Prevalence of gastrointestinal parasitic infections in sheep of Subarnachar upazilla in Noakhali district of Bangladesh

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This is to certify that we have examined this thesis and have found that it is complete and satisfactory in all respects, and that all revisions required by the thesis examination committee have been made

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DEDICATION

To my family members

who always valued education

above everything else.

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The Author
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List of Abbreviations

Abbreviations	**Elaborations**
DLS	Directorate of Livestock Services
GDP	gross domestic products
GI	gastrointestinal
GIN	gastrointestinal Nematode
GIT	gastrointestinal tract
ID	identification
CVASU	Chittagong Veterinary and Animal Sciences University
DPP	Department of Pathology and Parasitology
e.g.	example
etc.	et cetera
PCR	polymerase Chain reaction
US	United States
UK	United Kingdom
EPG	egg per gram
BLRI	Bangladesh Livestock Research Institute
GI	Gastrointestinal
P	pregnant
M	male
F	female
Y	year
%	percent
sp.	species

Abstract

Gastrointestinal parasitic infection is a major cause of failures in sheep production in Bangladesh. A study was conducted to determine the prevalence of gastrointestinal parasitic infections of sheep in Subarnachar upazilla of Noakhali district in Bangladesh during January 2017 to December 2017. In total, 200 rectal fecal samples of non-descriptive indigenous sheep were randomly collected and were examined by routine coproscopical methods and modified McMaster technique. The effects of topography, age, sex, rearing system, health status and management system on gastrointestinal parasitic infections were evaluated by chi-square test. The overall prevalence of gastrointestinal parasitic infections in sheep was 79.50%. The highest prevalence of gastrointestinal parasitic infections was found in Char Clark union (83.33%) than the others, although their relationship were statistically insignificant (P>0.05). Species wise prevalence of gastrointestinal parasitic infections was *Fasciola* sp. (37.5%), *Paramphistomam* sp. (41.0%), *Strongyloides* sp. (46.0%), Strongyle-type (39.5%), *Trichuris* sp. (28.0%) and *Moniezia* sp. (34.0%). The occurrence of gastrointestinal parasitic infections was more in young (90.0%) than the adult sheep (70.90%). Female sheep displayed a higher infection (85.0%) as compared to male (71.25%) and free range grazing sheep (82.66%) in bathan area was more infected as compared to semi-intensive system (77.66%). Good healthy animals had infection with EPG level of 380-1000 as compared to moderate healthy (>1000-2000) and poor healthy (>2000) animals. The animals those were reared under proper management system including regular deworemed by anthelmentics, proper housing and feeding with nutritional supplement were less infected by gastrointestinal parasites. As the present study was fresh of its type in the study areas, further investigation is recommended to evaluate the region specific risk factors.

Key words: Gastrointestinal parasitic infection, Sheep, Prevalence, Risk factor, Subarnachar

Chapter 1: Introduction

Livestock populations are the important asset for any country. Sheep are the earliest ruminants to be domesticated. They can withstand a period of draught better than any other livestock and they can use those pastures, which cannot be used by other livestock. Sheep and goat rearing plays an important role in the livelihood of poor, small and marginal farmers and provides a major source of income especially through self-employment and guaranteed supplementary (Rajarajan *et al.,* 2017). Small ruminants are widely distributed especially extensive rearing of sheep as flock wise in coastal belt and are of great importance as a major source of income for small and the landless farmers in rural areas. Coastal dumpy environmental contamination anchorage great overload of parasitic infection and unintended planning, backyard grazing system all are closely related to parasitic degree of Infection (Miller *et al.*, 2002). The association among anthropogenic environmental disturbance, pathogen pollution and the emergence of infectious diseases in wildlife has been postulated, but not always well supported by epidemiologic data. Specific evidence of coastal contamination of the marine ecosystem with the zoonotic protozoan parasite, like Taeniasis, Echinococcosis etc, and extensive infection of greater Maghna River water along the Subarnachar coast was documented by this study. Goat with large genetic diversity accounts for greater meat production in Bangladesh and the whole world (BLRI, 2016). Helminthiasis, especially parasitic gastroenteritis, pose a serious health threat and a limitation to the productivity of small ruminants due to the associated morbidity, mortality, cost of treatment and control measures (Nwosu *et al*., 2007). In addition to these threats, infestation with helminthes lowers the animal’s immunity and renders it more susceptible to other pathogenic infections; finally this may result in heavy economic losses (Garedaghi *et al.,* 2011). Sheep and goats are the earliest ruminants to be domesticated. They can withstand a period of draught better than any other livestock and they can use those pastures, which cannot be used by other livestock. Sheep and goat rearing plays an important role in the livelihood of poor, small and marginal farmers and provides a major source of income especially through self-employment and guaranteed supplementary household income to the majority of rural farming population of Indian sub-continent, since the sheep and goats are the good source of food protein, skin, fiber, manure, etc. and these animals provide an average net income of about 250/animal to its owner and to the Indian economy as a whole of 66.109 million annually (Madan, 1996). The problem is however much more severe in tropical countries due to very favorable environmental conditions for helminths transmission. Gastrointestinal parasitism is a worldwide problem (Regassa *et al.,* 2006). It is thought to be one of the major constraints that hinder the development of livestock population (Kakar and Kakarsulemankhel, 2008; Jabber and Green, 1983) and it also adversely affect the health and productivity of animal (Irfan, 1984). The losses caused by parasitic infestation are in the form of lowered general health condition, retarded growth rate, diminishing the working efficiency, decrease milk and meat production, abortion; cost associated with preventive measures and reduces the disease resistance capability, which may ultimately lead to higher mortality (Chavan *et al.,* 2008; Silvestre and Humbert, 2000; Radostits *et al.,* 1994). However, the geo-climatic condition of the country also favors the growth, development and survival of various parasites. It has been estimated that about 10% animal die annually due to parasitic disease. Gastro-intestinal parasitic infestations are widely prevalent in Bangladesh and produce a substantial economic loss. Some GI parasites may cause death in calves in heavy infestations. Prevalence of helminthes parasitic infestation in cattle in some areas of Bangladesh has been reported earlier (Rahman and Razzak, 1973). Livestock is one of the most potential sub-sectors of agriculture in Bangladesh which plays an indispensable role in promoting human health and national economy of the country. Livestock not only assists to upgrade the financial condition but also makes a substantial contribution to human nutrition. However, livestock is an integral part of farming system which has a better contribution to enhance the economy of Bangladesh. Large ruminants (Cattle and Buffalo) and small ruminants (sheep and goat) constitute the major portion of livestock. The present population of livestock is 22.87 million cattle, 1.21 million Buffalo, 20.75 million goat and 2.68 million sheep (DLS, 2008). The total contribution of livestock sub-sector to Gross Domestic Product (GDP) in Bangladesh is approximately 7.23% and livestock in agricultural production 17.32% (BLRI, 2016). It also generates 13% of foreign currency and provides 20% fulltime employment and 50% partial employment of rural population (Alam, 1993).

In Bangladesh, 80% rural people rear indigenous cattle (Siddiki *et al*., 2009) and many people are also involved with urban and rural dairy farming. Most animals are reared in houses under the traditional husbandry practices. Now a day, dairy farming in rural and urban areas is increasing with modern husbandry practices (Sardar *et al.*, 2006) where cattle are mainly reared for several reasons including meat and milk production (Lako *et al.,* 2007). The production and productivity of animals are greatly hampered by different diseases including gastrointestinal parasitism (Ngole *et al.*, 2004).

Gastrointestinal parasitism is a world-wide problem (Regassa *et al.,* 2006). It is thought to be one of the major constraints that hinder the development of livestock population and it also adversely affects the health and productivity of animals (Jabber and Green, 1983; Irfan, 1984; Kakar and Kakarsulemankhel, 2008). The losses caused by parasitic infections are in the form of lowered general health condition, retarded growth rate, diminishing the working efficiency, decrease milk and meat production, abortion, cost associated with preventive measures and reduces the disease resistance capability, which may ultimately lead to higher mortality (Chavhan *et al.,* 2008, Silvestre and Humbert, 2000; Radostits *et al.,* 1994). However, the geo-climatic conditions of the country also favor the growth, development and survival of various parasites.

Infections caused by gastrointestinal parasites especially nematodes are one of the major causes of calf mortality and act as a big threat for dairy industry of this country. Earlier reports revealed that 50% calves up to 1 year of age died due to gastrointestinal parasitism (Debnath *et al*., 1995). On the other hand, the adult cattle also severely affect by parasitism as they are kept for a longer period of time in breeding or milk production purposes and often supply insufficient feed against their high demand (Sardar *et al.,* 2006) resulting enormous economic losses. The total annual loss due to gastrointestinal parasites was 25-30 million sterling pounds reported by Rahman and Razzak (1973). Despite significant losses by gastrointestinal parasitism, the problems are often neglected and overlooked as majority of the infected animals show a number of little obvious clinical signs throughout their productive life and their effects are gradual and chronic (Raza *et al.,* 2010). Epidemiological pattern of the parasitic diseases in the different agro-climatic zones of the country usually provides a basis for developing strategic and tactical control systems against them. There are several research on gastrointestinal parasitic infections in different regions of Bangladesh were reported by many authors (Rahman and Razzak, 1973; Rahman and Mondal, 1983; Afazuddin, 1985; Amin and Samad, 1987; Chowdhury *et al.*, 1993; Shahiduzzaman *et al.*, 1999; Mondal, *et al.*, 2000; Samad *et al.*, 2004; Sardar *et al.*, 2006; Siddiki *et al.*, 2009; Alim *et al.*, 2011). The temperate agro-climatic conditions, traditional animal husbandry practices and poor veterinary infrastructure, abundance of pastures are natural determining factors of incidence and severity of various parasitic diseases of livestock in Subarnachar, Noakhali (Tariq *et al.*, 2008). Gastrointestinal parasitism is the major cause of damage and decreased productivity in the goat industry particularly in developing countries. Soulsby (1982) pointed out that tape worms are relatively less pathogenic but in heavy infections may cause reduced weight gain, diarrhoea and intestinal obstruction. Numerous epidemiological studies have been conducted throughout the world to arrive at the detailed information on the gastrointestinal parasites of livestock but very little references are available on epidemiology and prevalence of gastrointestinal parasitic infections of sheep. The major risk factors of helminthiasis are broadly classified as parasite factors (including epidemiology of the different species), host factors (genetic resistance, age and physiological status of the animal) and environmental factors (climate, nutrition, stocking density and management) (Odoi *et al.*, 2007).

