073					
074					
075					
076					
077					
078					
079					
080					

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age	Sex	Breed	Body Condition Score	Coproculture
	0 0 – 6 months 1 7 -12 months 2 >12 months	0 female 1 male	0 W/African short horn 1 Zebu 2 cross	0 poor 1 medium 2 good	0 negative 1 positive
081					
082					
083					
084					
085					
086					
087					
088					
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090					
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092					
093					
094					
095					
096					
097					
098					
099					
100					

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age	Sex	Breed	Body Condition	Coproculture
	0 0 – 6 months 1 7 -12 months 2 >12 months	0 female 1 male	0 W/African short horn 1 Zebu 2 cross	Score 0 poor 1 medium 2 good	0 negative 1 positive
101					
102					
103					
104					
105					
106					
107					
108					
109					
110					
111					
112					
113					
114					
115					
116					
117					
118					
119					
120					

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age	Sex	Breed	Body Condition Score	Coproculture
	0 0-6 months 1 7-12 months 2 >12 months	0 female 1 male	0 W/African short horn 1 Zebu 2 cross	0 good 1 medium 2 poor	0 negative 1 positive
121					
122					
123					
124					
125					
126					
127					
128					
129					
130					
131					
132					
133					
134					
135					
136					
137					
138					
139					
140					

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age	Sex	Breed	Body Condition	Coproculture
	0 0 – 6 months 1 7 -12 months 2 >12 months	0 female 1 male	0 W/African short horn 1 Zebu 2 cross	Score 0 poor 1 medium 2 good	0 negative 1 positive
141					
142					
143					
144					
145					
146					
147					
148					
149					
150					
151					
152					
153					
154					
155					
156					
157					
158					
159					
160					

ID number-----

Form number-----

Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age	Sex	Breed	Body Condition Score	Coprology result
	0 0 – 6 months	0 female	0 W/African short horn	0 poor	0 negative
	1 7 -12 months	1 male	1 Zebu	1 medium	1 positive
	2 >12 months		2 cross	2 good	
161					
162					
163					
164					
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177					
178					
179					
180					

