CHAPTER - 1

INTRODUCTION
1.1. The Kashmir Valley

The beautiful valley of Kashmir is nestled between the inner Himalayan range to the east, comprising of the Nanga Parbat and the outer Himalayan range to the South West called the Pir Panjal. This valley is bounded on the north by the Korakoram Range, on the northeast by Ladakh and on the south by Jammu. The valley of Kashmir is unique in its surroundings, which offers breath taking view of its varying topography. Nature has endowed Kashmir with exotic beauty, which is reflected in its picturesque landscapes, lush green forests of Chinar, Deodar and Pine trees, beautiful rivers and waterfalls, snow covered mountains and a range of flora and fauna.

The territory of the state of Jammu and Kashmir lies between four degrees of latitude from 32°17' to 36°58' North and seven degrees of longitude (73°35' to 80°36'). There is a sudden rise of altitude from 305 meters to 6910 meters above sea level. The state of Jammu and Kashmir therefore lies between the hot plains of the Jammu province and coldest dry table land of Ladakh. These territories are as such, transitional in climate.

The climate found in the zone of the middle mountains and the valleys enclosed is of a particular type. Altitude determines the degree of coolness, precipitation and summer temperature. Winter is cold and of long duration. When the monsoons are strong, rain is caused. In higher mountains round the valley, winter is cold and there is snow-fall. Summer is very short and mild. Annual rainfall of the Valley recorded is about 75cms. It rains in July and August and also in March and April. July is the warmest month. Temperature rises to 85 degree F. January is the coldest month, temperature falls down to below zero. December has 80 % humidity which is highest and May has 71% which is the lowest. In July atmosphere has a pressure of 62.68cms.
India has a large livestock population, regarded by some as an asset provided in plenty by nature, and by others as a burden. Since 1971, when poverty eradication became the main theme of planning development, livestock development has been recognized by the Indian Government as an important tool for poverty alleviation while funding support was provided for development programmes. However, the focus of the programmes has been on improving production of livestock commodities for income generation, applying the western models and assuming that ideal conditions would be provided. The geo-climatic conditions, soil topography, natural meadows and high land pastures of Jammu and Kashmir state are naturally conducive for sheep and goat production. Total sheep population of the state is 49,68,000 (livestock population census J&K). An area of 3,00000 hectares of land falls under alpine and sub-alpine pastures in Kashmir Himalayas having a dominant grass cover.

Owing to its peculiar situation coupled with varying physiography, five agro-climatic zones have been recognized as under:

1. Sub-Tropical Zone
2. Valley Temperate zone
3. Dry Temperate zone
4. Cold Arid zone
5. Intermediate zone

1. Sub-Tropical Zone: - The mean height above sea level ranges from less than 300 meters to nearly 1350 meters. These areas constitute the parts of Jammu, Kathua, Udhampure, Poonch and Rajouri districts. In Kashmir valley, Uri region falls in the subtropical region.
2. Valley Temperate: - The mean height above sea level ranges from 1568 meters to above 4200 meters. The zone especially covers the Kashmir valley and inner Himalayan valleys.

3. Dry Temperate Zone: - Altitude ranges from 1350 meters to more than 3000 meters. It includes all the areas above the outer hills including parts of the Poonch, Rajouri and Doda districts.

4. Cold Arid Zone: - High altitude areas of the inner Himalayas have severe cold and dry winters and moderately hot and dry summers. The zone covers the districts of Ladakh region in the east and Gilgit and adjacent in the North West. The altitude ranges from 2900 meters to peaks ranging to 7200 meters to more than 8400 meters.

5. Intermediate Zone: - This zone covers mid and high altitudes of Doda, Poonch, Rajouri and Udhampure Districts. From the months of October to June, the rainfall pattern resembles to that of the valley temperate zone.

1.2. Prevalence of Sheep Endoparasites

Sheep being a close grazer is regarded as museum of parasites especially for helminths. Economic losses due to helminth parasites in sheep throughout the world are considerable. There is no single requirement more crucial to the rational and sustainable control of helminth parasites in grazing animals than a comprehensive knowledge of the epidemiology of the parasites as it interacts with the host in a specific climatic, management and production environment.

