CHAPTER - 2

REVIEW OF LITERATURE
The present study on "Epidemiology and Haemato-Biochemical Studies of nematode Infection in the Calves of Kashmir Valley" was carried out between April 2005 to March 2007. The literature pertaining to the concerned problem was necessary to revise the present and past scenario of the economically important parasitic infestation worldwide and as such the literature pertaining to this problem was scanty for Kashmir region. In this regard, every possible effort was put together to assemble the maximum information and to observe the trends associated with the various epidemiological and haematobiochemical aspects of the said infestations. So that, the problem could be dealt with utmost care and responsibility in more efficient manner in this part of the world. The following literature was consulted and described under various subheadings:-

2.1. Prevalence of GIT nematodes

Pandey (1972) studied the epidemiology of gastrointestinal nematodes of 3,332 animals in various farms of Belgium. The researcher reported the nematode parasites: *Ostertagia ostertagia, Cooperia onchophora.*
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*Trichostrongylus axei, Bunostomum phlebotomum, Nematodirus battus* and *Oesophagostomum radiatum* in different age groups of host animals.

In Ireland, four experiments were carried out by Downey (1973) in successive years in which nematode parasite levels were studied on pasture and in spring-born calves grazing from April to September. *Nematodirus* larvae (mainly *N. battus* and *N. filicollis*) were recovered from the herbage in greatest numbers in April. There was no evidence that these nematodes adversely affected the calves. The numbers of Strongyle larvae followed similar trend, being low until July and then increasing to a high level which was maintained in August/September.

Slocombe (1973) evaluated the gastrointestinal parasitism in cattle in South-western Ontario and found that the number of positive samples was highest in May and late June-early July. GI nematode eggs were the most frequent findings, the incidence in calves not pastured and in calves and yearlings pastured was 20% and 40%, respectively. The culture of fecal samples showed that 90% of these eggs were from *Ostertagia* and *Cooperia* spp.

Jolivet *et al.* (1974) carried out experiments for three successive years to determine the effects of GI Strongyleosis on calves. Four groups, each of 15 calves were pastured in summer and autumn. The pastures were vacant in winter, but used the spring season for 2 year-old animals to disseminate parasites. One group was untreated and kept as control. During the 1st year parasitism was slight and economically unimportant and in the 2nd and 3rd years Strongyleosis due mainly to *Ostertagia* and *Cooperia* caused deaths.

Laudren *et al.* (1974) studied the epidemiology of parasites in heifers and the effect of climate on them in Brittany. The most important parasites present were *Ostertagia* and *Cooperia* and the levels of infection in the calf controls were moderate or high but the heifers showed no clinical symptoms. Temperature was found to have no influence on the development of parasites. The post mortem examinations confirmed that GI parasites were more important than pulmonary Strongyleosis in one area, whereas the pulmonary form caused serious economic losses in the other area.
Borgsteede et al. (1981) examined the fecal samples of cows after parturition and found Ostertagia most prevalent with 87.9% followed by Trichostrongylus, Cooperia, Bunostomum, Oesophagostomum and Haemonchus species. The worm burden was found proportionately most numerous in February (72%), decreasing in March (38%), during summer the proportion was about 20% and in October it rose to 58%.

Burger et al. (1981) reported that GI nematode counts in calves were generally high in February and March, and then decreased in April until very few larvae were present at the beginning of the month of May. The larval counts arose again to substantial levels between late July and early October and further rise occurred on many pastures in October and November.

Catto (1981) studied the epidemiology of GI parasitism of Zebu calves on pasture in the Pantanal region of Brazil. The most important nematodes found in terms of their prevalence and intensity were Haemonchus similes, Oesophagostomum radiatum and Cooperia punctata and the fecal egg counts reflected the fluctuations in adult worm burdens.

Eckert et al. (1981) observed the calves grazing on alpine pastures in Switzerland. It was found that the number of GIT nematode eggs in their feces was low until June and increased in July but the average counts did not exceed 100 EPG. Only a slight increase occurred up to the end of grazing in September. Dictyocaulus larvae were passed in the feaces of calves from the end of July.

Henriksen (1981) inoculated Cooperia oncophora L3 larvae to calves with no overt clinical signs and no obvious correlation was found between the number of larvae given and the fecal egg output.

Inderbitzen et al. (1981) studied the use of sheep pastures by cattle during the second part of grazing seasons (July-September). The result indicated a reduced fecal egg counts and serum pepsinogen levels in these cattle compared to the cattle that grazed on cattle pastures throughout.

The epidemiological studies on verminous bronchitis (D. viviparous) carried out weekly by Jorgensen (1981) and sampling of groups of calves and the
plots grazed by them, recorded a moderate larval contamination during weeks 5 and 6 giving a rise to an outbreak during weeks 8-10. The pasture contamination which was high in autumn persisted in the next grazing season. The number of infective larvae/kg of herbage dropped markedly before and after a period with frost and snow and reached an extremely low level in May, whereas the larval contamination of a pasture sample stored during the winter dropped markedly when the herbage dried out in mid-winter.

Kloosterman et al. (1981) inoculated the calves with Cooperia species larvae and after 3 weeks of infection, the faecal egg counts were reported to rise and were significantly higher in the non-resistant animals than in the resistant animals.

Nilsson (1981) showed by means of tracer calves in Sweden that the larval inhibition of Ostertagia ostertagia occurred as early as August, increased to over 90 % at the end of October. Between October and April, the author reported about 94 % of L4 larvae in the abomasums of young cattle and the figure decreased in May followed by further decrease to the beginning of July.

Raynaud et al. (1981) studied the epidemiology of nematode infections in cattle in Limousin, France and concluded that the suckling calves slaughtered in August had lower worm burden (4.9%) and in those killed at the beginning of October the burden was higher (83%), the majority were Ostertagia ostertagia. The heifers in their second grazing season were found to exhibit a self-cure in July but from September their worm burdens increased although egg counts remained low.

Smeal et al. (1982) studied the inhibited development of Ostertagia ostertagia in relation to production system for cattle. The study was carried on a coastal farm in New South Wales where separate pasture plots were contaminated with eggs of O. ostertagia by calves from each production system in autumn, winter or spring. It was observed that the proportion of inhibited early 4th stage larvae in tracer calves reached a maximum in spring and was consistently and very significantly higher in calves which grazed plots contaminated with O. ostertagia of beef cattle origin.
Catto et al. (1983) studied the GI nematoidiasis of weaning Zebu calves whose monthly eggs per gram (EPG) and autopsia showed a normal nematode infection (*Haemonchus, Cooperia* and *Oesophagostomum*) only partially controlled by anthelmintics. Both treated and untreated animals showed a high rate of inhibited L4 larvae during the dry season.

Williams et al. (1983) studied the seasonal changes of GI nematodes in yearling beef cattle in Louisiana and found that *Ostertagia ostertagia* was the major species present. After the cattle were slaughtered monthly, large numbers of inhibited *O. ostertagia* were found initially in March and increased numbers in April and May. Both normally developing and inhibition prone larvae were acquired during late winter to early spring, the later being more prevalent in April and May. The other nematodes like abomasal (*Trichostrongylus axei, Haemonchus* spp.) were found most abundant in spring whereas intestinal nematodes mainly *Cooperia* spp. were most common in autumn to spring.