In view of the impact on our gross economy and economic losses to livestock, there is need for the development of reliable methods for the detection of parasitic infection in coastal belt like Subarnachar under Noakhali district of Bangladesh. It is also important to take an action to identify the major Cause and remedy of Parasitic load like this coastal area because of Still now no epidemiological information was available on intestinal helminth of sheep in Subarnachar, Noahkhali.

A proper understanding about the epidemiology of GI parasitism is a prerequisite for the rational designing of the effective preventive and control measures against these dreadful GI parasitic diseases (Rajarajan *et. al*., 2017). Keeping the same in view the present study was taken into consideration in order to explore the epidemiology of various gastrointestinal parasites infesting the sheep in Subarnachar upazilla of Noakhali district in Bangladesh and various associated risk factors for an effective management.

The present study was carried out with the following objectives:

1. To estimate the prevalence of gastrointestinal parasitic infections according to age, sex and breed of sheep.
2. To know the infection load (epg) of gastrointestinal parasites in sheep.
3. To determine the factors that affects sheep production drastically in the saline areas of Bangladesh.

Chapter 2: Review of Literature

Many scientists from all over the world paid their keen interest towards advancement of sheep farming and its management due to its high food and market value. Thus it is difficult to prepare a brief and comprehensive account of the topic with the huge monumental scientific tasks done so far throughout the world. However, attempts have been made to explore all the literature to focus on the progress of science regarding sheep farming and its disease management.

2.1 Gastrointestinal Parasitism

Parasites cause disease when they are present in large numbers or when the host animal is weakened by another disease or by poor nutrition. Damage to the host occurs when the parasites attach to the lining of the gastrointestinal tract and ingest blood large numbers of parasites can create anemia from blood loss. Damage can also occur from other parasites when they either attach to the lining of the gastrointestinal tract and cause it to become inflamed, or they live in the lumen (open area) of gastrointestinal tract and have access to ingested feed nutrients before the host can digest them. This can result in impaired ability of the host animal to absorb nutrients, causing poor body condition (thinness), poor growth rates, low milk production, and/or poor hair coat or fleece growth. Some parasites cause a reduction in appetite by the host animal. Sheep and goats carry parasites that can be transmitted to each other (across different species). Parasites and pathogens represent an increasing threat to natural populations (Harvell *et al.*, 1999; Daszak *et al.*, 2000). Recently, attention has been focused on examining methods by which disease threats can be managed in free-ranging coastal animal and wildlife. Many of these parasites infect multiple host species; inter-specific interactions among hosts potentially play an important role in parasite transmission dynamics in ungulate communities. Gastrointestinal parasitism is closely related to host age sex, grazing land and nutrition. Effects of gastrointestinal parasitic infection on metabolism and nutrient utilization in sheep are closely related. Both resistance of the animal to larval establishment and performance in the face of larval challenge can be enhanced by improved protein nutrition (Sykes and Coop, 2001). Across individual hosts, Strongyle nematode abundance increased with increasing numbers of bovid species occupying a habitat. Furthermore, comparative analyses show a positive association between Strongyle prevalence and level of habitat. Prevention, rather than cure, is the philosophy used in developing control programs against gastrointestinal nematodes. It should be assumed that worms cannot be eradicated from the environment and livestock will continually be re-infected. However, infections can be limited to the extent that they will not cause economic loss to the producer.

A combination of treatment and management is usually necessary to achieve control. One approach is the strategic use of anthelmintics. Anthelmintics are used at a time when most of the total worm population is within the goat and not on the pasture, such as when Sheep are moved from a contaminated pasture to a parasite-free or nearly free pasture. Pastures become parasite-free when they have been tiled or given prolonged rest at a suitable time of year or were grazed by animals which are not satisfactory hosts for the target parasite species.

2.2 Epidemiology

Commonly occurring gastrointestinal parasitism in sheep are Haemonchosis, Strongyloidosis, Oesophagostomiasis, Bunostomiasis, Trichostrongylosis and Coccidiosis. Among these GI parasites, *Haemonchus contortus* is the most prevalent and important parasite (Khalafalla *et al.*, 2011)**.** The degree of infestation may be sub-clinical or clinical depending on level of parasitic load. Sub clinical infections remain dominant and as such are not recognized by the clinicians and owners. These are responsible for a number of economic losses in a variety of ways as: losses through lower fertility, reduced work capacity, involuntary culling, reduction in feed intake, lower weight gains, reduction in milk and meat production, increased treatment costs and mortality in heavily parasitized animals (Fikru *et al.,* 2006). The development and survival pattern of infective larvae in the environment differs according to the climate. Three broad types of climate are found in tropical and sub-tropical regions:

- Humid tropical climate
- Savannah-type tropical and sub-tropical climate with a long dry season
- Arid tropical and sub-tropical climate

The humid tropical climate characterizes much of West Africa as well as the regions surrounding Lake Victoria and parts of coastal eastern Africa. It is also the climate of much of southeastern Asia, Central America and northern South America. The parasites' eggs or larva developed into in the fecal material or in environment to make them accessible to ingestion by ruminants, the larvae have to migrate or be transported from the faces in which they were deposited on the ground to any nearby herbage. Such movement occurs in two ways: horizontal migration or transport and vertical migration or transport. Embryonation and hatching of the eggs depends on light, temperature, humidity and oxygen and this process does not take place while the eggs are in the fecal mass. The development of larvae in the environment depends upon warm temperature and adequate moisture. In most tropical and sub-tropical countries, temperatures are permanently favorable for larval development in the environment. Exceptions to this are the highland and mountainous regions throughout the world and the winters of southern Africa and Latin America where temperatures may fall below those favorable for the development larvae. The ideal temperature for larval development of many species in the microclimate of the tuft of grass or vegetation is between 22° and 26°C. Development can also occur at higher temperatures, even over 30°C, but larval mortality is high at these temperatures. The ideal humidity for larval development in this microclimate is 100%, the minimum humidity required for development is about 85%. The survival of larvae in the environment depends upon adequate moisture and shade. Desiccation from lack of rainfall kills eggs and larvae rapidly and it is the most lethal of all climatic factors (Hansen and Perry, 1994). Parasitic infection maintain a interactive relation and how much its impact depend upon according to the species, age, sex, management, climatic condition, flock size and health status of the animals etc. It is shown that prevalence of parasitic infection higher in large flock then smaller. The reason for higher prevalence in larger flock size, as compared to smaller flock size could be that the possibility of harboring the infection is high in case of larger flocks because of the larger population. The possible reason for slightly higher prevalence in weak animals of both the host species could be that these animals usually have a comparatively weak immune system which does not fight with the infections to the same extent as that of a healthy animal's immune system (Kuchai *et al.,* 2011). In the present study, combined the five points will monitor anemia, body condition, diarrhea, submandibular edema and coat condition, – which represent the clinical signs normally seen in parasitized animals.

2.2.1 Age, sex and seasonal variation of gastrointestinal parasites in the world

Molla (2014) conducted a study on Bonpala sheep in 'Teesta river' valley, West Bengal to investigate the prevalence of gastro-intestinal parasites (GI). The overall prevalence rate was very high (72.22%). The prevalence of *Haemonchus* sp., *Oesophagostomum* sp., *Trichuris* sp., *Trichostrongylus* sp. was 61.11%, 45.56%, 30.00% and 11.11% respectively and the mixed infection (57.78%) was also observed. Maximum infection was observed in young age group (80%) in comparison to older age group (62.50%). Sex wise prevalence of gastrointestinal nematode parasites was higher in female (76.67%) in comparison to male hosts (63.33%). There was a significant seasonal variation in prevalence of gastrointestinal nematode infections in Bonpala sheep. Season wise, the prevalence of gastrointestinal parasitic infections was significantly lower in summer (56.00%) in comparison to monsoon (82.86%) and winter (73.33%) although monsoon recorded the highest prevalence.

An epidemiological study of Gastrointestinal Parasitism in small ruminants in Pudukkottai District of Tamilnadu, India revealed that there were a total of 1300 sheep and goats examined and *Haemonchus contortus, Ostertagia columbianum, Bunostomum trigonocephalum, Strongyloides papillosus, Amphistomes* sp., *Moniezia expansa and Eimeria* sp. were detected. A total of 559 animals were found infected with one or more GI parasite species, it reveals the overall prevalence as (43.00%) with (39.53%) and (46.46%) in sheep and goats respectively. The study also observed higher prevalence in females (46.29%) and young ones (46.88%) as compared to males (34.68%) and adults (40.94%) in sheep and goats respectively. Similarly an association was found between the prevalence and flock size, wherein the prevalence was higher in larger flock (46.47%) as compared to smaller flocks (38.81%,). There were statistically significant differences in prevalence of parasites with respect to season; it was observed that the infection rate was higher in wet season (54.46%) than in the dry season (31.53%) in both the host species (Rajarajan *et. al*., 2017).

The higher prevalence in goats as compared to sheep is in agreement with reports of Thangathurai and Rao (2002). This could be due to slow or less development of immunity in goats to gastrointestinal parasites compared with the situation in the sheep, the later faced prolonged challenge over generations, but in goats, the less availability of sufficient browsing area and expansion of crop agriculture forced them to graze with the other species that had good resistance. In addition goats in this study region are managed under extensive pastoralism in which large number of animals is kept together. This could increase the degree of pasture contamination leading to higher prevalence rate (Fikru *et al.,* 2006). The higher prevalence of nematodes than trematodes and cestodes is in contest with many reports all over the world (Patel *et al.,* 2001; Sissay *et al.,* 2006).