Over the past decade considerable advances have been made in the epidemiology of ruminant helminthiasis. Although the plethora of factors are now known to influence the transmission and survival of helminths, these can conveniently be grouped under four key headings. Two of these relate to
seasonal changes in the numbers of free-living stages in the environment (usually the pasture) and other two to the changes in the composition of parasitic populations within the host while the latter are often seasonal in nature. Seasonal variation of parasites is now accepted fact throughout the world.

1.3. Effect of Parasitism on Metabolism of Host

Reductions in food intake are a common and consistent feature of parasitism of the abomasum, intestine and liver. The severity may range from 15-20% in chronic subtropical infestations to virtual complete anorexia in acute infections. This clearly has consequences for growth of skeleton, muscle and fat deposition. Poor food conversion in parasitized animals has been recognized for many years (Andrews et al., 1944). This poor food conversion in parasitized animals has recently become apparent. There have been reports of reduced digestibility in abomasal nematode infected sheep (Sykes and Coop 2001) and in intestinal parasitism (Steel 1974). An elevation in plasma cortisol and reduction in thyroxine (T4) concentrations was observed in acute intestinal parasitism (Prichard et al., 1974). There has been evidence for changes in thyroid hormone metabolism in several chronic parasitic states. Siddiqui et al., (2005) observed decreased levels of copper and other tracer elements in *Haemonchus contortus* infected animals.

1.4. General Pathology of Helminth Parasites

Indian subcontinent possesses the largest livestock population in the world, which contributes 7% towards the national income. The productivity of domesticated animals is poor due to complex factors which may be varied and compounded by clinical or subclinical often with the worm infections. Much of work has been published on helminth parasites of sheep in India (Shashi et al., 2005; Agrawal et al., 2004) and abroad (Fraser et al., 2006; Torina et al.,
Very little work has been done on the prevalence of helminth parasites of sheep in Kashmir valley (Pandit et al., 1989; Pandit et al., 2004).

World wide helminthiasis is an important cause of production losses in small ruminants (Karira and Kanyari 2001). These losses include the direct effects of severe clinical signs such as anaemia and associated Oedema, diarrhoea and anorexia. These can easily result in poor general performance, particularly in younger animals. More important are less visible sub-clinical losses, such as decreased weight gain (Ploeger et al., 1990b, c; Ploeger and Kloostermans, 1993), decreased milk yield (reviewed by Gross et al., 1999), decreased wool production (Liu et al. 2003), and decreased fertility (Ankers et al., 1998). Among the helminths Paramphistomum, Dicrocelium, Fasciola, Monezia, Stilesia, Avitellina, Haemonchus, Bunostomum, Dictyocaulus, Ostertagia, Oesophagostomum, Cooperia and Trichuris are most common genera.

Paramphistomiasis is one of the most common diseases of ruminants causing morbidity and mortality in topical and sub-tropical areas. A large number of paramphistome species have been described from the rumen and reticulum of domestic and wild ruminants. These include Paramphistomum cervi, P. microbothrium, P. ichikawia, P. gotoi and P. Hibernia. Paramphistomum cervi is the commonest species and is found throughout the world. The adult parasites are light red, pear shaped, slightly concave ventrally and convex dorsally, with a large posterior subterminal sucker. The life cycle is generally similar in all the species. It starts from eggs which are operculate. The eggs hatch into miracidium. The development time to the miracidium varies with the temperature and the species and is approximately
12-21 days. Miracidium swims freely in water and then enters into the water snail. Young snails are more susceptible than old because the route of miracidium entry is mantle cavity which is completely filled with water and pulmonary aperture is permanently open. Soon after the penetration, the maracidium loses its ciliated epithelium and gets changed into the sporocyst. Sporocysts give birth to redia which remain active for few months and encyst on herbage or on other objects in water. This encysted cercaria is called metacercaria which remain viable for three months. Infection of the final host is by ingestion of metacercaria with herbage.