Brauer et al. (1984) studied the epidemiology and control of GI parasitism in grazing cattle in Missouri and reported that pasture larval counts declined steadily during the summer while in calves the number of arrested 4th stage *Ostertagia* larvae significantly increased from April-August.

Valle (1984) reported that the worm burden of 2 month old Holstein calves was positively correlated with the larvae (*Cooperia, Haemonchus* and *Ostertagia*) on a test pasture. When the second group of calves was introduced on the same pasture, the larvae increased rapidly on the pasture.

Fenerich et al. (1985) examined 96 cattle for GIT nematodes and reported *Cooperia* species as the most prevalent parasite. The other nematode species found were *Trichuris discolor, Haemonchus contortus, Trichostrongyle axei, Ostertagia species, Strongyloides papillosus* and *Oesophagostomum radiatum*. The worm burden was found to increase with an increase in mean monthly rainfall and temperature.

Girao et al. (1985) studied the prevalence and seasonal variation of helminthes in calves in Piaui, Brazil, which revealed that EPG data indicated
increased levels of *Strongyloid* infection during the rainy season but necroscopy showed that the calves were parasitized all year round.

Gupta *et al.* (1985) reported the prevalence of helminth infection higher in the calves of Haryana state during autumn followed by spring, summer and winter. Overall, the prevalence of infection showed a negative correlation with age of the host except *Strongylees*, which showed a positive correlation.

Omara-O Pyene (1985) conducted a survey on GI parasitism in cattle during the dry and rainy seasons and concluded that *Strongyles* was the most important parasites contributing to morbidity within the area. *Strongyloides* was found serious in young stock of post weaning age and they also reported that GI parasitism was predominantly a rainy season problem.

Rivera *et al.* (1985) carried out fecal examination, larvae culture and necropsy on young cattle and found high populations of *Cooperia, Haemonchus, Oesophagostomum, Strongyloides* and *Trichuris*. The highest intensity of infection was recorded from November to March and in June.

Rodrigues *et al.* (1985) showed the highest frequency of infection of *Cooperia punctata* (82.5%) followed by other nematodes in cattle at the Irapua slaughter house in Sao Paulo of Brazil.

Al-Dulaimi *et al.* (1986) studied the GIT helminthes of cattle in Arbil and reported *Haemonchus placei* as the most prevalent parasite followed by *Cooperia punctata*.

Ambrosi *et al.* (1986) reported that the vegetation of the Appenines area favoured the spread of endoparasites and showed that Strongyleosis was widespread in cattle whereas Strongyloidiasis, Trichuriasis and Ascariasis were less common. Capillariasis occurred rarely and Dictyocaulosis was absent.

Baker *et al.* (1986) reported infective *Ostertagia* larvae more numerous in California Sierra foothill pastures grazed by cattle in early spring and less in mid to late spring showing decreased infection with the onset of summer.

Fabiyi *et al.* (1986) reported the contamination of pasture in northern Queensland with *Haemonchus placei* and *Cooperia punctata* during warm season
and fewer larvae during wet season, a large number of infective Strongyloid larvae were found from January to April and relatively low to moderate levels from May to November showing a monthly variation in the rate of infection.

Genchi et al. (1986) reported higher prevalence of Ostertagia ostertagia in dairy cows in the intensive farms on the Po plain and the serum pepsinogen levels were significantly higher in infected animals and positively correlated with worm burden.

Gronvold et al. (1986) carried out fecal sample examination of 305 calves from 17 farms during April and May and reported that 9 of the farms from which 169 calves were examined had lungworm infection during previous year. Calves of 6 farms fed with fresh cut grass were found Dictyocaulus viviparous free.

Gupta (1986) detected the infection of Neoascaris (Toxocara vitulorum) in buffalo calves as young as 6 days but majority of the worms were detected on or after 19 days and not beyond 90 days of age.

Miyoshi (1986) reported the occurrence of several GIT nematodes and Dictyocaulus viviparous (Lung worm) in Holstein calves on the pasture of Yamaguchi prefecture during summer and spring only.

Prosl (1986) studied the epidemiology of Trichostrongylidosis of cattle on Austrian alpine pastures and reported that autumn maturing larvae over wintered under the snow cover with almost no losses, number of larvae decreased in April and May, and serum pepsinogens increased with increasing worm burden.

Soldati et al. (1986) reported that on fecal examination of dairy cattle, nematodes were most commonly found; about 40 % of heifers and steers being infected and 6 % of calves harboured Coccidia.

Vercruysse et al. (1986) found the highest counts of abomasal nematode parasites in dairy cows from December to January and showed no statistically significant relationship between pepsinogen levels and nematode burden.

Wen et al. (1986) detected neoascariosis in 40 % of buffalo calves on the bases of rectal feacal samples. The younger calves from 16 to 162 days old were
found infected whereas no eggs were detected in calves aged < 15 or >17 days. The infection rates were also found slightly higher in males than that in females.

Bairden et al. (1987) showed that young cattle readily acquired heavy burdens of *Nematodirus battus* eggs in spring, although the majority of *Nematodirus battus* eggs hatched in the spring, some hatched in autumn and the calves developed a strong immunity to the parasite during grazing season.

Bianchin et al. (1987) reported *Cooperia* species with highest prevalence in the cattle in Cerrado region of Brazil and the infection dominated by the alternation of rainy and dry season.

Carneiro et al. (1987) found the fecal egg counts significantly higher in younger cattle than in adults and the amount of precipitation directly affecting the number of eggs/gram in all the animals. From the coproculture *Cooperia, Haemonchus, Oesophagostomum* and *Trichostrongylus* were diagnosed.

Gatongi et al. (1987) studied the GIT nematodes of cattle at their infective larval stages and assessed the percentage of various genera present. They showed the presence of *Cooperia, Trichostrongylus, Haemonchus, Oesophagostomum* and *Strongyloides* in descending order of their prevalence in the study area.

Grenfell et al. (1987) showed the mathematical model of the population biology of *Ostertagia ostertagia* in calves and yearlings which revealed that the regulation of parasite numbers is mediated by the effect of climate on the development and survival of the free living stages, changes in the rate of establishment of the infective larvae and the density dependent variations in parasite survival and fecundity.

Lau (1987) reported that 47% of the buffalo calves died due to *Neoascaris vitulorum* in the first 6 months of their life and the remained died due to mixed infections of Ascarids and Coccidiasis.

Marnu et al. (1987) worked on the monthly fluctuations in abomasal nematode worm burden of naturally infected cattle in Austria and reported that *Ostertagia* eggs rose in spring while in autumn and winter the immature eggs predominated.
Smith et al. (1987) analyzed the *O. ostertagia* in calves by using a mathematical model in which parasite fecundity was assumed to be an inverse function of both the duration and intensity of infection.

Tekdek et al. (1987) examined the fecal samples of calves (up to 6 M old) for GI parasites and reported that 74.0% of the calves were infected having single (31.8%) and multiple (42.2%) infection, respectively. The most common nematode parasites found were *Strongyloides* (24.5%) and *Toxocara* (21.5%).