The sex of animals show an association with the prevalence of the parasites, the higher prevalence in females than their counter partners may be due to some physiological peculiarities of the female animals, which usually constitute stress factors thus, reducing their immunity to infections and also the females happen to be lactating which leads to weakness or malnutrition. These findings agree with the reported findings of Radostits *et al.* (2000). The significantly higher prevalence in wet season than that of the dry season is in consent with many reports around the world (Gupta *et al.,* 2006). This could be due to the existence of a direct relationship between prevalence with rainfall, humidity and temperature. The presence of sufficient rainfall and moisture during wet season favored the survival of infective larvae in pasture and higher probability of uptake of the infective larvae leading to higher prevalence rate (Sissay *et al.,* 2006). Similarly the higher prevalence recorded in younger animals as compared to the adult ones are in agreement with most literatures from different corners of the world (Dunn, 1978, Shah-Fischer and Say, 1989; Nganga *et al.,* 2004). This could be due to the fact that younger animals are more susceptible to infections than adults. Adult animals may acquire immunity to parasites through frequent challenge and expel the ingested parasites before they establish infection (Dunn, 1978; Shah-Fischer and Say, 1989).

2.2.2 Geographical distribution

Parasitic infections have tremendous effect on host specific interaction and demographically it is distributed in accordance with Environmental condition. Parasites of livestock cause diseases of major socio-economic importance worldwide. The current financial and agriculture losses caused by parasites have a substantial impact on farm profitability. Parasites Can grow extensively in different condition of environment as for example *Monizia* sp. is greater loaded in non irrigated pasture then irrigated on the other hand irrigated pasture aggregated by higher prevelance of *Fasciola* sp., *Dricrocoelium* sp., Protostrongylus then non-irrigated pasture (Uriarte *et al.*, 1985). This concern for that why it average output are considered, the sheep grazing irrigated pasture excreted more eggs and larvae of Fasciola and Protostrongylids and less *Trichuris* sp, and *Dictyocaulus filaria*. The emergence of anthelmintic-resistant strains of parasitic nematodes and the increasing reliance placed on anthelmintics for their control can exert profound changes on the epidemiology of those nematodes causing parasitic gastroenteritis. As a consequence, the effectiveness of existing control strategies presents a major threat to sheep production in many areas around the world. The incidence of the liver fluke, *Fasciola hepatica*, is inextricably linked to high rainfall and is particularly prevalent in high rainfall years. Over the last few decades, there have also been increasing reports of other fluke associated diseases, such as dicroceliosis and paramphistomosis, in a number of western European countries, possibly introduced through animal movements, and able to establish with changing climates.

2.2.3 Factors affecting the size of gastrointestinal infections

The size of any gastrointestinal nematode infection depends on the following six main factors: (1) The number of infective larvae/eggs ingested by the host, which in turn is influenced by the climate, the amount of protection provided by vegetation, the livestock density and the grazing pattern of the ruminants present; (2) The rate at which acquired resistance develops in the host, which is influenced by the species of the parasite and host, genetic factors, nutrition and physiological stress (e.g., parturition); (3) The intrinsic multiplication rates of the species of parasites present which are controlled by the fecundity, pre-patent period, environmental development and survival rates of these species; (4) Management, particularly grazing patterns (Radostits *et al.,* 1994); (5) Geographical distribution and availability intermediate hosts and (6) Use of anthelmintics, including the timing and frequency of administration (Hansen and Perry, 1994; Radostits *et al.,* 1994).

2.2.4 Prevalence of gastrointestinal parasitism in sheep in Bangladesh

Nuruzzaman *et al.* (2012) carried out a study to estimate the prevalence, species composition and worm burden of abomasal nematodes of small ruminants slaughtered at different abattoir of Thakurgaon district during the period of November, 2009 to April, 2010. During the study period, 250 abomasums of sheep goats were examined according to standard procedures. Two species of nematodes were identified in abomasums of goats with an overall prevalence of 74.00%. The specific prevalence rate for *Haemonchus contortus* (58.00%) was higher than *Trichostrongylus axie* (16.00%).

Hassan *et al.* (2011) conducted an investigation was carried out to measure the prevalence of ecto and endoparasites in semi-scavenging Black Bengal goat and non descriptive deshi sheep breed (*Capra hircus*) at Pahartali thana under Chittagong district, Bangladesh during the period of February to May, 2006. The overall prevalence of gastrointestinal helminthes in sheep were 63.41% (N=317). In these positive samples *Strongyloides* sp. (51.74%) was more prevalent and *Moniezia* sp. and *Caphlaria* sp. were least prevalent. Age was evident as risk factor where older goats (>24 months) were more infected by endo-parasites than younger ones (<24 months).

Islam *et al.* (2015) carried out a year-round study on 136 Bengal sheep and 224 Bengal goats with the aim to compare the species diversity and prevalence of infections with protozoa, flukes, tapeworms and nematodes parasitizing gastrointestinal tract and lungs of the small ruminants from various parts of Bangladesh. The prevalence of internal parasitic infections was higher in goats (74.55%) than in sheep (55.88%). Liver fluke (*F. gigantica*) was more prevalent in goat (14.28 %) than in sheep (8.82%) whereas tapeworm infection was more frequent in sheep (24.26%) in comparison to goat (16.52%). Goats (33.48%) showed eight times higher prevalence of *Muellerius capillaris* (lungworm) infections than sheep (4.41%) did. The most prevalent gastrointestinal nematode in both host species was *Trichostrongylus* followed by the occurrence of *Haemonchus.* A total of 10 different types of internal parasites were identified of which 9 were common for both species. The most commonly occurring parasites in both species include *Eimeria, Trichostrongylus, Haemonchus. Moniezia* and *Fasciola.*

Mohanta *et al.* (2007) conducted a study on prevalence, population dynamics and pathological effects of intestinal helminths in Black Bengal goats with sheep were studied by examining 150 viscera collecting from different slaughter houses of Mymensingh district from the period of November, 2005 to May, 2006 in the Department of Parasitology and Pathology, Bangladesh Agricultural University. Mymensingh of which 94.67% goats were infected with one or more species of helminths. A total of 5 species of helminth parasites were identified such as *Oesophagostomum columbianum* (92%), *Trchuris ovis* (56.66%), *Schistosoma indicum* (38%), *Moniezia expansa* (10.66%) and *Moniezia benedeni* (2.66%). Single infection was observed in case of *O. columbianum* (16%) and *S. indicum* (2.66%). Single sex infection was established by *S. indicum* male (5.33%). Overall mean parasitic burden was 34.02 ± 2.20. Mean parasitic burden was the highest in case of *O. columbianum* (29.91 ± 2.00) followed by that of *T. ovis* (5.70 ± 0.47), *S. indicum* (4.66 ± 0.42), *M. expansa* (2.59 ± 0.54). Prevalence of intestinal helminth was significantly (P<0.05) higher in winter (100%) than that in summer (89.33%) Uddin *et al.* (2006) investigated on the prevalence of amphistome parasites in Black Bengal goats slaughtered at different slaughterhouses of Mymensingh district, a total of 144 gastrointestinal tracts were examined during the period of July 1998 to June 1999 in the Department of Parasitology, Bangladesh Agricultural University, Mymensingh. Out of 144 Black Bengal goats, 105 (72.92%) were infected with a single or multiple species of amphistomes. In that investigation, three species of amphistomes viz *Paramphistomum cervi*, *Cotylophoron cotylophorum* and *Gastrothylax crumenifer* were identified. The highest infection was observed with *Paramphistomum cervi* (65.28%) and lowest infection with *Cotylophoron cotylophorum* (36.11%). Mixed infections with two or more species of amphistomes were found in 60.42%. Age had a significant (P<0.01) influence on the prevalence of amphistomes in goat. A higher prevalence (89.58%) was observed in older animals followed by young animals (78.57%), whereas a lower prevalence (45.0%) in growing animals. The prevalence increased with the increase of age. The females (75.0%) were found more (1.44 times) susceptible to amphistomes infection than the males (67.5%). Shahiduzzam *et al.* (2003) conducted a study to seasonal influence on the occurrence of *Haemonchus contortus* parasite on 672 slaughtered small ruminants during one period from july 2002 to June 2003.An overall 65.63% goats had *H.contortus* infection and significantly higher infection rate was recorded in female (70.43%) than male (58.61%) goats. Mondal *et al.* (2000) conducted a study to determine association of grassland with parasitic diseases of livestock in Bangladesh; the Tracer animals (two calves and two goats) were released for a month in grassland used for communal grazing of livestock near school premise in kanthal, Mymensingh, Bangladesh. After slaughtering of the tracer animals, their gastrointestinal tract examination revealed six species of nematode and one cestode. The nematode spices were *Haemonchus contorsus, Trichostrongylus axei, Mecistocirrus digitatus, Oesophagostomum* sp. *Trichuris* sp. *and Bunostomum* sp. The cestode was one of the genus *Moniezia.* Uddin *et al.* (2006) carried out a study on the overall infection rate of different species of gestro-intestinal helminthes in Bandarban district. They showed the infection rates were *Haemonchus* sp. (42.5%), *Bunostomum* sp. (55.83%), *Oesophagostomum* sp. (24.17%) *Trichuris* sp. (12.08%), *Strongylus* sp. (15.42%), *Fasciola* sp. (15.42%), *Paramphistomum* sp. (56.66%) and *Moniezia* sp. (11.25%). Mondol had mentioned that ruminant mostly cattle, goat, sheep and buffalos are vulnerable to several helminthes parasites in Bangladesh. These are trematode, cestode and nematode. Among the trematodes Fasciola, Amphistomes and Schistosomes are most important. Hossain *et al.* (1994) studied on pathological examination of 173 slaughtered buffaloes revealed some disease condition is 85 (49.13%) cases. The indentified diseases were hepatic fascioliasis (45.88%) and Paramphistomiasis (16.47%). Kamal *et al.* (1991) conducted a study to determine the prevalence of gastro intestinal nematodes in the Chittagong hilly area of Bangladesh. A total of 870 goats from Nikhongchari FSR site of Bandarban to examine the GI nematodes. The parasites which were encountered were as follows: *Haemonchus* sp. *Bunostomum* sp., *Oesophagostomum* sp. and *Strongyloides* sp. The overall infection rate was 78.41% where prevalence of *Haemonchus* sp. was most prevalent.