ID number-----

Form number-----

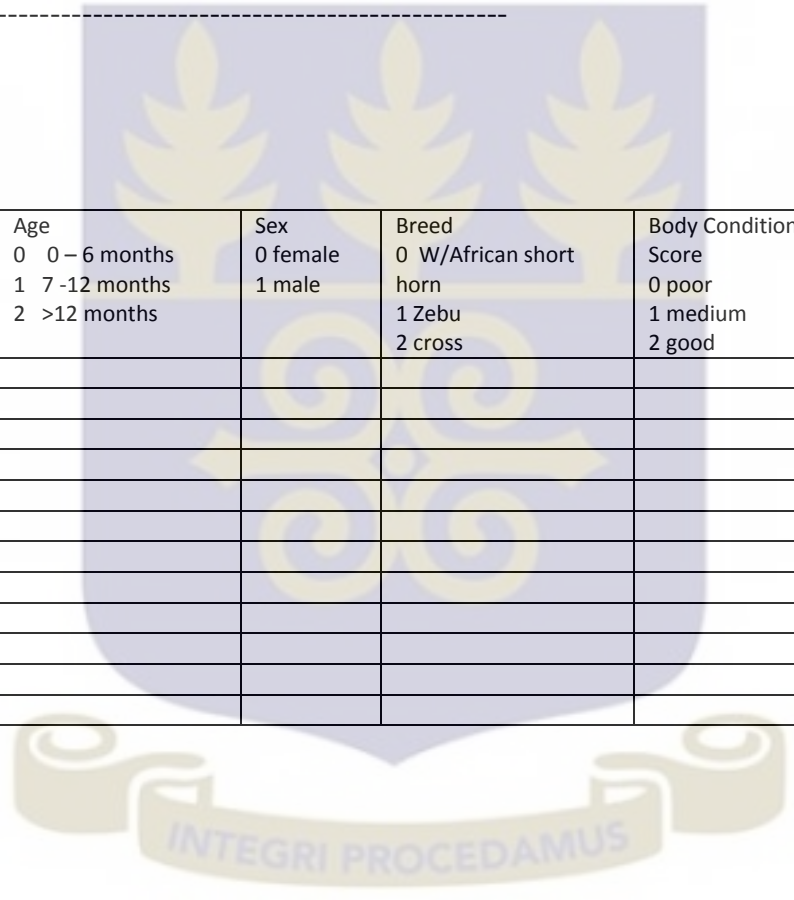
Name of the herdsman-----

Number of cattle-----

Sampling settlement-----

Date-----

Serial No.	Age 0 0 – 6 months 1 7 -12 months 2 >12 months	Sex 0 female 1 male	Breed 0 W/African short horn 1 Zebu 2 cross	Body Condition Score 0 poor 1 medium 2 good	Coprology result 0 negative 1 positive
181					
182					
183					
184					
185					
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191					
192					



APPENDIX II: Questionnaires for assessing husbandry/management practices such as grazing, watering and helminth control practices of herd owners or Herdsmen.

Form Number -----

Identification Number -----

Name of the Settlement: -----

Number of cattle Manage -----

Number of years served as cattle farmer -----

Location of kraal (GPS coordinates)-----

Pictures of the Kraal-----