Williams et al. (1987) examined the epidemiology of *Ostertagia ostertagia* and other gastrointestinal nematodes in Lousiana yearling cattle. *Ostertagia ostertagia* was found predominant during early May and which was decreased between June and September. *Trichostrongylus axei* had a similar seasonal prevalence.

Berdie et al. (1988) reported the hypobiotic larvae in beef cattle of Uruguay from July to December with a peak during spring time. During summer season prevalence of L3 larvae was low on the pastures.

Lemekhov (1988) showed that the calves born the previous year transmit the *Dictyocaulus viviparous* to younger calves which turned out to pastures in June. The larvae of the nematode were capable of surviving the winter but they loose their infectivity for cattle where as in the same year, the author reported the calves raised in cages in the open air from the age of 12 hours for 2-3 months, as less susceptible to infection with *Dictyocaulus* when released on pastures in May. At the 2 farms under investigation, the rates of infection were 15.0 and 10.0% compared to 75.8 and 82.7%, respectively in calves raised under standard indoor conditions.

Rossanigo et al. (1988) showed that the feacal egg counts of cattle arose during autumn and winter and fell during spring and summer and highest egg counts from 7-8 months old calves were recorded during April- June. Genera identified by coproculture were *Haemonchus* (42.5%), *Cooperia* (31.0%), *Ostertagia* (17.0%), *Oesophagostomum* (8.0%), *Trichostrongylus* (1.0%) and *Nematodirus* (0.5%).
Tarmudji et al. (1988) reported that the fecal sample examination of cattle from the Tapin and Tabalong districts of Southern Kalimantan showed *Strongylus* as the principal nematode present.

William et al. (1988) worked on the epidemiology of *Ostertagia ostertagia* in warm temperate regions of the US and reported that there were seasonal differences in Ostertagiasis based on a north and south plane, with larval inhibition occurring during autumn in the north and during spring in the south and parts of the west.

Aumont et al. (1989) reported that there was no clear relationship between the climatic data and cattle nematode larvae population dynamics.

Barbosa et al. (1989) examined the fecal samples of a group of buffalo cows and their calves for *Toxocara vitulorum* eggs and found that these eggs were rarely present in some adults but all the calves were positive for *T. vitulorum* eggs, (58%) in the 1st week of life, 87.5% in the 2nd week, 96% in the 3rd and 100% in the 4th week.

Catto (1989) reported low infection rates of GIT nematodes in the cows in Pantanal region of Brazil and Celep et al. (1989) described *Ostertagia lyrata* from abomasums of cattle.

Chandrawathani et al. (1989) monitored 25 calves for GIT parasites for one year from birth which were with their dams for the whole duration of the study. The most common nematode parasites found was *Strongyloides papillosus* present in all the calves during the 0-3 months. *Strongyle* eggs were found in 23 (92%) of the calves from 3 months onwards. Fecal culture showed that *Haemonchus pallcei* was the only *Strongyle* present. *Toxocara vitulorum* was found in only 2 calves (8%) in the group within the 1st 2 months. All the calves appeared to have a subclinical level of infection.

Fabiyi et al. (1989) suggested that the minor nature of inhibition of TrichoStrongyleid worms in grazing cattle was due to the mild climatic conditions, indicating that they were not in any way of major epidemiological importance.
Lamothe et al. (1989) studied 30 herds of heifers which were all infected with *Strongyles* and 40% of herds infected with *Strongyloides papillosus*.

Owen et al. (1989) studied the aspects of the epidemiology of nematode infection in a cow-calf herd in Ontario. The principal parasite eggs found were *Trichostrongyle*-*Strongyle* morulate followed by *Nematodirus, Trichuris, Strongyloides, Moniezia* and *Coccidia*. A marked increase in infection was observed in mid-summer to peak in September and then decrease in October. The larvae were recovered first in July with primarily *Cooperia* and *Ostertagia* which were maximum in number in September.

Bellmer (1990) conducted sero-epidemiological survey to determine the occurrence of *Dictyocaulus viviparous* in first year grazing calves and the percentage found was higher in herds with spring turn out before the mid-May.

Camposr et al. (1990) conducted a survey on GIT nematodes found in cows and calves and the nematode larvae identified in both the groups were *Cooperia* spp., *Ostertagia* spp., *Haemonchus* spp., *Oesophagostomum* spp., *Trichostrongylus* spp. and *Strongyloid* spp.

Celep et al. (1990) counted and identified helminthes in 6 slaughtered cattle. They found the prevalence of species like *Ostertagia* (65.5%), *Cooperia* (45.8%), *Oesophagostomum* (32.4%), *Trichostrongylus* (31.0%), *Haemonchus* (23.9%), *Bunostomum* (15.5%), *Setaria* (15.5%), *Capillaria* (12.0%), and other *Trichostrongylus* spp. (8.5%), *Chabertia* (4.9%), *Trichuris* (4.2%), *Nematodirus* (2.1%) and *Dictyocaulus* (0.7%). The infections were found generally light with increases in summer and autumn.

Gupta et al. (1990) sampled 10-15 days old buffalo calves for the examination of helminth ova. The hosts were found invariably infected with *Toxocara vitulorum, Strongyloides papillosus* and *Strongyles* (mostly *Haemonchus* and *Trichostrongylus* spp.). The incidence and severity of *T. vitulorum* was highest in calves up to 2 months of age, whereas *S. papillosus* and *Strongyles* became more prevalent when the calves reached 2 months of age or over.
Gupta et al. (1990) reported that fecal survey of young buffalo calves (< 6 months) revealed helminths in 73.8% cases. *Toxocara vitulorum* (41.2%) was the most predominant parasite found followed by *Strongyloides* spp. (25.9%) and *Strongyles* (3.8%). In the calves over 6 months of age, *T. vitulorum* was not found and *S. papillosus* was the main parasite.

Kaufmann et al. (1990) identified and enumerated parasites in cattle after post mortem and found that apart from mal-nutrition during the dry season, GIT nematodes especially haemonchosis represented a major constraint on health and productivity of N'Dama cattle.

Pandey et al. (1990) detected the eggs of *Toxocara vitulorum* in the feacal samples of calves from the age of 24-110 days in Zimbabwe and none of the calves showed clinical signs of illness.

Paskal et al. (1990) studied the principal helminthiasis of livestock in Siberia and their prophylaxis and found the most pathogenic helminths as *Dictyocaulus* in lambs and calves.

Roberts et al. (1990) observed the high egg counts of *Strongyloides papillosus* in calves up to 6 months old without any pathogenic effect.

Urquhart (1990) concluded that in endemic situations, clinical signs of parasitic diseases were usually confined to young animals and pulmonary and GIT helminthiasis in young ruminants was usually followed by the development of immunity.

Abdel et al. (1991) examined the abomasums and intestines collected from cattle at slaughters for nematodes and found abomasa with 13.6% prevalence with 8 different species of which *Haemonchus* and *Ostertagia* were most commonly encountered. 24.3% of Small intestines were infected with nematodes with *Trichostrongylus* spp. the most frequent and 24.3% of caecum was infected with *Oesophagostomum* spp. as the most common parasite.