2.2.5 Prevalence of gastrointestinal parasitism in sheep in different countries of the world

Rahman and Ali (2001) assessed the month-wise prevalence of gastrointestinal trematode, nematode and cestode in Damani sheep and goats in Pakistan. A total of ninety six positive gastro-intestinal tracts of sheep and goats (forty eight each) were examined. Trematode infection was 16.66% both in sheep and goats in the month of May, whereas in the month of June, July and August it increased to 25% in sheep. In goats a similar increase was recorded in June and July which dropped to 8.33% in August. Highest custodial infections in sheep and goats were recorded in the month of June (33.33%) and August (41.16%), respectively. The lowest nematode infections recorded in sheep in June (41.66%), which increased in July (50%), May (58.33%) and August (58.33%). The lowest records were observed in the month of June (41.66%), with an equal increase in May and August (50%) in goats.

Colwell *et al.* (2002) reported that the prevalence and intensity of nematodes in slaughtered lambs from central Alberta. Two trichostrongyles, *T. ostertagi* and *N. helvetianus*, accounted for greater than 99% of nematodes recovered from gastro-intestinal tracts of forty seven lambs pastured in central Alberta during the summer season. Their prevalence and intensity increased from less than 10% and less than 50 worms or host, in late June, to greater than 80% and approximately one thousand worms or host by mid-July respectively.

Patra *et al.* (2002) in West Bengal recorded 24.66% prevalence of *Fasciola* sp. infection based on abattoir studies in Garole sheep. Purohit *et al.* (2002) in a study of paramphistomosis in Garole sheep in West Bengal recorded 9.04% incidence of paramphistome infection comprising *Cotylophoron* sp. (60%), *Paramphistomum* sp. (48%), *Gastrothylax* sp. (32%) and *Fischoederius* sp. (24%). The highest incidence was recorded in the rainy season (11.65%). Richter (2002) studied the gastro-intestinal tract of lambs for parasitic helminths. Eleven nematode species and one cestode species were recorded, which include *T. circumcincta, T. axei, C. ovina, O. venulosum, T. ovis* etc. and cestode *M. expansa.* Wanjala *et al.* (2002) conducted a research on prevalence of parasitic infection in small ruminants in a post oral community in Narok district, Kenya and the investigation was done in one hundred fifty sheep and one hundred fifty goat during wet season (May to June) and dry season (August to September). The findings of the study showed that 52% of animals were infected. The most prevalent genera of GI helminthes identified were Strongyle group.

Woldemariam (2002) reported that the *Haemonchus contortus* (91-100%) and *T. colubriformis* (90-100%), followed by *O. columbianum* (33-83%) and *T. ovis* (8-33%) in a study conducted on fifty lamb and fifty three kid during different seasons in mid-rift valley of Ethiopia.

Aydenizoz and Yildiz (2003) investigated the prevalence of Anoplocephalidae species in sheep and cattle. They examined small intestine of three thousand one hundred thirty three sheep and eight hundred seventy cattle. The infections were detected in 4.43% and 0.34 % sheep and cattle respectively. The species of anoplocephalidae recorded were *M. expansa, Avitellina centrzpunctata* and *Thysaniezia ovilla* in sheep and *M. mbenedini* and *M. expansa* in cattle. They observed that the rate of infection was highest in July (9.89%), lowest in September (1.32%) in sheep.

Uriarte *et al.* (1985) reported that GI nematodosis in sheep under an intensive grazing system was caused by the most prevalent species *O. circumcinata* followed by *H. contortus and T. colubriformis*. There was an increased egg output during January-

May and after the end of June and July, which was the most important source of infection causing parasitism in permanent lambs.

Yadav *et al*. (2006) reported that 77% prevalence of gastro-intestinal nematode infection in sheep. The infection comprising *Haemonchus* sp., *Oesophagostomum* sp., *Trichostrogylus* sp., *Bunostomum* sp. and *Trichuris* sp. had the intensity in terms of EPG ranging from zero to twenty eight thousand. Chaudhri (2004) reported that the major species of GI parasites infecting sheep and goats in India include the Paramphistomes (rumen fluke), liver fluke (*F. gigantica* and *F. hepatica*), blood flukes (*Schistosoma spindale* and *S. indicum*), GI nematodes *(H. contortus, Trichostrongylus* sp., *Oesophagostomum* sp., *Strongyloides* sp. and *Trichuris* sp.) and tapeworm like *Moniezia* sp., *Avitellina* sp. and *Thysaniezia* sp.

Dhand and Jain (2004) reported an outbreak of fascioliopsis in sheep and goat in Punjab. They reported that seventy goats and fifty sheep of different age groups were affected and these animals were suffering from high fever with diarrhoea. Among these animals forty sheep and five goats died before the investigation. Through post-mortem examination *F. gigantica* was recovered. Hussain *et al.,* (2004) studied the prevalence of cestode parasites and studied relative efficacy of five different anthelmintics used for control of cestodes in Rambouillet sheep. Out of total animals examined, 28% were found infected with cestodes. They found treatment efficacy of Albex, Systamex and Vety wormex as 100%. Manga-Gonzalez *et al.,* (2004) opined hepatic marker enzymes, biochemical parameters and pathological effects in lambs experimentally infected with *Dicrocoelium dendriticum.* A survey covering twelve states namely, Punjab, Haryana, Delhi, Rajasthan, Himachal Pradesh, Karnataka, Uttar Pradesh, Uttaranchal, Tamil Nadu, Andhra Pradesh and Kerala revealed 0.2 to 8.2% prevalence of *Schistosoma* sp. infection in sheep and 0.1 to 7.7% in goats .The infection comprised *S. indicum* only in Punjab, Haryana, Rajasthan and Himachal Pradesh, whereas, in Madhya Pradesh and other states it was *S.spindale* and *S. indicum* (NATP Report, 2004). Sheikh *et al.* (2004) examined ovine fasciolosis in Kashmir valley where they studied one thousand one hundred fifty fecal samples from endemic and non-endemic and hilly or migratory groups collected directly from the rectum. To compare the percent prevalence, three hundred eighty nine livers of locally reared sheep were examined for the presence of flukes and they found both immature and mature flukes.

Nasreen *et al.* (2005) reported that the GI nematode infection in sheep in Kashmir valley comprised of five types of nematodes namely, *Strongyle* sp. (60.78%), *Trichostrongylus* sp. (35.56%), *Haemonchus* sp. (20.73%), *Nematodirus* sp. (3.66%) and *Marshallagia* sp. (1.37%). The overall prevalence was highest in summer season (67.14%) and lowest in winter season (44.31%).

Singh *et al.* (2005) in Ludhiana (Punjab) reported 78% prevalence of different helmintic infections in sheep. The GI helminthes included *Strongyle*, *Trichuris*, *Strongyloides and Paramphistomum*, of which *Strongyle* infection was prevalent during and after rainy season. The prevalence of mixed helmintic infections was 11.52% of which the most common were *Strongyle* and *Moniezia* sp. Sreedevi *et al.* (2005) reported the occurrence of *Stilesia globipunctata* in sheep and attributed inappetance, rapid loss of weight, progressive dehydration and dark mucoid diarrhea followed by death to this infection in Andhra Pradesh.

Craig *et al.* (2006) observed that large proportion of the feral sheep on Hirta died due to shortage of food. They observed that *Teladorsagia circumcincta* the predominant and most pathogenic nematode species in all age groups of Sqay sheep. It was shown that the burden of *Trichostrongylus* sp. decrease with the host age and *T. circumcincta* increase in burden over the first few age classes.

Mungube *et al.* (2006) estimated the prevalence and economic losses caused by *F. hepatica* and *F. gigantica* in the ruminant production systems of Taveta division of Kenya. They also reported that liver condemnation rates differed significantly between bovines, caprines and ovines ($P \leq 0.05$) for *F. hepatica* (0.4%, 22% and 28%, respectively) and for *F. gigantica* (26%, 6.6% and 5.2%, respectively).

Saravanan *et al.* (2009) in Arunachal Pradesh reported 59.15% overall prevalence of GI parasitism in sheep and the parasites include trematode (14.25%), cestode (11.27%), nematode (43.67%) and *Eimeria* sp. (31.00%). The nematodes included Strongyle-type (31.00%) and *S. papillosus* (28.87%) while *Moniezia* sp. was the only cestode recorded. The intensity of infection of nematode was very low i.e. EPG <50. Yadav *et al.* (2006) examined fecal samples (n=five hundred twenty) from sheep (n= two hundred forty five) and goats (n=275) from Jammu district which revealed a total of 83.07% gastro-intestinal parasitic infection. 83.24%, 80.00%, 84.72% and 80.55% infection was observed in sheep, lambs, goats and kids, respectively. *Strongyles* sp.

(44.62%) were predominant followed by *Amphistomes* sp. (8.07%), *Eimeria* sp. (6.73%), *Fasciola* sp. (3.08%), *Trichuris* sp. (3.08%), *Dicrocoelium* sp. (1.92%), *Strongyloides* sp. (1.15%) and *Moniezia* sp. (0.96%). Mixed infection with one or more gastro-intestinal eggs or ova was also detected in 13.46% of animals. Throughout the year seasonal variation was recorded and was highest during rainy season (88.54%) followed by summer (83.15%) and winter (76.01%).

Skirnisson (2007) identified ten species of *Eimeria* in sheep of Iceland and the species were; *Eimeria ovinoidalis* predominated in all seasons with a relative abundance of 40.7%, followed by *E. bakuensis* (18.9%), *E. weybridgensis* (11.1%), *E. granulosa* (8.2%), *E. parva* (6.7%), *E. ahsata* (5.6%), *E. faurei* (4.2%), *E. intricate* (1.6%), *E. pallida* (1.6%) and *E. crandallis* (1.4%). All the ten species reported in central and Western Europe, *E. marsica,* has also been identified in Iceland but in a different flock of sheep. Seasonal incidence differences were mainly observed for *E. ovinoidalis*, *E. bakuensis*, *E. weybridgensis* and *E. granulosa*. Spring and summer coccidiosis was rarely reported, probably due to the early releasing of ewes and their lambs to sparsely oocyst-contaminated grazing areas.

Al-shaibani *et al.* (2008) collected herbage samples from selected sites from the Hyderabad district and analyzed for presence of parasitic larvae. Investigation revealed that the highest pasture larval counts were recorded in the month of August, which coinciding with summer rainy season, whereas the lowest in the month of January, which coinciding with dry winter season. The infective larvae collected from pasture samples were *H. contortus*, *O. circumcincta*, *Trichostrongylus* spp., *S. papillosus*, *O. columbianum* and *C. ovina*. The infective larvae of *H. contortus* were the most prevalent and pathogenic.