1. What type of grazing system do you practice?
 - a. Zero grazing
 - b. Extensive grazing
2. Is the vegetation available and accessible to the cattle throughout the year?
 - a. Yes
 - b. No
3. Is the vegetation used used by other animals within or outside the settlement?
 - a. Yes
 - b. No
4. Where do your cattle get water to drink?
 - a. At Home
 - b. Outside home such as Dams, lakes tec
5. If outside, is the water accessible to the cattle throughout the year?
 - A yes
 - B no
6. If outside, is the drinking place for your cattle used by other livestock
 - a. Yes
 - b. No
7. How many times do you cattle drinks from the water source?
 - a. Once a day
 - b. Two times in a day

8. Do you practice deworming for your cattle?
 - a. Yes
 - b. No

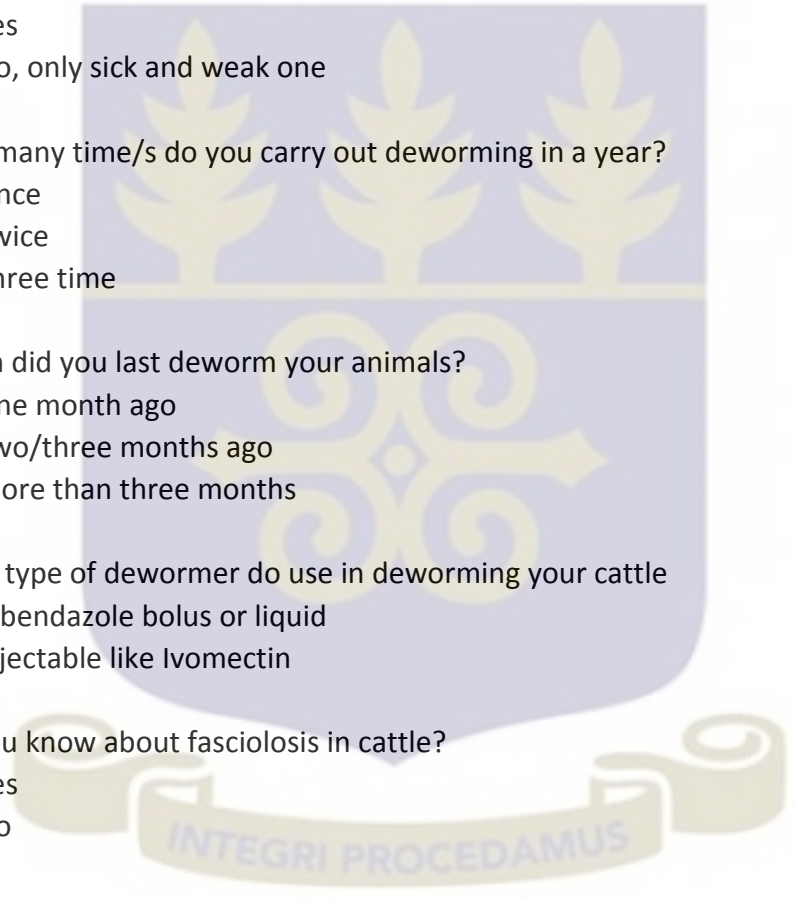
 9. Do you carry out regular three months deworming of the cattle?
 - a. Yes
 - b. No