Agyei (1991) reported that the calves in southern Ghana showed *Toxocara vitulorum* eggs as early as 2 days after birth and maximum potency occurred after 2 months and the fall in *T. vitulorum* ova coincided with a rise in that of
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_Haemonchus_ spp., _Trichostrongylus_ spp. and _Oesophagostomum_ spp. High Strongyle ova output occurred during high rainfall and low ova counts when the rainfall was lower.

Barbosa _et al._ (1991) studied the occurrence of genus _Strongyloides_ in buffaloes and their calves and found that all the calves were parasitized with _Strongyloides_ spp. and the ova of that parasite were already found at 1 week of age. The maximum number of parasitized calves was seen at the 5th week. However, by the 30th week all the calves were negative. In adult female cows, parasitoses were found at the 33, 92, 111 and 157 days postpartum.

Bejsovec (1991) worked out the transmission of endoparasites in large herds of cattle and identified some nematode species, of which the most frequently found were _Haemonchus_ spp., _Trichostrongylus, Bunostomum_ spp., _Trichuris, Oesophagostomum_ spp., _Strongyloides_ spp., _Nematodirus_ spp., _Cooperia_ spp. and _Ostertagia_ spp..

Hayashi _et al._ (1991) investigated the survival of infective larvae of cattle GIT nematodes on pasture in Japan. It was found that the number of larvae increased from March to August and decreased gradually from September, and survival of larvae was closely related to climatic factors on the raising pastures.

Hollands _et al._ (1991) suggested _Nematodirus helvetianus_ as mainly a summer parasite in warmer climate and its epidemiology probably similar to _N. battus_ and _N.filicollis_ under British conditions.

Kurtoeva _et al._ (1991) examined the fecal samples of calves (5-180 days old) and obtained _Strongyloides_ spp. from 10 days and _Strongyles_ from 90 days old calves.

Lyons _et al._ (1991) studied 50-naive tester dairy calves on helminth-infested pasture once a month (1-3 calves) for one month. At necropsy, the predominant mature parasites recovered were _Cooperia, Nematodirus, Ostertagia_ and _Trichuris_ spp.

Pradhan _et al._ (1991) examined the fecal samples of calves with 61.6% positive for parasitic infections and of the positive samples, 84.8% were due to
nematode infections. The age-wise distribution of parasites revealed that Neoascaris, Trichuris and Strongyloides were the commonest parasites in the age group 0-60 days, whereas bursate infection was highest in 121-180 days age group.

Sahoo et al. (1991) examined buffalo calves and reported that 71.7% were infected with intestinal parasites and Ascariasis (T. vitulorum infection) was found alone in 129 calves with a greatest prevalence in 2-3 month old calves.

Satrija et al. (1991) studied three groups of calves fed with either milk only (Gp A and C) or hay and concentrate in addition to milk (Gp B) from birth. They gave the infection of infective larvae of Ostertagia ostertagia and the results suggested that the degree of development of the ruminal function influences the establishment of O. ostertagia.

Stromberg et al. (1991) studied the epizootology of helminth parasitism of cattle in Minnesota and found that Trichostrongyle-type eggs were the most prevalent throughout the year, except in the month of May when Strongyloides papillosus eggs were predominant.

Taira et al. (1991) studied a total of 152 calves that died suddenly on 3 farms in southern part of Japan. Calves often died within a few minutes of a violent fall without showing previous clinical signs. On necropsy of these cases, only a slight lesion was observed, although all showed heavy infection with Strongyloides papillosus (SPL). They appeared to have not only a large number of SPL eggs in the feces together with many adult SPL worms in the intestines but also many migratory SPL larvae in tissues such as the lung and muscle. These outbreaks ceased following medication with thiabendazole or ivermectin. It was concluded that sudden death was associated with heavy infection of SPL.

Barbosa et al. (1992) examined the G1 parasite fauna of buffalo, cows and their young during the 30 weeks after birth. In 48.53% of cows, Toxocara vitulorum eggs were found in their feces and Strongyloid eggs were found in feces of 87.5% cows. In calf feces, Toxocara vitulorum eggs were the earliest forms encountered. In the 1st week after birth, 58.33% calves were found infected. The Strongyloid eggs were present in the 1st week in 8.33% calves and in the 5th week
in all calves. The Strongyloid eggs appeared continuously in the feces of calves from the 11th week onwards.

Bianchin et al. (1992) investigated the aspects of the epidemiology of cattle nematodes and conducted three experimental cycles. In each cycle, 128 weaned Nellore calves were used and found that key factors in the population dynamics and pathogenicity of *Trichostrongylus* were interspecific interaction, stocking rates and pasture degradation. *Trichostrongylus* was found more sensitive to stocking rates than other nematode species found like *Cooperia*, *Haemonchus* and *Oesophagostomum*.

Hossein et al. (1992) conducted the post mortem examination of cattle and diagnosed death due to massive infection with one or more helminth species. In young calves mortality was found due to *Strongyles* (15.8%), *Trichuriasis* (11.0%) and *Ascariasis* (2.2%).

Maingi et al. (1992) examined the fecal samples of cattle (including calves, immature and adults) from 4 dairy farms in Kenya for GIT nematodes. From 6-12M old cattle, a minimum of 100 larvae were examined from coprocultures from each farm and *Haemonchus* spp. and *Trichostrongylus* spp. were accounted for more than 41% and 32% of all larvae, respectively. *Cooperia*, *Oesophagostomum* and *Strongyloides* were also found with mean prevalence of 15.2%, 7.9% and 3.3%, respectively.

Obwolo et al. (1992) monitored the fecal Strongyle egg counts monthly in a group of 50 mashona heifers and cows in Zimbabwe. It was found that overall mean egg counts were generally low but highest during the wet months of the year and no essential difference was found in egg counts between cows and heifers. The main species represented were *Haemonchus placei* and *Oesophagostomum radiatum* while as *Cooperia* spp., *Nematodirus* spp. and *Bunostomum* spp. were relatively rare.

Ranjan et al. (1992) observed that *Strongyle* egg counts of calves began to rise soon after turnout to pastures and reached peak levels at the end of the grazing season. It was reported that the number of infective larvae on pasture was highest during September/October. *Ostertagia*, *Cooperia* and *Nematodirus* were the most
prevalent genera found at necropsy. They suggested that the high egg output of cows at the time of turnout served as a source of infection for their calves and responsible for the late season rise in pasture larval counts.

Sanyal et al. (1992) found that August-October were the months of high risk for nematodiasis. *Haemonchus* was found as the predominant genus in buffalo, *Haemonchus* and *Mecistocirrus* headed the list in crossbred (CB) cattle. *Oesophagostomum* was an important species in heifers and adults of both CB cattle and buffaloes. *Bunostomum, Cooperia, Mecistocirrus* and *Trichostrongylus* were found in both host species. Infective larvae were more abundant on pastures during October-November and absent during May-July.