Okaiyeto *et al.* (2008) examined the frequency and occurrence of single infection is 17.4%, double infections 39.5%, triple infections 37.9% and quadruple infections 5.8% among sheep. In this study most of the animals examined had low to moderate infection, suggesting that the infections were probably at sub-clinical level. Tariq *et al.* (2008) carried out the epidemiological studies of GI nematode parasites in sheep. The parasites recorded were in decreasing order of prevalence in sheep were *H. contortus* (59.6%); *O. circumcincta* (38.0%); *B. trigonocephalum* (37.7%); *C. ovina* (37.7%); *Trichostrongylus* sp. (33.9%); *N. spathiger* (29.4%); *O. columbianum* (28.4%); *T. ovis* (23.5%) and *Marshallagia marshalli* (22.1%). In the present study season, gender, age and genotype were the factors that influenced the epidemiological prevalence of GI nematode in sheep. The maximum nematode infection was recorded in summer season and lowest in winter (P=0.0005).

Biu *et al*. (2009) conducted a faecal survey of ova or oocysts of gastro-intestinal parasites of ruminants on the University of Maiduguri Research Farm using saturated sodium chloride floatation and formal ether sedimentation technique. The prevalence rate of 47.0%, 54.0% and 58.0% was obtained for cattle, sheep and goats respectively (P>0.05). The younger ruminants were more infected (cattle: 50.0%; sheep: 54.7%.; and goats: 58.1%) in comparison to the older ruminants (cattle: 44.0%, sheep: 52.8% and goats: 57.9%) (P > 0.05). Female ruminants were also more infected (cattle: 52.0%; sheep: 60.4%, and goats: 62.7%) in comparison to the males (cattle: 52.0%; sheep: 46.8% and goats: 51.2%) (P > 0.05).

Chandrawathani *et al*. (2009) reported the occurrence of GI helminth and protozoan infections on small ruminants from eight farms in Kinta and Perak Tengah district, Perak. The results of this investigation indicate that helminthiasis and coccidiosis is rampant in sheep and goat farms. Several anthelmintics have been used to control the GI helminth parasites.

Dubinsky *et al.* (2010) revealed 54.5% of specimens being infected with one or more helminth species and a high prevalence of eimerid coccidia (91.89%). *Trichuris leporis* (55.41%) was the most prevalent helminth species. Lower prevalence was observed for *Passalurus ambiguous* (12.16%) and *Trichostrongylus retortaeformis* (6.76%). The intensity of infection rate was low for all parasite species. As for coccidia, *Eimeria semisculpta* (74.35%) and *E. leporis* (61.54%) were observed in all districts. Other coccidia showed lower prevalence rates: *E. robertsoni* (15.38%), *E. europaea* (12.82%), *E. babatica* (12.82%), *E. hungarica* (5.13%) and *E. towsendi* (2.56%), occurring only in some districts. The highest infection rate was observed in *E. semisculpta*, 7657.8 oocysts per gram (OPG) of faeces.

Sultan *et al.* (2010) carried out a study on one hundred eighty nine slaughtered sheep of local breeds and observed ninety eight (51.9%) had helminths infection, the recovered species were identified as *Fasciola* sp., *P. cervi*, *M. expensa*, *A. centripunctata*, *Cysticercus tenuicollis*, *H. contortus*, *Parabonema skrjabini* and *Graphidiops* sp. (Tavassoli and Khoshvaghti, 2010) in Iran studied on forty one wild sheep *(Ovis ammon orintalis)* from Kabodan Island of National Park of Urmia Lake. The intensity of infection for Strongylid form, *Marshalagia, Trichuris* eggs, and lung worm larvae were eight (19.5%), twelve (29.5%), seventeen (41.5%) and fourteen (34.1%), respectively. Thirty three (80.48%) out of forty one wild animals were infected to one or more *Eimeria* species including *E. parva, E. ahsata, E. ovinoidalis* and *E. faurei*.

Nabavi *et al*. (2011) reported that the overall percentage of infection was 30.98% and *H. contortus, T. circumcincta, M. marshalli, O. occidentalis, O. trifurcata* and *Parabronema skrjabini* were six species identified in all three studied areas. The overall prevalence and intensity of worm burden as representative of Iran, as well as in each of three different climatic zones were low, although *Teladorsagia circumcincta* was the most prevalent and frequent worm species found. Mohamed (2012) observed in lung worm infection and assumed with regard to age, generally, highest prevalence (28%) was observed in small ruminants of six to twenty four month age groups while the lowest prevalence (24.5%) was observed in animals of age groups greater than twenty four months. Possible reason for the present finding could be due to the fact that, animals in semi intensive management system were grazed in the same pasture with extensively grazing animals; feeding moist pastures in the field until environment temperature rises like those of extensively managed small ruminants in the area.

2.2.6 Parasitic Infection with associated risk factor

In all cases of Parasitological studies have to consider some definite risk factors which are included in basic epidemiological survey such as Breed, age, sex, geographical location, Nutritinal status and herd health management etc. Gastrointestinal parasite infections are a worldwide problem for both small- and large-scale farmers, but their impact is greater in sub-Saharan Africa in general and Ethiopia in particular due to the availability of a wide range of agro-ecological factors suitable for diversified hosts and parasite species. Male animal are less susceptible then female which reduced fertility, work capacity, involuntary culling, a reduction in food intake and lower weight gains, lower milk production, treatment costs and mortality in heavily parasitized animals (Fikru *et al.*, 2006). Small ruminants have also been reported to survive better under drought conditions than cattle due to their low body mass and low metabolic requirements which in turn minimize their water requirements and maintenance needed in arid and semi-arid areas.

The sheep populations have become adapted to a range of environments from the cool alpine climate of the mountains to the hot and arid pastoral areas of the lowlands (Mirkana, 2010). Adverse climatic situation, amalgamated parasitic infection such conditions are the major key points to access host specific interaction like draught, heavy rainfall, cyclone, over stocking density, low intake of nutrients ,low muddy and marshy land, flock management etc. In the research all essential elements have attributed to include properly for the easiest isolation of epidemiological data.

2.2.7 Diagnosis of gastrointestinal parasitism

To diagnose gastrointestinal parasitic infections of ruminants, the parasites or their eggs/larvae must be recovered from the digestive tract of the animal or from faecal material. These are subsequently identified and quantified. The following are the main tasks involved in this process- collection of faecal samples, separation of eggs/larvae from fecal material and their concentration, microscopical examination of prepared specimens, preparation of faecal cultures, isolation and dentification of larvae from culture (Baermann apparatus technique).

2.3 Effects of gastrointestinal nematode infection in small ruminants

Sheep and goats, and particularly young lambs and kids, are highly susceptible to infection with parasitic nematodes, primarily the bloodworm (Haemonchus contortus) and the bankrupt worm (Trichostrongylus colubriformis). Haemonchosis, caused by the blood-sucking activity of H. contortus in the abomasum, can cause severe anemia, anorexia, condition loss, reduced growth rate and eventual death of infected animals (Miller, 1996). The bankrupt worm resides in the small intestine and causes scours, unthriftiness, and weight loss in small ruminants, but rarely results in death. These two species most often occur in combination, causing devastating consequences unless appropriate control measures are taken.

As described in detail by Miller *et al.* (2005) in a previous paper in this series, the life cycle of GIN consists of a host phase and a free-living phase. During the host phase, a single female of *H. contortus* feeding on blood in the abomasum can produce up to 10,000 eggs per day, which are passed out of the animal in its feces. On pasture, the eggs are susceptible to desiccation and will not survive very hot, dry conditions, but thrive in hot, humid areas with summer rainfall (Smith and Sherman, 1994). Under these conditions, the eggs hatch, develop into infective larvae, and migrate onto surrounding forage, moving laterally and vertically with the available moisture. The grazing animal consumes the plant material, and once inside the host, the larvae travel to the gastrointestinal tract, become imbedded in the abomasal mucosa, and mature to egg- laying adults, allowing the cycle to be repeated. The warm, humid climate of the southern US is ideal for growth and survival of *H. contortus* larvae on pasture, and with a short life cycle of 4-5 weeks from ova to mature, egg-laying adult, the number of infective larvae on pasture can build up very rapidly during warmer months (April to October).

Chapter 3: Materials and Methods

3.1 Study area

The study was conducted topographically in a coastal belt of Subarnachar upazilla under Noakhali district. The study areas were comprises of 6 unions namely Char Jabbar, Char Bata, Char Clerk, Char Wapda, Char Muhammadpur and Char Jublee. All those areas were low laying salty land. Preference of this study areas were accompanied with probability and potentiality of high prevalence of different risk factors, climatic condition and geographical location which might favors the occurrence of GI parasitic infections of sheep.

3.2 Study Population

A total of 200 of which 80 male and 120 female non-descriptive indigenous sheep were taken from two types of farm (125 from semi-intensive farm and 75 from bathan) for sampling where 90 sheep counted as young and 110 as adult. Total 75 fecal samples were collected randomly from 20 flocks of bathan and 125 samples from 10 semi-intensive farms.

3.3 Sampling strategy

A model questionnaire was used to record the information such as breed, age, sex, rearing system, deworming history, feeding history, housing management etc. During this study a total of 200 sheep were examined 12 months from January to December, 2017. For sampling in bathan, an identifying marker was used to avoid repeated sampling. To determine the age specific susceptibility of different parasites, sheep were categorized into two sub group i.e young (< 1.5 year) and adult (> 1.5 year) by using dentition method (Banerjee and Banerjee, 2006). The samples were collected on monthly basis in order to analyze the parasitic infections in the coastal areas of Noakhali district. The collected samples were carefully labeled with animal identification, sex, age and month of collection.