 10. Do you deworm all the cattle?
 - a. Yes
 - b. No, only sick and weak one

 11. How many time/s do you carry out deworming in a year?
 - a. Once
 - b. Twice
 - c. Three time

 12. When did you last deworm your animals?
 - a. One month ago
 - b. Two/three months ago
 - c. More than three months

 13. What type of dewormer do use in deworming your cattle
 - a. Albendazole bolus or liquid
 - b. Injectable like Ivomectin

 14. Do you know about fasciolosis in cattle?
 - a. Yes
 - b. No
- 
- The image contains a large, semi-transparent watermark of the University of Ghana crest. The crest is a shield-shaped emblem with a blue background and gold-colored decorative elements. At the top, there are three stylized leaves or branches. Below them is a central gold-colored emblem featuring a cross-like shape with intricate scrollwork. At the bottom of the shield, there is a gold-colored banner with the Latin motto "INTIGRI PROCEDAMUS" written in blue capital letters.

Form Number -----

Identification Number -----

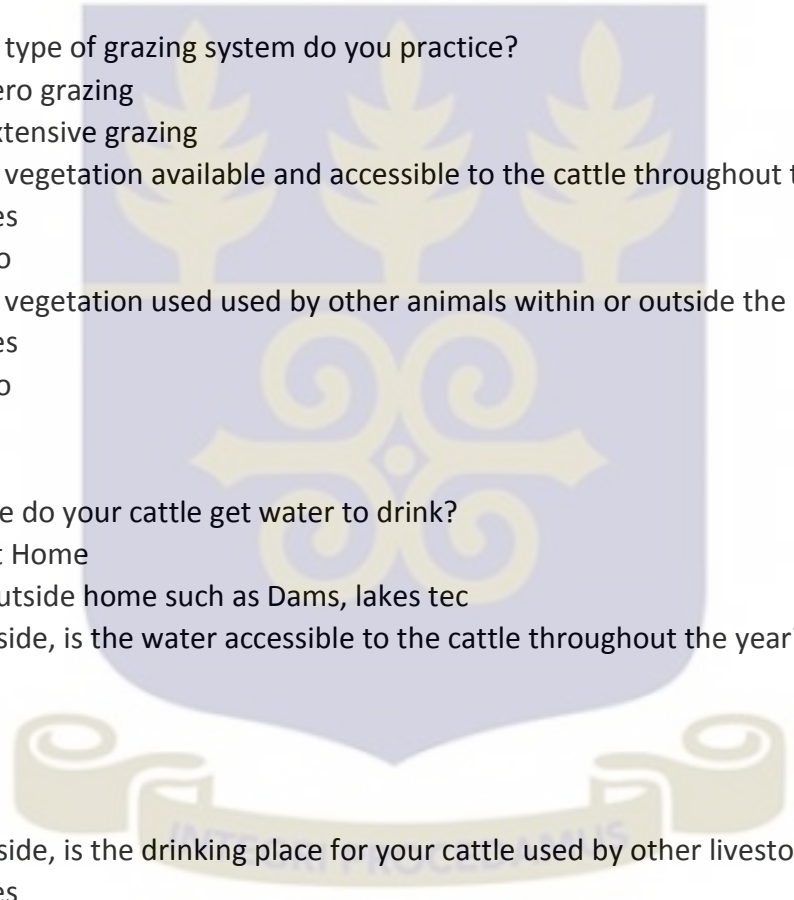
Name of the Settlement: -----

Number of cattle Manage -----

Number of years served as cattle farmer -----

Location of kraal (GPS coordinates)-----

Pictures of the Kraal-----

- 
6. What type of grazing system do you practice?
 - c. Zero grazing
 - d. Extensive grazing
 7. Is the vegetation available and accessible to the cattle throughout the year?
 - c. Yes
 - d. No
 8. Is the vegetation used used by other animals within or outside the settlement?
 - c. Yes
 - d. No
 9. Where do your cattle get water to drink?
 - c. At Home
 - d. Outside home such as Dams, lakes tec
 10. If outside, is the water accessible to the cattle throughout the year?
 - A yes
 - B no
 15. If outside, is the drinking place for your cattle used by other livestock
 - c. Yes
 - d. No
 16. How many times do you cattle drinks from the water source?
 - c. Once a day
 - d. Two times in a day
 17. Do you practice deworming for your cattle?
 - c. Yes
 - d. No

18. Do you carry out regular three months deworming of the cattle?
- c. Yes
 - d. No
19. Do you deworm all the cattle?
- c. Yes
 - d. No, only sick and weak one
20. How many time/s do you carry out deworming in a year?
- d. Once
 - e. Twice
 - f. Three time
21. When did you last deworm your animals?
- d. One month ago
 - e. Two/three months ago
 - f. More than three months
22. What type of dewormer do use in deworming your cattle
- c. Albendazole bolus or liquid
 - d. Injectable like Ivomectin
23. Do you know about fasciolosis in cattle?
- c. Yes
 - d. No



APPENDIX III:

Pictures taken during feecal sample collection in the study herds









APPENDIX IV
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
CSIR-IRB CONSENT FORM TEMPLATE

Title: *[Name of research project]*

Principal Investigator: *[Name]*

Address: *[Name of institution/company and complete address]*

General Information about Research: Things to indicate (These things are just to guide you as to what to write kindly delete them fill in with the information also do not bullet your information)

- *State clearly the objective of the research in easily-understood words.*
- *There must be a statement that you are conducting a research,*
- *The purpose of the research*
- *The expected duration of the participant's participation,*
- *A description of the procedures to be followed*
- *Identification of any procedures which are experimental and what the participant(s) is supposed to do.*
- *Other relevant information about the research must be stated)*

(NB: Avoid the use of technical language or jargons, the language should be very simple, about half a page)

Possible Risks and Discomforts

(Description of any reasonable foreseeable risks or discomfort to the participant. Include physical, social and psychological risk if anticipated.)

Possible Benefits

(Specific language about benefits to individuals and/or society that can be reasonably expected.)

Alternatives to Participation

(Disclosure of appropriate alternatives or courses of treatment, if any, that might be advantageous to the subject).

(This does not apply to all studies and usually used for intervention studies)

Confidentiality

(A statement describing the extent, if any, to which confidentiality of records identifying the subjects will be maintained. For example, "We will protect information about you to the best of our ability. You will not be named in any reports. Some staff of [list all groups that may access the research records] may sometimes look at your research records").