Excystation occurs in intestines where the immature paramphistomes spend first part of their life in vertebrate development cycle. Immature paramphistomes attach themselves to the mucosa of duodenum and after six to eight weeks they migrate forward through the reticulum to the rumen where they attain sexual maturity. Adult parasites, especially those inhabiting the rumen, have less pathogenic effects. However, migrating immature stages cause severe pathological disturbances including haemorrhagic inflammation in the alimentary cannal, Oedema and anaemia (reviewed by Horak, 1971). In India, numerous outbreaks of acute paramphistomiasis associated with high mortality among young sheep, goats, cattle and buffaloes have occurred (Pande, 1935; Bewa, 1939; Katiyar and Varshney, 1963; Panda and Misra, 1980). Various species of amphistomes infecting domestic ruminants have been reported and most of the literature is confined to taxonomic and histomorphological descriptions (Tharpar, 1956).

*Dicrocoelium dendriticum* occurs in the bile ducts of sheep, goat, ox, deer, pig, dog, donkey, hare, rabbit, rats etc. It completes its life cycle in three hosts; one primary host and two intermediate hosts. (Snail and Ant). The small flukes penetrate into the fine branches of the bile ducts, in which they remain greatly extended and attached by means of their suckers. The heavy
infection of *Dicrocelium* causes extensive cirrhosis and scarring of the liver surface and the bile ducts are markedly distended with large numbers of flukes. Early fibrosis occurs in the portal triads and this later extends in an interlobular and perilobular manner, ultimately producing a condition resembling portal cirrhosis. Marked proliferation of the bile duct glandular epithelium occurs. The clinical picture in severe cases consists of anemia, oedema and emaciation, but many cases show no clinical signs.

Fascioliasis is an important helminth disease responsible for causing heavy economic losses to livestock industry in India (Bhalerao, 1973). This disease is caused by liver flukes of genus *Fasciola* which damage the liver of animals causing heavy morbidity and mortality (Radostis et al., 2000). The disease commonly occurs in the form of outbreaks in sheep and goat flocks, in addition to sub-acute and chronic forms. The disease outbreaks occur even in animals that are regularly deformed due development of resistance by the flukes to routinely used anthelmintics.

Monieziasis is an important disease affecting sheep, goat and cattle. It is caused by tape worms of genus *Moniezia* viz, *M. expensa* and *M. bendeni*. *Moniezia* species inhabit in the small intestines feed on the digested feed of the host. *M. expensa* differs from *M. bendeni* in being broader and in having the interproglotidal glands arranged like a short continuous row close to the mid line of the segment. The proglottids and eggs are passed along with the faeces of the host animals. Birds may disseminate the infection by eating eggs. Oribatid mites of genera *Galumna*, *Oribatula*, *Peloribates*, *Protoscheloribates*, *Schcleribates*, *Scutovertex* and *Zyfiorihalula* may act as secondary host in which cysticercus develop. Infective cysticercus may develop approximately in four months. Primary host is infected by ingesting the infected mites with herbage.
The nematode parasites of the digestive tract of domestic ruminants are of major economic importance. The worms belong to two main families (Trichostrongylidae and Strongylidae). The domestic ruminants are usually parasitized with several species which occupy the different parts of the digestive tract. *Haemonchus contortus* and *Ostertagia circumcincta* inhabit the abomasae of sheep, goat, cattle and other ruminants in most parts of the world. *Haemonchus contortus* commonly called Barber pole worm, is one of the most pathogenic nematode parasite which causes high mortality (Marin et al., 2002). Male is small in size and has radish colour while female is bigger in size and the white ovaries are spirally wound around the red intestines producing the appearance of a barber's pole. Life cycle is very simple short and is completed in one host only. Eggs change into larvae in four to six days. Low temperature retards the development and below 9°C little or no development takes place. Eggs which have reached the pre-hatch stages are more resistant to the adverse conditions and can survive freezing and desiccation more readily than other stages. Eggs and infective larvae of *Haemonchus contortus* are intolerant of desiccation and low temperatures. Following the ingestion of infective, larvae exsheathment occurs in the rumen and parasitic larval stages migrate to the abomasae and penetrate gastric epithelial cells from which they emerge as fourth stage larvae where they develop into adult worm.