3.4 Sample collection and preservation

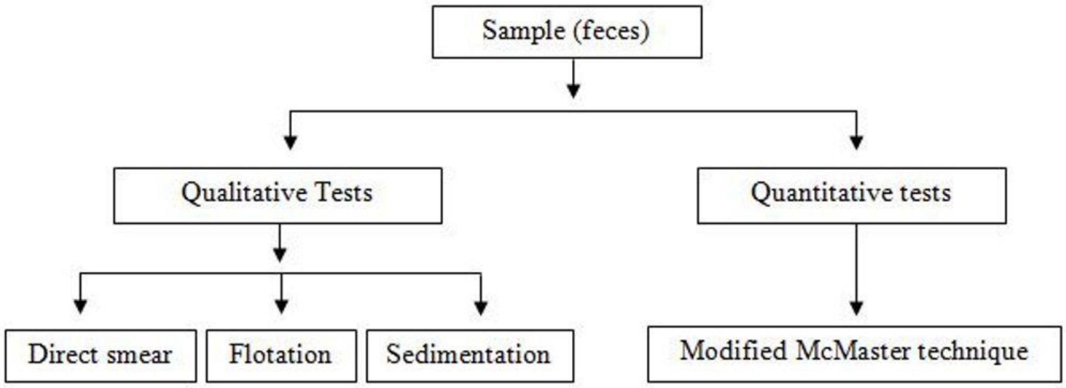
Around 5.0 gm of fresh fecal sample from each individual was collected directly from the rectum by using hand gloves. Then the samples were kept in air tight vials containing 10% formalin. Each vial was marked with the unique identification number and that time basic demographic information (owner's name and address, animal ID, farm size, breed, age, sex, weight, deworming history etc.) also collected through questionnaire. Then the samples were immediately transferred to the laboratory in the Department of Pathology and Parasitology, CVASU and refrigerated at 4ºC temperature for further examination.

3.5 Laboratory examination

The direct smear, flotation and sedimentation methods described by Urquhart *et al.* (1996) were performed to screen out the positive samples. Modified McMaster Counting technique developed by Soulsby (1982) and Tibor (1999) was also carried out to determine the parasitic eggs load (epg).

3.6 Experimental design

The study was designed according to Tibor (1999).



Experimental design for the diagnosis of GI parasitic diseases

3.7 Statistical analysis

The obtained data was imported, stored and coded accordingly using Microsoft Excel-2007. Then this data was transported from MS Excel-2007 to STATA/IC-13.0 (Stata Corporation College Station, Texas) for analysis. Descriptive analysis was performed by means of frequency (N, %) of positive and negative sample test results overall and stratified by different explanatory variables. Invariable analysis was conducted using Chi-square test and those having P-value ≤ 0.05 were considered as significant.

Pictorial presentation of some research activities


Fig. 1: Data collection


Fig. 2: Animal examination


Fig. 3: Preparation before sample collection


Fig. 4: Marking of animal


Fig. 5: Collection of sample


Fig. 6: Observation of egg under microscope

Microscopic pictures of eggs of different gastrointestinal parasites

Fig. 7: Egg of *Fasciola* sp.

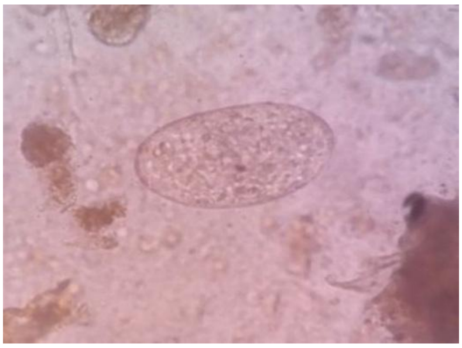


Fig. 8: Egg of *Paramphistomum* sp.

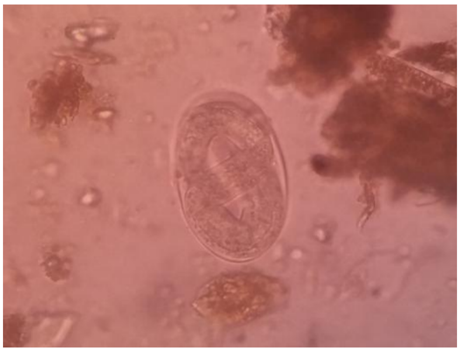


Fig. 9: Egg of *Strongyloides papillosus*

Fig. 10: Egg of *Trichostrongylus* sp.

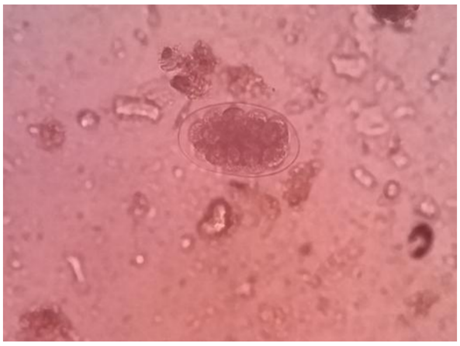


Fig. 11: Egg of *Haemonchu* sp.

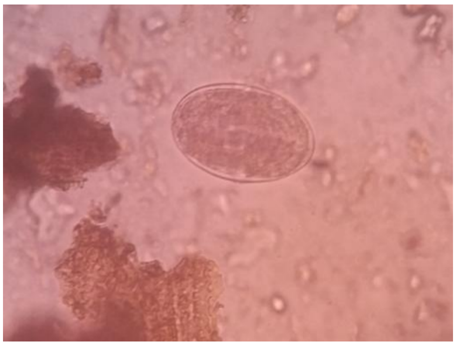


Fig. 12: Egg of *Nematodirus* sp.

Fig. 13: Egg of *Trichuris* sp.

Fig. 14: Egg of *Moniezia expansa*

Chapter 4: Results

4.1. The overall prevalence of gastrointestinal parasitic infections

The overall prevalence of gastrointestinal parasitic infections of sheep is shown in table 1 and pointed out that the overall prevalence of gastrointestinal parasitic infections of sheep in Subarnachar upazilla was 79.50%. It was also found that the highest parasite infection was *Strongyloides* sp. (46.0%) and lowest parasite infection was *Trichuris* sp. (28.0%).

Table 1: Overall prevalence of gastrointestinal parasitic infections in sheep

Types of parasite	Species	Total number of sample	No. of infected animal	Infection percentage (%)
Trematode	*Fasciola* sp.	200	75	37.5
	Paramphistomum sp.		82	41.0
Nematode	*Strongyloides* sp.		92	46.0
	Strongyle-type		79	39.5
	Trichuris sp.		56	28.0
Cestode	*Moniezia* sp.		68	34.0
Overall			159*	79.5*

**Total no. of infection is less than the summation of individual infection because same animal was infected by more than one type of gastrointestinal parasite.*

4.2 Area wise prevalence of gastrointestinal parasitic infections in sheep

Prevalence of gastrointestinal parasites of sheep in various areas of Subarnachar upazilla is presented in table 2. The highest prevalence of parasitic infection was found in Char Clark (83.33%) and the lowest prevalence of parasitic infection was found in Char Jublee (74.29%). Among the species of parasite in different areas of Subarnachar upazilla, the highest prevalence of *Strongyloides* sp. (60.00%) was found in Char Clerk and the lowest prevalence of *Trichuris* sp. (5.71%) was found in both Char Jabbar and Char Jublee.

Table 2: Area wise prevalence of gastrointestinal parasites of sheep in Subarnachar upazilla

Areas (unions)	No. of sample examined	Percentage of positive infection (%)	P value	Types of parasite					
				Fasciola sp.	*Paramphist-omum* sp.	*Strongyloides* sp.	Strongyle-type	*Trichuris* sp.	*Moniezia* sp.
Char Jabbar	35	29 (82.86%)	0.90	9 (25.70%)	12 (34.29%)	8 (22.86 %)	6 (17.14%)	2 (5.71%)	7 (20.00%)
Char Bata	35	29 (82.86%)		14 (40.00%)	13 (37.14%)	16 (45.71%)	14 (40.00%)	9 (25.71%)	10 (28.57%)
Char Clark	30	25 (83.33%)		13 (43.33%)	12 (40.00%)	18 (60.00%)	14 (46.67%)	12 (40.00%)	11 (36.67%)
Char Wapda	30	23 (76.66%)		11 (36.67%)	14 (46.67%)	15 (50.00%)	16 (53.33%)	10 (33.33%)	11 (36.67%)
Char Muhammadpur	35	27 (77.14%)		13 (37.14%)	14 (40.00%)	17 (48.57%)	13 (37.14%)	12 (34.29%)	11 (31.43%)
Char Jublee	35	26 (74.29%)		9 (25.71%)	12 (34.29%)	8 (22.86%)	6 (17.14%)	**2 (5.71%)**	7 (20.00%)

Table 3: Age specific prevalence of gastrointestinal parasitic infections in sheep

Age (years)	No. of sample examined	Percentage of positive infection (%)	P value	Types of parasite					
				Fasciola sp.	*Paramphist-omum* sp.	*Strongyloides* sp.	Strongyle-type	*Trichuris* sp.	*Moniezia* sp.
Young (<1.5)	90	81 (90.00%)	0.001	47 (52.22%)	49 (54.44%)	44 (48.89%)	45 (50.00%)	28 (31.11%)	38 (42.22%)
Adult (>1.5)	110	78 (70.90%)		28 (25.45%)	33 (30.00%)	48 (43.64%)	34 (30.91%)	28 (25.45%)	30 (27.27%)
Total	200	159 (79.5%)		75 (37.50%)	82 (41.00%)	92 (46.00%)	79 (39.50%)	56 (28.00%)	68 (34.00%)

4.3 Age specific prevalence of gastrointestinal parasitic infections in sheep

Occurrences of gastrointestinal parasitic infections were influenced by the age of sheep in this study. Age specific prevalence of gastrointestinal parasitic infections in sheep in Subarnachar upazilla is shown in table 2. The highest prevalence of gastrointestinal parasitic infections was found in young sheep (90.00%) than that of adult sheep (70.90%). This result was statistically significant ($P<0.05$). Among the gastrointestinal parasitic infections in sheep by different genus, the highest prevalence was observed in *Paramphistomum* sp. (54.44%) but the lowest prevalence was observed in both *Fasciola* sp. and *Trichuris* sp. (25.45%).

4.4 Sex specific prevalence of gastrointestinal parasitic infections in sheep

The highest prevalence of gastrointestinal parasitic infections was found in female sheep (85.0%) than that of male sheep (71.25%). This result was statistically significant ($P<0.05$). Among the gastrointestinal parasitic infections in sheep by different genus, the highest prevalence was observed in *Strongyloides* sp. (49.17%) but the lowest prevalence was observed in *Trichuris* sp. (25.0%). In this study, the prevalence of other gastrointestinal parasitic infections of sheep was also recorded (Table 4).