Compensation

(If there are any compensation packages either in cash or kind available for participants it must be clearly spelt out in terms of the actual amount to be given or gift to be given, conditions for receiving the package and when it will be made) Usually compensation should be given at the end of the study

Additional Cost

(Any additional cost to the participant that may result from participation in the research should be stated)

This does not apply to all studies

Staying in the Research

(If the research method is to be used with another method, list conditions of use and any exceptions to the exclusive use requirements)

(This does not apply to all studies)

Voluntary Participation and Right to Leave the Research

(A statement that the research is voluntary and participant can withdraw without penalty)

Termination of Participation by the Researcher

(Any anticipated circumstances under which the participant's participation may be terminated by the investigator without regard to the participant's consent must be specified)

(This does not apply to all studies)

Notification of Significant New Findings

(A statement that significant new findings developed during the course of the research that may relate to the participant's willingness to continue participation will be provided to the participant)

(This does not apply to all studies)

Contacts for Additional Information

(Give an explanation of whom to contact for answers to pertinent questions about the research and whom to contact in case of research-related injury. Give names and mobile numbers that are accessible to the participant)

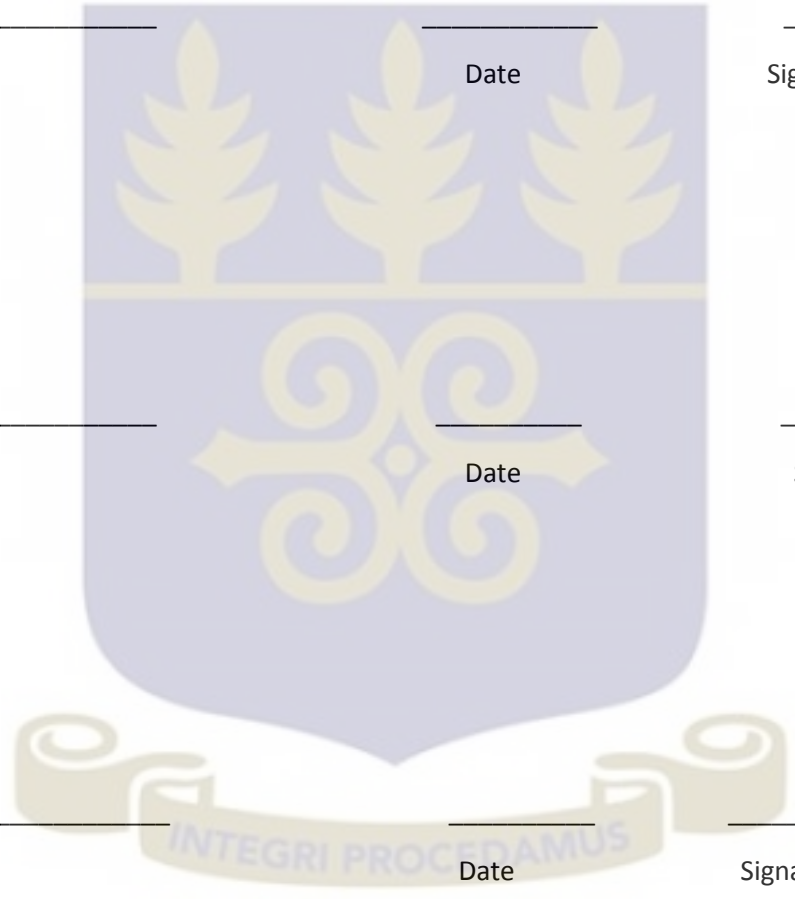
Your rights as a Participant

This research has been reviewed and approved by the Institutional Review Board and Institutional Animal Care and Use Committee of Council for Scientific and Industrial Research (CSIR-IRB/IACUC). If you have any questions about your rights as a research participant you can contact the IRB/IACUC Office between the hours of 8am-5pm through the landline 0302777651 or email addresses: csirirb_iacuc@csir.org.gh or pselormey@gmail.com. You may also contact the chairman, Mr. Okyere Boateng through mobile number 0204362635 when necessary.



VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research title (***name of research***) has been read over and explained to me in (**language**) and I have perfectly understood the explanation. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.