*Ostertagia circumcincta* also occurs in the abomasae of sheep and goat. Males are bigger than females. Life cycle is short, simple and completed in one host. Eggs hatch into larvae. Third stage larvae are infective to primary host which ex-sheath in the rumen and then penetrate the gastric glands in the abomasal mucosa. The third and fourth stage moult occur in the gastric glands and the adult parasites emerge 18-21 days after infection unless hypobiosis has occurred. *Bunostomum*, a hookworm inhabits small intestines
(ileum and jejunum) of sheep and goats in many parts of the world. The development is direct and infection of the host occurs through the moist skin. After penetration the larvae migrate to the lungs, where the third ecdysis occurs to form fourth stage larvae. The forth stage larvae migrate to the intestines again and first eggs are passed 30-56 days after infection. The presence of worms in the stomach or intestines is associated with important structural changes in the mucosa. In abomasal parasitism, the penetration and presence of larvae within the mucosa provoke modifications of the gastric glands as the parietal and zymogenic cells are replaced by undifferentiated, non-functional cells. When the worms emerge, they induce major damage to the occupied glands as well as sloughing of surface epithelial cells. In small intestines, the main lesions associated with the different species of parasites (Trichostrongylus, Nematodirus and Cooperia) are an abrasion of villi and hyperplasia of the crypts of Lieberkühn. These histological changes are usually found in the proximal small intestine, which corresponds to the site of parasitism for most species. The severity and the extent of the structural changes depend on the worm burden. These histological lesions associated with modifications of enterocytes show signs of degeneracy and severe alterations in the brush border.

1.5. Haematobiochemical Response of Sheep to Parasites

The host parasite relationship is the most intimate of all relationships, because of this, it is extremely difficult to study. The environment of the parasite is the inside of another organism. The host provides a physical and chemical medium, a space with important characteristics of pH, oxidation reduction potential and the availability of nutrients (organic and inorganic compounds). It also offers a complex biochemical environment in which intermediates and hormone regulators of the host metabolism create a background of biochemical noise in which the parasite must complete its own
life cycle. Blood is an important and reliable medium for assessing the health status of an organism. It is customary to quote normal range for the concentration of the constituents in the body fluids to indicate the values found in animals who are in good health and infection free.

Plasma proteins are complex mixture of essential proteins which perform varied functions such as nutrition, blood coagulation, transport, buffer, enzymes, protection etc. The total plasma protein concentration normally ranges from 60-80 g/l and albumen ranges from 35-50 g/l while as globulin from 20-25 g/l. Significant increase in plasma protein may arise from an increase in total globulins usually gamma globulins. A decrease in total protein concentration is usually the result of a fall in albumin. Plasma albumin concentration is appreciably reduced shortly after severe hemorrhages. A definite relationship exists for *Haemonchus contortus* infection in small ruminants between blood loss and faecal egg count. *Haemonchus contortus* is a high egg producer and faecal egg counts of several thousand eggs per gram faces in anaemic sheep form strong evidence that this nematode is causing the pathogenic alterations in host.

The state of health of any organism can be expressed by a set of numerical values of its variables. The biochemical parameters in a normal range play a vital role in sustaining life and maintaining good health. *Haemonchus contortus* which is a blood feeding parasite is associated with biochemical changes which include plasma pepsinogen, plasma gastrin (Mapes and Coop, 1970; Hunter and Mckenzie, 1982; Nicholls et al., 1988 and Simpson et al., 1997).
1.6. Immunological Response of Sheep to Helminth Parasites

The immune system has not been conspicuously successful in producing resistance to helminth parasites in mammals. In a sense it has been detrimental since the IgE-mediated immune responses appear to have evolved in order to control these parasites.