Suzuki et al. (1992) collected the intestinal parasites from 113 heifers from Japan and examined GI nematodes of 11 species found in 77.9% cows. *Ostertagia ostertagia* was found in 31.8%, *Oesophagostomum radiatum* in 18.2%, *Cooperia punctata* in 15.9% and *Trichuris* spp. in 13.6%.

Taira et al. (1992) carried out parasitological examination of calves and observed extensive infection of the small intestines with *Strongyloides papillosus* in every case. Autopsy revealed the presence of migratory larvae in various tissues especially the lungs, eyes orbit and muscles of upper limbs and ankles. Outbreak of the disease ceased following the administration of thiabendazole or ivermectin.

GIT parasitism in calves in Malaysia was studied by Chandrawathani et al. (1993) and their fecal examination showed the presence of *Strongyloides, Haemonchus* and *Toxocara* spp. The infected calves were treated accordingly with anthelmintics to compare their daily weight gains with untreated animals.

Dominguez et al. (1993) studied the calves by copro-parasitological examination, collection of pasture samples and post mortem examination. The nematode parasites identified were *Toxocara* spp., *Strongyloides* spp., *Bunostomum* spp., *Oesophagostomum* spp., *Ostertagia* spp, *Trichostrongylus* spp., *Cooperia* spp., *Haemonchus* spp. and *Trichuris* spp. The nematodes of the order Strongyleida were the most prevalent especially *Trichostrongylus* spp., *Cooperia* spp. and *Haemonchus* spp. Climate and season had no effect on parasitism but there was a statistically significant relation between age and faecal worm counts.
(FWC) for Strongylidae and Trichuris. Strongylida FWC was highest around the 3rd month of age and declined gradually until 13th month. Strongylidae infections exceeded 90% of total worm burdens in calves between 6 and 9 months of age.

Javed et al. (1993) studied the prevalence of endoparasites in buffalo and cattle and reported 14.4% of calves (<1 year) and 7.2% of calves (> or = 1-3 years) as positive for GIT parasites. *Oesophagostomum radiatum* was the most common parasite with prevalence of 26.4% and 34.1% in the two age groups, respectively. Other species found were *Mecistocirrus digitatus*, *Strongyloides papillosus*, *Bunostomum phlebotomum*, *Haemonchus contortus*, *Ostertagia ostertagia*, *Trichostrongylus axei*, *Chabertia ovina*, *Cooperia pectinata* and *Nematodirus helvienus*.

Miller (1993) carried out the fecal egg count (FEC) and nematode identification in calves and their nursing cows in various regions of the USA and reported the overall mean FEC value for calves higher as compared to the cows. It was also observed that the fall-born calves acquired high nematode burdens (i.e. 400-500 EPG) as early as 3 months of age. Spring-born calf FEC started low (10-30 EPG) and reached high levels (200-400 EPG) at about 5M of age In California *Ostertagia* and *Cooperia* were found the predominant nematodes acquired from the pastures. In Louisiana *Ostertagia* (fall/winter) and *Haemonchus* (summer/fall) were the predominant genera acquired by cows and that *Ostertagia* (winter/spring), *Haemonchus* (summer) and *Cooperia* (all seasons) were the predominant genera acquired by calves.

Singh et al. (1993) found significantly higher incidence of helminths in cattle in un-adopted villages of Ranchi and recorded 9.0% for *Toxocara vitulorum* and 7.17% for *Trichuris* species in these areas.

Tigin et al. (1993) studied the seasonal variations in cattle GIT nematodes and found larval contamination of pastures by Strongyle larvae generally with relatively higher numbers occurring in the winter and spring. The highest larval count was noted in December and activity was very low during the autumn and summer months. *Strongyle* (45.2%) infection of cattle was found to persist throughout the year and a peak in the autumn. In fecal cultures *Cooperia* and
Ostertagia were the dominant genera. It was also found that Toxocara vitulorum and Strongyloides papillosus, which were detected by fecal examination, were not present in the intestinal samples taken after slaughtering of cattle.

Waruira et al. (1993a) found Haemonchus species in 9 month old heifer at necropsy and recovered these worms in large numbers (> 10,000 worms) from the lumen of the abomasums, other parasites recovered were Trichostrongylus spp. and Bunostomum spp. in the small intestines and Oesophagostomum spp. in the large intestines.

Waruira et al. (1993b) conducted a prevalence survey of GI parasites of calves in Kenya and their fecal egg and oocyst counts revealed that 66.1% of calves were infected with at least one type of parasite, 68% of these had Strongyle parasites and 0.2% were infected with Trichuris bosis, 2.7% with Strongyloides and 1.5% with Nematodirus. Strongyle infections were found primarily due to Cooperia, Haemonchus, Trichostrongylus and Oesophagostomum. Age and season appeared to influence the intensity of the infection.

Ambrosini et al. (1994) studied the beef cattle (including cows, calves and bulls) on 242 farms in 3 different upland areas in Central Italy and found 25.5% of cattle infected with GIT nematodes and 0.3% with lungworms. 1% with Capillaria spp. and 1.5% with Trichuris spp.

Anene et al. (1994) found Strongyles (mainly Haemonchus spp.) the commonest GIT parasites. More infection was present in the wet than in dry season and prevalence of Strongyle infection was found lower in young animals but had higher EPG. The distribution of infection by ecological zone did not show any consistent trend and this was attributed to the uneven distribution of the cattle breeds amongst the different zones.

Basak et al. (1994) studied the hemorrhagic enteritis in neonatal calves whose fecal samples were invariably examined for protozoal and endoparasitic burden (Ascaris, Haemonchus etc). The clinical signs were characterized primarily by slight diarrhea, which turned into hemorrhagic dysentery followed by dehydration, anemia and death in untreated cases.
Bisset (1994) studied the helminths of economic importance in cattle of Newzealand and reported the cattle as the definitive host of at least 27 nematode species. The nematode infection to cattle was simply incidental resulting from cross transmission from different host species particularly sheep.

Cardona et al. (1994) found higher number of Neoascaris vitulorum eggs in the feces of 25% calves and the autopsy of 1 calf of the herd aged between 55 and 78 days revealed 3200 Neoascaris (Toxocara) vitulorum eggs/gram.

Chollet et al. (1994) carried out monthly faecal analysis in 17 traditionally managed herds and found Toxocariosis (58%) in the calves of age 0-6 months. The samples with high egg counts were more frequent in the dry season. Strongyloides was found in 75.5% of 0-12 M old calves. The intensity of Trichuris was found generally rare.

Fernadez et al. (1994) reported the prevalence of Ostertagia as 47.1%, Cooperia (22.4%), Haemonchus (15.1%), Trichostrongylus (13.0%) and Oesophagostomum (2.4%) in 5-6 month old heifers.

Garcia et al. (1994) recorded 90.30% prevalence of Trichostrongyloid with a mean of 759 worms per animal (bovine) and found single infections less frequent than mixed ones. Nine Trichostrongyle spp. were identified (Ostertagia ostertagia, O. lyrata, O. circumcinata, Haemonchus contortus, Cooperia punctata, C. onchophora, C. mcmastri, Trichostrongylus axei and Nematodirus halvetianus). Ostertagia ostertagia was most prevalent (79.79%) followed by T. axei, O. lyrata, H. contortus and C. punctata. The highest intensity of infection was between July and Nov. with Ostertagia and Trichostrongylus the predominant genera during this season.