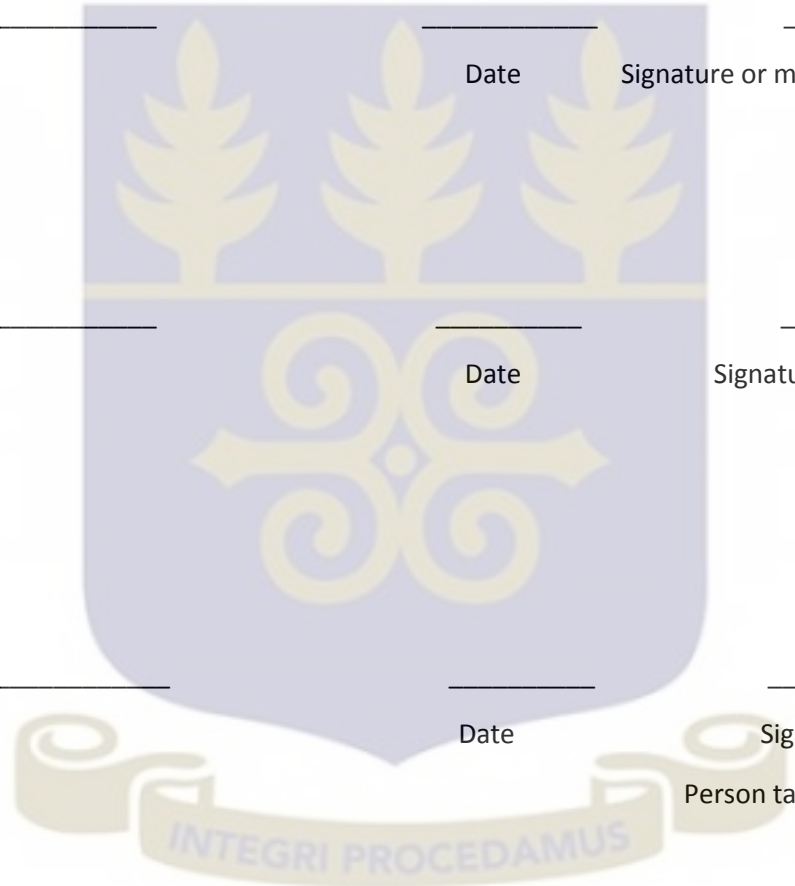
Name of volunteer _____ Date _____ Signature or mark _____

Name Witness _____ Date _____ Signature of _____

Name _____ Date _____ Signature of _____
Person taking Consent

VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research title (***name of research***) has been read over and explained to me in (**language**) and I have perfectly understood the explanation. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.



Name _____ Date _____ Signature or mark of volunteer _____

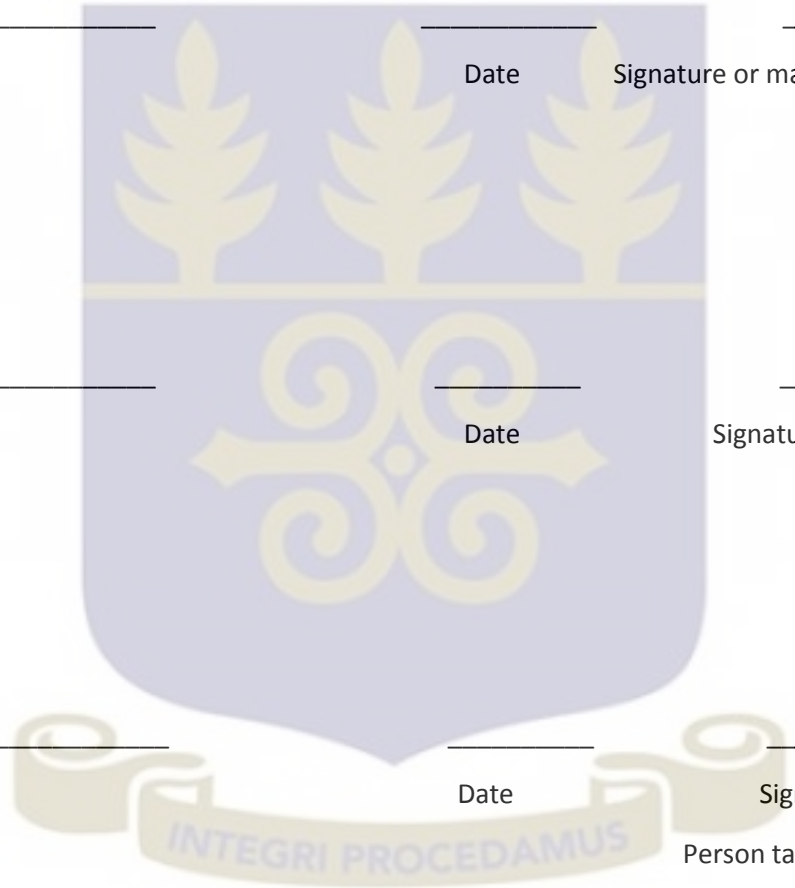
Name _____ Date _____ Signature of Witness _____