4.5 Prevalence of gastrointestinal parasitic infections on the basis of rearing system

Flock wise prevalence of gastrointestinal parasitic infections in sheep in Subarnachar upazilla is presented in table 5. From this table we found that, the gastrointestinal parasitic infections of sheep were significantly ($P<0.05$) higher in bathan (82.66%) than that of small farm (77.60%). Among the gastrointestinal parasitic infections in sheep by different genus, the highest prevalence was observed in both *Fasciola* sp. and *Paramphistomum* sp. (53.70%) but the lowest prevalence was observed in *Moniezia* sp. (22.58%).

Table 4: Sex specific prevalence of gastrointestinal parasitic infections in sheep

Sex	No. of sample examined	Percentage of positive infection (%)	P value	Types of parasite					
				Fasciola sp.	*Paramphist-omum* sp.	*Strongyloides* sp.	Strongyle-type	*Trichuris* sp.	*Moniezia* sp.
Male	80	57 (71.25%)	0.018	27(33.75%)	30 (37.50%)	33 (41.25%)	31 (38.75%)	20 (25.00%)	23 (28.75%)
Female	120	102 (85.0%)		48 (40.00%)	52 (43.33%)	59 (49.17%)	48 (40.00%)	36 (30.00%)	45 (37.50%)

Table 5: Prevalence of gastrointestinal parasitic infections on the basis of rearing system

Rearing system	No. of sample examined	Percentage of positive infection (%)	P value	Types of parasites					
				Fasciola sp.	*Paramphist-omum* sp.	*Strongyloides* sp.	Strongyle-type	*Trichuris* sp.	*Moniezia* sp.
Semi-intensive	125	97 (77.60%)	0.39	29 (53.70%)	29 (53.70%)	25 (46.30%)	27 (50.00%)	21 (38.89%)	21 (38.89%)
Free range	75	62 (82.66%)		11 (35.48%)	14 (45.16%)	13 (41.94%)	13 (41.9%)	10 (32.26%)	7 (22.58%)

4.6 Prevalence of gastrointestinal parasitic infections on the basis of management

Prevalence of gastrointestinal parasitic infections on the basis of management is shown in table 6 and we found 52.38% and 91.97% sheep was infected in case of regular dewormed and non-dewormed sheep, respectively in different areas of Subarnachar upazilla. 51.79% sheep was infected among those are reared with nutritional supplement and 90.28% sheep was infected among those are not reared with nutritional supplement. In sheep those are reared with proper housing, 61.11% was infected by gastrointestinal parasite and 89.84% sheep was infected among those are not reared with proper housing. All of this results were statistically significant ($P<0.05$).

Table 6: Prevalence of gastrointestinal parasitism on the basis of management

Types of management	Categories	Exposure of treatment	Positive case (%)	P value
Regular deworming (n=200)	Yes	63	33 (52.38%)	0.0001
	No	137	126 (91.97%)	
Nutritional Supplement (n=200)	Yes	56	29 (51.79%)	0.0001
	No	144	130 (90.28%)	
Housing management (n=200)	Yes	72	44 (61.11%)	0.0001
	No	128	115 (89.84%)	

4.7 Prevalence of gastrointestinal parasitic infections on the basis of health status and EPG levels

Current study further revealed that health status of the sheep has a major effect on the prevalence of gastrointestinal parasitic infections where it was observed that the animals which were good healthy had no infection with EPG level of (380-1000) as compared to moderate healthy (>1000-2000) and poor healthy (>2000) animals. Among the all genus of gastrointestinal parasite, the higher prevalence was found in *Strongyloides* sp. (57.73%) in poor healthy animals but lower prevalence was found in *Trichuris* sp. (28.21%) in moderate healthy animals on the basis of their EPG levels (Table 7).

Table 7: Prevalence of gastrointestinal parasitic infections on the basis of health status and EPG levels

Health status	No. of sample examined (n=200)	EPG level	Types of parasites					
			Fasciola sp.	*Paramphist-omum* sp.	*Strongyloides* sp.	Strongyle-type	*Trichuris* sp.	*Moniezia* sp.
Good	25	380-1000	-	-	-	-	-	-
Moderate	78	>1000-2000	30 (38.46%)	36 (46.15%)	36 (46.15%)	36 (46.15%)	22 (28.21%)	31 (39.74%)
Poor	97	>2000	45 (46.39%)	46 (47.42%)	56 (57.73%)	43 (44.33%)	34 (35.05%)	37 (38.14%)

Chapter-5: Discussion

5.1 The overall prevalence of gastrointestinal parasitic infections

The present study revealed that 79.5% sheep were infested with various types of gastrointestinal parasites. This result is agreed with the observation of Nuruzzaman *et al.* (2012) who observed that 76.6% sheep were infected with helminthes but this result disagreed with the reports of Khajuria *et al.* (2013) in Jammu province who reported 67.2% sheep were infected with helminths. According to Gadahi *et al.* (2009) and Emiru *et al.* (2013), about 84.3%, 59.1%, 58.7% and 53.3% of sheep were infested with single or multiple helminths, respectively. The present finding is lower than the prior findings of Mazid *et al.* (2006) in Mymensingh (94.7%) and Sangma *et al.* (2012) in Tangail (81.1%), Bangladesh. Hassan *et al.* (2011) reported that the overall prevalence of gastrointestinal helminthes in sheep were 63.41% in Chittagong, Bangladesh. This variation might be due to the distinction in geographical locations, climatic state, rearing and management of sheep and the variation in the sampling methods. Also, another reason is the free range husbandry of sheep in the study area specifically in the bathan area, where animals in this rearing system are exposed to many potential sources of parasitic infection via contaminated pastures and water sources as reported by Poddar *et al.* (2017). In case of specific parasitic infection, *Strongyloides* sp. (46.0%) was more prevalent and *Trichuris* sp. (28.0%) was less prevalent in this study.

Prevalence of *Strongyloides* sp. infection of this study was somewhat consistent with the report of Hassan *et al.* (2011), who reported 51.74% in Chittagong districts, Bangladesh. However, prevalence of *Strongyloides* sp. infection showed somewhat discrepancy with the reports of Varadharajan and Vijayalakshmi (2009) and Poddar *et al.* (2017) where they observed 13.79% in Tamilnadu, India and 12.13% in Sherpur, Bangladesh, respectively.

Prevalence of *Trichuris* sp. infection of this study was a little bit consistent with the report of Varadharajan and Vijayalakshmi (2009), who reported 13.20% in Tamilnadu, India. However, prevalence of *Trichuris* sp. infection showed inconsistency with the reports of Nasreen *et al.* (2005) and Poddar *et al.* (2017) where they observed 1.37% in Kashmir valley and 1.90% in Sherpur, Bangladesh, respectively. This variation might be due to geo-climatic conditions including sample size, availability of intermediate hosts and rearing pattern of the sheep in the study areas.

Prevalence of *Fasciola* sp. infection of this experiment was more or less similar with the reports of Rahman and Razzak, (1973); Garrels (1975); Iqbal *et al.* (2007) who recorded 16.30% in Bangladesh, 22.0% in Bangladesh and 21.42% in Pakistan, respectively. Poddar *et al.* (2017) showed 11.3% infection in *Fasciola* sp. in Sherpur, Bangladesh. These variations may be due to geographical locations, climatic state, rearing and management of sheep and the variation in the sampling methods.

Prevalence of *Strongyloides* sp. infection found inconsistent with the observations of Poddar *et al.* (2017) and Rajarajan *et al.* (2017), who recorded 12.30% in Sherpur, Bangladesh and 9.23% in Pudukkottai, India, respectively. Causes of this inconsistency might be geo-climatic conditions, sample size, rearing pattern and husbandry practices.

5.2 Area wise prevalence gastrointestinal parasitic infections

In the current study, prevalence of the gastrointestinal parasitic infection in sheep varied in the six different unions of Subarnachar upazilla, Bangladesh. Comparatively higher prevalence of parasitic infection was found in Char Clerk (83.33%) than other five unions. This observation was inconsistent with the result of Hassan *et al.* (2011) who reported 63.41% prevalence in goat in Chittagong regions. Variation in the occurrence of gastrointestinal parasitic infection in six different unions of Subarnachar upazilla might be due to different hosts, geo-climatic conditions, sample size, rearing pattern and husbandry practices. Among the species of parasite in different areas of Subarnachar Upazilla, the highest prevalence of *Strongyloides sp.* (60.00%) was found in Char Clerk and the lowest prevalence of *Trichuris sp.* (5.71%) was found in both Char Jabbar and Char Jublee. Poddar *et al.* (2017) reported the similar observations in Sherpur district, Bangladesh.

5.3 Age specific prevalence of gastrointestinal parasitic infections

In the present study, age was evident as risk factor where young sheep (90.00%) were more infected by gastrointestinal parasites than older ones (70.90%). Singh *et al.* (2013) and Asif *et al.* (2007) recorded similar findings in sheep from Rajasthan, India and Islamabad, Pakistan, respectively. However, Swarnkar *et al.* (1996) recorded higher prevalence of gastrointestinal parasites in adults, followed by hoggets and weaners in India. Mazid *et al.* (2006) reported higher infection in adult (100%) compared to young sheep (76.1%) in Mymensingh, Bangladesh. However, lower occurrence in adults might be due to acquired immunity of adults to gastrointestinal parasites making them less susceptible. This hypothesis has been commissioned experimentally by some other authors (Rajapakse *et al.,* 1994; Colditz *et al.,* 1996; Knox, 2000). On the other hand, several researchers have observed increased helminthiasis in young age also (Starke *et al.*, 1983; Roberts *et al.*, 1996).

5.4 Sex specific prevalence of gastrointestinal parasitic infections

The gastrointestinal parasitic infections were significantly more in female sheep (85.0%) than male (71.25%) in this current study. In Kashmir, Pakistan, higher prevalence of gastrointestinal parasites was found in female sheep than in males, but the difference was insignificant (Wani *et al.,* 2011). Similarly, Mazid *et al.* (2006) in Bangladesh recorded higher prevalence of gastrointestinal parasites in female sheep (100%) than male (78.6%). This study was found inconsistent with Yeasmin *et al.* (2015) who reported male sheep (81.5%) were more infected with gastrointestinal parasites as compared to female (72.7%) in Bangladesh. This result also differed from the report in Nigeria by Okafor *et al.* (1988) who concluded that prevalence was not related to sex.