Hon et al. (1994) studied the Ascariasis and Strongyloidiasis of calves (2-11 weeks old) through fecal examination and recovered Strongyloides in 55.8% animals and 91.3% farms and Ascaris from 3.3% animals and 16.6% farms.

Lin (1994) showed 18% prevalence of Strongyloides in buffalo and 13.8% diarrheic calves which were infested with Strongyloides. The prevalence was zero in 1-10 days old calves, 23% in 11-90 days, 17% in 91-160 days and 14.6% in 161-
360 days. Least prevalence was observed during September-December, followed by increasing prevalence between January and March and further increasing in April and August.

Mejia et al. (1994) examined the fecal samples of cattle for parasitic oocysts, eggs and larvae during 1992-93 and 95% of cattle under 1 year of age were found positive. The multiple infections (3 or more species) were more frequent in the youngest age group (62.2%) and the commonest parasites were Strongylidae (60-70% prevalence), Strongyloides (50% in the youngest age group), Bunostomum (10-30%) and Dictyocaulus viviparus (10%). The intensity of infection showed seasonal variation, which was linked with high temp, humidity and rainfall, nematode eggs were most frequent in December and January and again from June to August; larvae of D. viviparus peaked in July.

Ploeger et al. (1994) estimated the level of exposure to Ostertagia ostertagia and Cooperia species infection in first year calves and the results supported that levels of exposure were often very low on commercial farms in Netherlands.

Saatkamp et al. (1994) determined the causes of outbreaks of lungworm disease (Dictyocaulus viviparus) from 25 affected herds of young cattle in the province of Utrecht, Netherlands and the results indicated that light pasture contamination by carriers and subsequent auto-infections were the most prominent cause of the disease, followed by heavy pasture contamination by carriers. Adult dairy cows seemed to be the predominant carriers when light pasture infections were concerned and calves and yearlings almost always caused heavy pasture infections.

Silva et al. (1994) investigated the helminth fauna of cattle which were Haemonchus contortus, Ostertagia ostertagia, O. circumcinata, Trichostrongylus axei, T. colubriformis, Cooperia punctata, C. onchophora, Capillaria bovis, Nematodirus spathiger, Bunostomum phlebotomum, Chabertia ovina, Oesophagostomum radiatum, Trichuris discolor and Dictyocaulus viviparus. The highest prevalence was recorded for Trichostrongylus spp. (63.1%) followed by a
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low incidence of *Cooperia* spp. (16.3%), *Ostertagia* spp. (15.7%) and *Haemonchus* spp. (3.7%). Highest rates of infection occurred in spring and autumn.

Vassilev (1994) carried out the epidemiological study of seasonal variation of endoparasitic infections of cattle in Chiweshe Communal land (CCL) and reported *Strongyles* (59.7%) as the most predominant among nematode worms and *Trichuris globus* with least prevalence (0.1%). The seasonal fluctuation of egg excretion by *Strongyles* followed the rainfall pattern. In calves *Strongyle* spp. was found with 69.3% and *T. globulosa* with 0.8%.

Joha! et al. (1995) examined the fecal samples of cattle and buffaloes for GIT nematodes which were found in 40% of the samples out of which *Strongyloides papillosus* ova were present in 18.7%, *Strongyles* in 20.4%, *Neoascaris vitulorum* in 6.1% and *Trichuris* in 1.2%. *Neoascaris vitulorum* infection was found intense with EPG levels ranging from 15000-18000 in 11 calves and infection of *Strongyloides papillosus* and *Strongyles* were found in 13 and 18 calves respectively with EPG in the range of 0-500.

Lyons et al. (1995) examined the fecal samples of cattle including calves and found the helminth eggs of *Trichostrongylus* (including *Haemonchus, Cooperia, Ostertagia* and *Trichostrongylus* but excluding *Nematodirus*) in 93% of the calves, *Strongyloides* in 7%, *Trichuris* in 2% and *Capillaria* in less than 1% of the calves.

Mezo et al. (1995) studied two groups of treated and control second year grazing heifers and identified the main genera of *Cooperia, Trichostrongylus, Ostertagia* and *Oesophagostomum* in them.

Ndao et al. (1995) reported that all the cattle examined were at least infected with one nematode species. *Haemonchus contortus* was found in 92%, *Cooperia punctata* (88%), *C. pectinata* (65%), *Oesophagostomum radiatum* (75%) and *Bunostomum phlebotomum* (54%). Adult *Cooperia* spp. and *Bunostomum* spp. were found throughout the year and it was concluded that worm burdens were very large during rainy season and decreased during the dry season.
Serra et al. (1995) examined the Jersey cattle monthly for ecto- and endoparasites and the fecal sample examination revealed higher infection rates of intestinal nematodes in calves (94.7%) followed by cows and heifers. From larval cultures Haemonchus spp. and Cooperia spp. were identified.

Sridhar et al. (1995) revealed the presence of 156 Toxocara vitulorum worms in the intestines of 2 month old buffalo calf after post mortem examination and also 3 T. vitulorum worms within the gall bladder.

Suarez et al. (1995) studied the comparative tolerance of Bos taurus and B. indicus crossbred calves to naturally acquired GIT nematodes and suggested that B. taurus may be more resistant to nematode infections than B. indicus crossbred. The nematodes; Ostertagia, Cooperia and Trichuris species were found dominant in autumn and Trichostrongylus species in winter seasons respectively.

Suto et al. (1995) reported that a 60-day-old calf died excreting 73 trichurid eggs/gram feces and revealed e large number of trichurid worms in the congested caecum and colon.

Tembely et al. (1995) recorded the presence of the following nematode species in the calves: Cooperia spp. (53.7%), Haemonchus spp. (38.3%), Oesophagostomum spp. (6.7%), Trichostrongylus spp. (0.9%) and Bunostomum spp. (0.1%).

Umur et al. (1995) examined the fecal samples from 814 cattle between March 1993 and May 1994 and found Toxocara vitulorum eggs in 13% samples (7 days to 6 months of age) and 0.6% in older animals. The highest prevalence was in calves, 1-3 month of age. Eggs were first detected in feces of calves at 21 days.

Almeria et al. (1996) studied monthly fluctuations of worm burdens and arrested development of GIT nematodes in calves from a mountainous region of Spain and identified Ostertagia ostertagia, O. lyrata, Teladorsagia circumcinata, Trichostrongylus axei, T. longispicularis, Cooperia onchophora, Capillaria bovis, Nematodirus helvetianus, Oesophagostomum radiatum, Chabertia ovina and Trichuris spp. The highest number of worms from tracer calves was observed in
spring (May and June) and autumn (September and November). In permanent calves, the highest number was observed in June.

Anwar et al. (1996) found the overall prevalence of GIT helminths in buffalo calves as 63.8% in Faisalabad, Pakistan and the species identified were *Strongyloides* spp., *Toxocara* spp., *Haemonchus* spp., *Trichostrongylus* spp., *Ostertagia* spp., *Oesophagostomum* spp., *Bunostomum* spp., *Nematodirus* spp. and *Cooperia* spp.