It is not surprising that the immune system is relatively inefficient in controlling helminth parasites. After all, these organisms have adapted to an obligatory parasitic existence. This adaptation must necessarily have involved either overcoming or evading the immune response. Parasitic helminth are, therefore not maladapted pathogenic organisms but fully adapted obligate parasites whose very survival depends on reaching some form of accommodation with the host. Consequently, organisms of this type usually cause only mild or sub-clinical disease. Helminths are usually found in two locations in the body in tissues as larval forms or within the gastrointestinal or respiratory tracts as adults. Obviously, the form of the immune response that is most effective in each location differs considerably. Nematode parasites usually have a thick extracellular cuticle that protects the nematode hypodermal plasma membrane. Some nematodes also have a loose coat that they can readily slough when attacked.

Protective immunity in sheep against helminth parasites is associated with IgM, IgG and IgA classes, (Smith et al., 1984, 1985). The most significant class involved in resistance to helminths is IgE. Helminth antigens appear to preferentially promote the activation of the Th 2 cells (Laeroux et al., 2006). As a result, IgE levels are greatly elevated in parasitized individuals. Many helminth infestations are associated with the characteristic signs of type I hypersensitivity, including eosinophilia, oedema, asthma and urticarial dermatitis (Valderrabano et al., 2005).
1.7. Diagnosis of Helminthiasis

Stool examination is widely used for the diagnosis of the helminthiasis. Various methods of the coprological examination have been used for the diagnostic purposes (Kleiman et al., 2005). Although stool examination is the standard diagnostic method for diagnosis, sero diagnosis by ELISA is now widely used because of its convenience (Farrel et al., 1981; Hillyer and Soler 1988, 1991; Hillyer 1993; Hillyer and Sanchez 1985; Fagbemi and Guobodia 1995; Hadighi 2001; Dixit et al., 2003; Gupta et al., 2003; Abdel-Rahman et al., 2005; Arias et al., 2006; Reichel et al., 2005; Razijalali et al., 2005; Rokni et al., 2006). Double immunodiffusion test and indirect florescence antibody technique have also been used for diagnosis of helminthiasis (Doganay et al., 2003). Nowadays PCR is widely used for the serodiagnosis of helminth parasites (Cucher et al., 2006).

1.8. Control of Helminth Parasites

Helminth parasites are a major constraint for the sheep and goat production in many parts of the world. The control of the parasites is largely based on pasture management (Barger 1997) and the use of anthelmintics. However, the clean pastures are not readily available under intensive grazing conditions. More over the parasites show resistance to anthelmintics (Daiz-Rivera 2000; Bordin 2004; O’ Brien 2004; Rocha et al., 2005; Taylor 2005; Yadav et al., 2005; Sissay et al., 2006; Troell et al., 2006; Alvarez-Sanchaz et al., 2006; Waller et al., 2006; Wrigley et al., 2006). Since anthelmintic resistance is spreading geographically, both in terms of variety of the anthelmintics involved, indicating the necessity for studies on alternative or complementary methods for the control of the parasites. Natural resistance to helminth parasites and vaccination are two alternative methods for the control of helminth parasites. Genetic resistance in sheep to gastrointestinal
nematodes is mediated by an immune response and is based on the recognition of parasite antigens by the major histocompatibility complex (MHC) and stimulation of CD\(^4\) T-lymphocytes. The resistant animals can be identified using parasitological, immunological and production parameters. The most widely employed parameters are the number of the eggs per gram of faeces (EPG), blood eosinophilia, concentration of antibodies, cytokines and mediators released by most cells and production parameters, such as weight gain, meat and wool production. The genetic resistance to helminth parasites have been studied by many authors (Kassi et al., 1990; Joshi 2000; Castells et al. 2004, 2005; Cote et al., 2005; Gicheha et al., 2005; Martinez -Valladares et al. 2005; Mugambi et al., 2005; Yacob et al., 2006).

Vaccination of lambs is second alternative control measure of helminthiasis. Purified antigens of *Haemonchus contortus* have been used for vaccination purposes (Schalling et al., 1994, 1997and Hillyer 2005).