Basically, many authors accepted sex as the chief factor for influencing parasitic prevalence (Valcárcel and Romero, 1999). Factually, females are more vulnerable to parasitic infections during parturient and peri-parturient period due to stress and reduced immune status (Urquhart *et al.,* 1996). Mostly, all males were grazed more compared to females as the latter did not graze during parturient period, so that, infection is chiefly found in male than female (Gulland and Fox, 1992).

5.5 Prevalence of gastrointestinal parasitic infections on the basis of rearing system

Rearing system of sheep did not exhibit any significant effect ($P>0.05$) on gastrointestinal parasitism. Higher prevalence was observed in sheep reared in free range grazing system in bathan area (82.66%) as compared to the sheep of semi-intensive grazing system (77.60%). These observations are inconsistent with the report of Poddar *et al.* (2017) where they observed higher prevalence in sheep reared in semi-intensive system (73.90%) than the sheep of free range grazing system

(63.30%) in Sherpur district, Bangladesh. In free range sheep in bathan area, prevalence was the highest in case of *Paramphistomum* sp. (45.16%). In contrast, semi-intensive sheep expressed the highest prevalence for both *Fasciola* sp. and *Strongyloides* sp. (53.70%). The causes of the higher infections in free range grazing sheep in bathan areas may be due to the impact of grazing land containing amalgamation of various flocks, mixed pasture, unhygienic conditions, low dumpy land as well as farmers are less attend in knowledge of healthy management.

5.6 Prevalence of gastrointestinal parasitic infections on the basis of management

In this study, various management factors including regular deworming, nutritional supplementation and proper housing were observed to have significant effects on gastrointestinal parasitic infections in sheep in Subarnachar, Bangladesh. The higher prevalence of gastrointestinal parasitic infections were observed in the animals those were being reared under proper management such as regular deworemed by anthelmentics, proper housing and feeding with nutritional supplement etc. These similar observations were observed in sheep in Western Ethiopia by Gizachew *et al.* (2014).

5.7 Prevalence of gastrointestinal parasitic infections on the basis of health status and EPG levels

In this experiment, health status of the animal was evident as risk factor for gastrointestinal parasitic infections. We observed the animals which were good healthy had no infection with EPG level of (380-1000) as compared to moderate healthy (>1000-2000) and poor healthy (>2000) animals. Among the all genus of gastrointestinal parasite, the higher prevalence was found in *Strongyloides* sp. (57.73%) in poor healthy animals but lower prevalence was found in *Trichuris* sp. (28.21%) in moderate healthy animals on the basis of their EPG levels. Rajarajan *et al.* (2017) observed the similar findings in sheep in Pudukkottai district, Tamilnadu, India. Amran *et al.* (2018) reported that highest EPG (50-500) was in goat in Mymensingh region (28.08%) and Hassan *et al.* (2011) reported that 45.47% goats were infected with EPG (>300) in Chittagong regions of Bangladesh. This dissimilarity was may be due to the species and regional variation.

Chapter-6: Conclusion

The study was performed aiming to determine the prevalence of gastrointestinal parasitic infections in sheep in Subarnachar upazilla of Noakhali district in Bangladesh. The overall prevalence of gastrointestinal parasitic infections in sheep was 79.50%. The highest prevalence of gastrointestinal parasitic infections was found in Char Clark union. The animals were more infected by *Strongyloides* sp. among the others gastrointestinal parasitic infection. Gastrointestinal parasitic infections were strongly associated with age and sex of animals where young female animals were more susceptible in bathan area. Good healthy animals had no infection as compared to moderate healthy and poor healthy animals. In conclusion, we recommended further investigations to identify the region specific risk factors for taking further control strategies in the study areas.

Chapter-7: Recommendation and Future Perspectives

Based on this study, following recommendations are given for the owner of the animals:

1. Be aware to improve the management system and health care of sheep.
2. Anthelmentic medication practice should have taken to reduce the gastrointestinal parasitic infections in sheep.

This study provides the baseline information about the stance of gastrointestinal parasitic infections of sheep in Subarnachar upazilla of Noakhali district in Bangladesh. So, following recommendations are given for future studies:

1. Identify the regional and seasonal specific prevalence for taking further control strategies in the study areas.
2. Molecular analysis should be done for species identification and parasitic diseases resistance on the basis of bionomics of coastal environmental parasites.

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Appendix-I

Questionnaire for an investigation of gastrointestinal parasitic infections in sheep of Subarnachar upazilla of Noakhali district in Bangladesh

Area: Subarnachar Upazilla, Noakhali district

1. Case No. | | | | | | 2. Date: ………..

3. Source of Sampling: Char jabbar/ Char bata/ Char clerk/char wapda./Char Amanullah

4. Sheep is from- Bathan/ small semi intensive farm.

4. Owner's Name: ……………………………………………………………….…...

5. Address of the Owner: ………………………………………………………….

……………………………………………
Mobile………………………………..

6. Socio-economic status of farmer: …………………………………………………

a. Occupation: service/Business/Farmer/Others

b. Rearing experience: 1year/2year/3year/more than three

7. Demographic information:

a. Breed:………………

b. Age:……………………

c. sex:………….

d. Color………

e. Identification of animals …………………..

f. Physiological status….. .. Pregnant/ non pregnant

8. Animal data:

a. BCS………..

b. Diarrhoea: yes/Not

b. Anemia- Absent/ Mild/ Moderate/ Severe

c. Last Deworming history………………….., Deworming: regular/ not regular

d. Parasitic Infection history: Yes/not

If yes, signs……………………………………………………………………….

e. date of lambing…………………

g. History Of Itching?: Yes/No

h. Have any diseases? – Yes/No... ……………………………………….

i. History of previous disease ……………………………

e.g. Bottol jaw/abortion/ still birth/ Retained placenta/ Uterine infection/ Others

j. History of previous treatment:……………

k. Vaccination history…………

9. Farmers complain (if any)………….

e. g. Diarrhoea, Itching

Inappetence

10. Use of Vitamin-min premix…Yes/ No,

If yes, name?…………………………….., amount/ day………………………

11. Management system:

a. Housing…………

b. Grazing system- free ranging/ semi-intensive/Intensive

c. Hygienic measure……………..

d. Nature of feed:

Green grass…Yes/ No…. (If yes, amount/day………)

Concentrate…Yes/NO….. (If yes, amount/day………)

Name of concentrate: Total amount per day:

1.
2.
3.
4.

Appendix-II

Identifying characteristics of findings egg (Soulsby, 1982)

Egg of *Fasciola* sp.

- Embryonated egg
- Embryonic cells not so clear
- The egg shell is thin
- Operculated egg but less prominent
- shell membrane yellow color
- Absent of posterior knob

Egg of *Paramphistomum* sp.

- Embryonated egg
- Embryonic cells more prominent
- Thick shell
- Operculum on one pole and prominent
- Pale gray or gray or greenish color

Egg of *Strongyloides papillosus*	Egg of *Trichuris* sp.	Egg of *Moniezia* sp.
Size: 55 x 30 µm.	**Size:** 50-55 micrometers by 20-25 µm.	**Shape:** Irregular shape, tri- or quadrangular
Shape: Oval , Clear	**Shape:** They are football-shaped.	**Shell:** Thick shell
Shell: Thin shelled Similar to hookworm but are smaller.	**Shell :** Thick-shelled and possess a pair of polar “plugs” at each end	Embryonated with pyriform apparatus
In feces: A fully developed embryo is seen.	**In feces:** Eggs are passed unembryonated in stool.	Onchospore present within a Pyriform apparatus

(Soulsby, 1982)

General morphology of *Strongyloides* type egg: (Soulsby, 1982)

- A typical strongylid type egg has a smooth surface.
- Oval shape egg.
- An ellipsoidal shaped shell is present.
- Contains an embryo in the morula (cluster of cells) stage of development when passed out in the faeces.

Procedure of McMaster technique (Soulsby, 1982)

Equipment & Reagent:

1. Two beaker or Plastic Container
2. Balance
3. Measuring cylinder
4. Stirring device
5. Nylon tea strainer & Single Layer of Cotton gauge
6. Pasteur Pipette
7. Mc. Master counting chamber
8. Microscope
9. Floatation Fluid

Procedure:

1. Approximately 4 gm of feces were transferred to Plastic container or a beaker & added 56 ml of floatation fluid in a beaker by means of measuring cylinder
2. Feces and floatation fluid were mixed thoroughly with a stirring device.
3. Immediately after stirring the fecal suspension was poured through a tea strainer or cotton gauze into another beaker.
4. The retained fecal debris was discarded & immediately after the filtering procedure when the suspension is still well mixed a suspension sample is taken in a Pasteur pipette.
5. Both sides of Mc. Master counting chamber were filled with fecal suspension.
6. Be carefully avoided air bubbles & the Mc. Master chamber was left to rest 3-5 minutes before counting (minimum 3 minutes allow all eggs to floatate and maximum 10 minutes as some eggs may be destroyed in the floatation fluid.
7. The number of eggs were counted in both counting fields under the Microscope at 10 x-40 x magnification and calculated the number of eggs per gram of feces by Multiplying the numbers of eggs.

Brief Biography

This is Md. Meraj Hossain, son of Md. Liyacat Ali and Nazma Begum from Burichong upazilla under Cumilla District of Bangladesh. He passed the Secondary School Certificate Examination in 2006 followed by Higher Secondary Certificate Examination in 2008. He obtained his Doctor of Veterinary Medicine (DVM) Degree in 2014 (held in 2016) from Chittagong Veterinary and Animal Sciences University (CVASU), Bangladesh. Now he is a Candidate for the degree of MS in Parasitology under Depertment of Pathology and Parasitology, Faculty of Veterinary Medicine, CVASU. Carrying by the degree of DVM, he triggers himself in a govt. project, related to Extension of Veterinary Sector. He has keen interest to work on Government oriented Public Service, enhancing the prestige of Veterinarian and Livestock Sector.