Couvillion et al. (1996) determined the seasonal changes in population of GIT nematodes of calves in northeast Mississippi and indicated that with respect to *Ostertagia ostertagia*, northeast Mississippi can be considered a summer inhibition zone. The researcher further studied the epidemiology of GIT nematodes in a spring cow-calf herd in Mississippi and reported that mean monthly EPG of cows was consistently low and that of calves increased from spring through fall. *Ostertagia* and *Cooperia* species were found predominant.

Le Hai Duong et al. (1996) examined fecal samples of 1057 buffaloes of 1-180 days of age and 743 calves of same age, which showed *Toxocara vitulorum* in 38% of the buffaloes and 17% of the calves. *Toxocara vitulorum* eggs were not found in the feces of 116 adult buffaloes and 82 adult cattle examined.

Malczewski et al. (1996) worked on the prevalence and epidemiology of Trichostrongylids in Wyoming cattle which showed that the magnitude and species composition of nematode parasitism in cattle rose in high altitude grass plains, underscored the inaccuracy of fecal egg counts as an indicator of worm burden during fall and winter seasons.

Mathur et al. (1996) interpreted from helminth egg count data that high-risk period of nematode infection in calves and heifers was from June to September and no such seasonality was observed in adult animals in which low fecal egg excretion was maintained throughout the year. The most predominant was *Haemonchus* spp. in both cattle and buffalo. The availability of infective larvae was highest during June to November. Overall egg counts in buffalo and native cattle were low compared with crossbred cattle.
Toparlak et al. (1996) examined the fecal samples of 796 cattle for *Toxocara vitulorum* eggs. Out of 326, with less than 6 months of age, 14(4.3%) were positive but 470 over 6 months of age were all negative.

Umur (1996) examined the GIT tract of 50 cattle between September 1992 and August 1994 and identified 20 nematode species. The dominant species were *Ostertagia ostertagia* (92%), *Trichostrongylus axei* (58%), *Cooperia onchophora* (48%), *C. pectinata* (24%), *C. memasteri* (14%), *Oesophagostomum venulosum* (22%), *Marshallagia marshalli* (14%) and *Trichuris discolor* (14%). *Ostertagia, Cooperia* and *Trichostrongylus* spp. were found in all seasons but highest infection levels of *Trichostrongylus* was noted in winter while as *Cooperia* spp. was prevalent in summer and autumn and *Ostertagia* spp. in summer, autumn and winter respectively.

Yasuda et al. (1996) surveyed the Japanese Black cattle for abomasal nematodes at autopsy and detected worms in 38.5 % of cattle and 28 % had parasitic nodules in the abomasal mucosa. The prevailing species were *Ostertagia ostertagia* (36.4%), *Mecistocirrus digitatus* (7.0%), *Haemonchus contortus* (2.8%), *Trichostrongylus axei* (3.5%), *Trichostrongylus colubriforms* (0.7%), *Nematodirus helvetianus* (1.4%) and *Cooperia* species (1.4%).

Agnessens et al. (1997) studied the epidemiology of gastrointestinal nematode infection in cows and calves on pasture in Belgium. The study was conducted on group 1 of cows with their spring born calves and group 2 of cows with their winter born calves. In the first group, the cows were found to be the major source of pasture contamination with higher egg counts while in the second group, the winter born calves were largely responsible for high nematode pasture contamination.

Aken et al. (1997) found *Thelazia rhodesii* in the eyes of 23% bovine heads examined at the abattoir of Phillipines. The monthly prevalence of infection ranged from 13-36%. *T. rhodesii* infection was significantly more common in old cattle (25%) than in younger animals (15%). While as in 1998 Aken et al. studied the Zebu-cattle of 1-30 months old and found a number of GIT nematode species: *Mecistocirrus digitatus, Haemonchus placei, H. similis, Cooperia punctata, C.*
pectinata, Bunostomum phlebotomum and Oesophagostomum radiatum. The Strongyle eggs appeared first in the faeces of 2 month old calves and the egg counts peaked at 3-6 months after which they steadily and significantly declined. Fecal egg output of M. digitatus increased up to the age of 10 months after which a steady but non-significant decline was found. In fecal cultures, a relative decrease of Cooperia larvae was observed from 0-6 month to 19-24 month old animals and a corresponding increase in the proportion of Mecistocirrus was observed.

Paula et al. (1997) stated that Strongyloides papillosus was responsible for enteritis in newborn calves in Brazil. Fecal examination of 115 cows revealed high prevalence of S. papillosus larvae infestation.

Poot et al. (1997) used immunological test (ELISA) to monitor the levels of gastrointestinal nematode infections of calf herds at the end of grazing season in the Netherlands. The results indicated a wide variation in infection level. The length of season showed a positive correlation with Ostertagia spp. but not Cooperia spp.


Tembely et al. (1997) studied the epidemiology of nematode infection in sheep in a cold tropical environment in the highlands of Ethiopia and indicated that rainfall and humidity are the most important factors for the development of eggs and free living stages.

Borthakur et al. (1998) conducted an epidemiological study of nematode infection in both native and crossbred calves, which were found to carry significantly higher nematode burdens than heifers and cows. Crossbred cattle were found more susceptible than native cattle and Strongyle infection was more common in monsoon and post-monsoon seasons; Toxocara spp. and Strongyloides spp. were recorded throughout the year and seen only in calves.
El-Khalid et al. (1998) studied the prevalence of GIT helminths and some other endoparasites in cattle calves and reported *Nematodirus filicollis*, *N. spathigar*, *Strongyloides papillosus*, *Monezia expansa* and *M. benedini* for the first time in the digestive tracts of calves in Syria.

Lima (1998) assessed the seasonality of infections of GIT parasites in calves extensively raised at a farm in the state of Minas Gerais of Brazil and found highest worm burdens in rainy season and *Strongyloides* as first infection in calves.

Waruiru et al. (1998) obtained the gastrointestinal tracts of crossbred cattle from various abattoirs in Kenya and found nematode species in 86.8% of the animals. The nematodes in order of their prevalence were: *Haemonchus placei* (67.0%), *Cooperia pectinata* (53.0%), *Oesophagostomum radiatum* (38.4%), *Trichostrongylus axei* (24.3%), *Nematodirus helvetianus* (19.6%), *Trichuris globulosa* (9.7%) and *Strongyloides papillosus* (3.6%). The total nematode burden was least during the dry seasons and increased gradually during the rainy season.

Cardona et al. (1999) reported that the main parasites recovered from faecal cultures of calves were *Cooperia* spp., *Haemonchus* spp., *Oesophagostomum* spp. and *Trichostrongylus* spp., *Cooperia* spp. was found common at wetter times of the year (spring and summer) and *Oesophagostomum* spp. and *Trichostrongylus* spp. in drier seasons (autumn and winter). L1 larvae of *Dictyocaulus viviparus* observed between May and October.

Lentze et al. (1999) studied the prevalence and importance of endoparasites in calves raised in Swiss cow-calf farms and reported the average prevalence within the first 3 months higher for *Strongyloides papillosus* followed by *Trichostrongylidae*.