Name _____ Date _____ Signature of Person taking Consent _____

INTEGRI PROCEDAMUS

VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research title (***name of research***) has been read over and explained to me in (**language**) and I have perfectly understood the explanation. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.



Name _____ Date _____ Signature or mark of volunteer _____

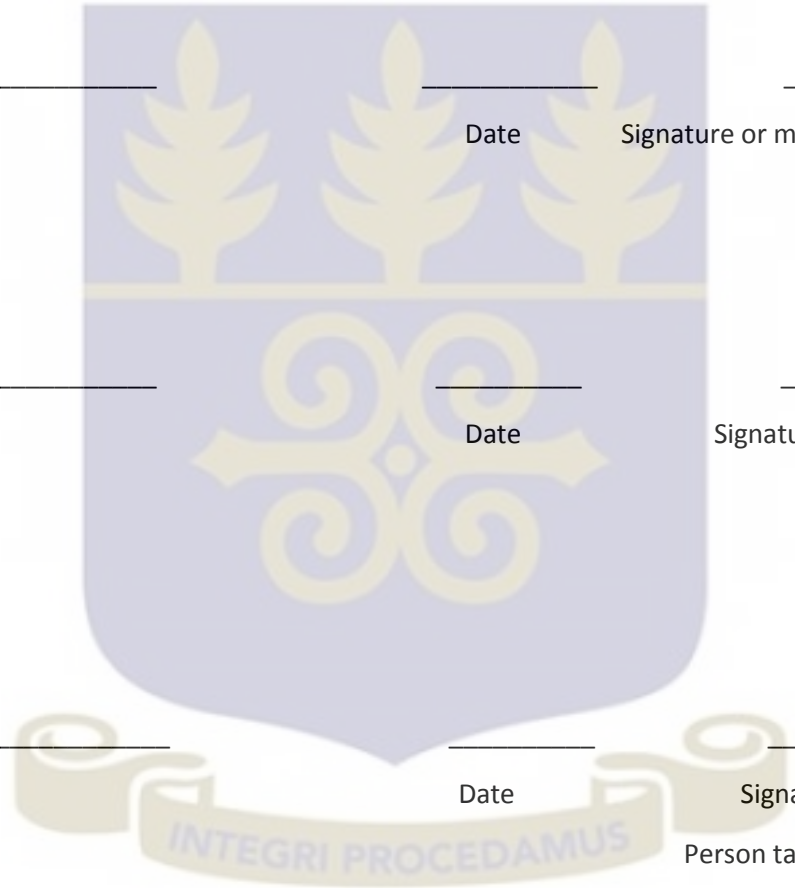
Name _____ Date _____ Signature of Witness _____

Name _____ Date _____ Signature of _____
Person taking Consent

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Person taking Consent

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_____	_____	_____
Name	Date	Signature or mark of volunteer
_____	_____	_____
Name	Date	Signature of Witness
_____	_____	_____
Name	Date	Signature of Person taking Consent