Yadav et al. (1999) investigated an outbreak of GI nematodiasis dominated by *Haemonchus placei* in a herd of 50 exotic and crossbred dairy cattle in Haryana. After post-mortem (PM) examination majority of *H. placei* worms were recovered. A few *Oesophagostomum radiatum*, *Bunostomum phlebotomum* and *Trichuris globus* were also found in some animals.
Borgsteede et al. (2000) examined the abomasums, blood samples and fecal samples of dairy cows for nematode infection and reported nematode eggs in the feces of 88.5% of cattle, worms in the abomasa of 96% and antibodies against Dictyocaulus viviparus in 6% of animals.

Chaudhri et al. (2000) studied the helminth parasites of domestic animals in Haryana and found single or mixed infection of Toxocara vitulorum, Strongyloides papillosus and Strongyles in buffalo and cow-calves.

El-Sherif et al. (2000) investigated the buffalo calves for GIT nematode infestations as well as some enteric protozoal infections and observed highest rate of nematode infection in calves up to one month of age which decreased with age.

Le-Minh-Ha et al. (2000) examined the Brahman calves for digestive parasites and reported the Strongyloides in 7 day old calves, Ascaris and Coccidia in 14 day old and Strongyles in 45 day old calves.

Mondal et al. (2000) examined the gastrointestinal helminths in livestock grazing in grassland of Bangladesh. The examination was conducted on calves and goats and the parasites found were Haemonchus spp., Trichostrongylus spp., Mecistocirrus spp., Oesophagostomum spp., Trichuris spp. and Bunostomum spp. It was reported that grasslands were the main source of gastrointestinal parasitic disease of livestock.

Pimental et al. (2000) examined the pasture and faecal samples of Zebu × Holstein-Friesian calves for Haemonchus placei, Trichostrongylus axei, Cooperia punctata and Oesophagostomum radiatum larvae and found highest counts of eggs per gram of feces at the end of winter and in spring, coinciding with warm temperatures and higher levels of relative humidity. In the dung pats and pastures, the survival of larvae was high in spring and sporadic or low in the summer and autumn except genus Cooperia that showed an ability to survive at high and unfavorable ecological conditions.

Ribeiro et al. (2000) identified the enteropathogens from buffalo calves with and without diarrhea and the most frequently found enteropathogens were Strongyloides papillosus, Toxocara vitulorum, Eimeria species and Enterobacter.
Sarkunas et al. (2000) compared the grazing of calves and heifers together with those grazing separately and found that mixed grazing strategy protecting the young calves from Trichostrongylid infection with no clinical signs while as most of the calves that grazed alone exhibited clinical signs.

Scharf et al. (2000) investigated the epidemiology of endoparasitic infections in suckling calves and their prophylaxis and found that open pasture grazing calves had low levels of Trichostrongylid infection than those grazing in conventional farms.

Soca et al. (2000) investigated the GIT nematodes in young cattle between 5 and 6 months of age during rainy and dry seasons. The genera *Haemonchus, Trichostrongylus, Oesophagostomum* and *Cooperia* were present with percentages of 36.2, 27.4, 19.3 and 17.1%, respectively. The highest infestation during the rainy season was between July and September, while in the dry season infestation was highest in March.

Usharani et al. (2000) studied the prevalence and epidemiology of *Toxocara vitulorum* in cow and buffalo calves in and around Ranchi, Bihar. The influence of species, age, sex, managerial conditions and season on the prevalence and epidemiology of toxocariasis was studied and it was found that female calves had higher infection rate as compared to their male counterparts and prevalence was significantly higher in buffalo calves. The seasonal prevalence was found maximum in monsoon followed by winter, spring and least in summer.

Borges et al. (2001) investigated the presence of helminth parasites in Holstein-Zebu cattle aged 8-14 months after necroscopy. The helminths with their respective prevalence and intensity were: *Haemonchus placei* (97.62%), *Cooperia punctata* (92.86%), *Oesophagostomum radiatum* (73.81%), *Trichuris discolor* (38.19%), *Trichostrongylus axei* (26.19%), *H. similis* (21.43%), *C. pectinata* (19.05%), *Bunostomum phlebotomum* (16.66%), *Dictyocaulus viviparous* (16.665), *C. spatulata* (14.29%), *Capillaria bovis* (11.90%), *Ostertagia ostertagia* (7.145), *O. lyrata* (4.76%), *Trichostrongylus colubriformis* (2.38%) and *Strongyloides papillosus* (2.38%). The mixed infection was commonly observed in 71.43% of the animals and *Haemonchus* and *Cooperia* were most frequently observed.
Bulman et al. (2001) conducted an experimental infection of *Oesophagostomum radiatum* in two groups of crossbred Zebu-Friesian calves, 12-15 weeks old, and observed the clinical signs of anorexia, moderate hypothermia, decreased feed conversion and weight gain compared to the control animals.

Drake et al. (2001) surveyed and sampled the California beef cattle to describe the prevalence of internal parasites in them and found that the majority of cattle shedded parasitic eggs during spring which were principally major Strongyle nematodes (51.9%)

Fader et al. (2001) studied the GI parasitism in Friesian calves in Argentina and the helminth found were *Cooperia* spp., *Haemonchus* spp., *Ostertagia* spp. and *Nematodirus* spp.

Landim et al. (2001) studied the prevalence of nematodiasis in calves of 8-10 months age. The GIT nematodes were collected, identified and counted which were *Cooperia punctata, Haemonchus contortus, C. pectinata, Oesophagostomum radiatum, H similis, Trichostrongylus axei, C. spatulata, Trichuris discolor Bunostomum phlebotomum* and *Capillaria bovis*. The most prevalent were *Haemonchus* and *Cooperia* species.

Nasreen et al. (2001) reported the prevalence of helminthiasis in buffaloes as 15.20% in the cattle colony Hyderabad (Pakistan) of which 9.2% were infected with nematodes. The nematodes identified were *Toxocara vitulorum* (3.6%), *Oesophagostomum radiatum* (3.0%), *Strongyloides papillosus* (2.4%), *Ostertagia ostertagia* (1.0%) and *Trichuris* spp. (0.2%).

Rajkhowa et al. (2001) studied the prevalence of intestinal nematodes in female calves of Assam and investigated that *Strongyloides papillosus* infection gradually increased with the advancement of age. The mixed type of infection was also recorded with *Strongylid* and *Monezia* species. The higher rate of infection was recorded during rainy season (May-August), moderate infection during March-April and least in winter season (January-February).

Waruiru et al. (2001) studied the epidemiology of gastrointestinal nematodes of dairy cattle in Central Kenya which revealed that *Haemonchus placei*
was the predominant nematode present in young cattle and other GI nematodes *Trichostrongylus axei*, *Cooperia* species and *Oesophagostomum radiatum* were also responsible for gastroenteritis. The total worm burden in the animals was highest during the rainy season (March-June and October-December) and lowest during the dry season (July-September and January-February).

Agrawal *et al.* (2002) studied the epidemiological features of parasitic diseases of bovines in some parts of Chattisgarh state. The effect of season, age and breeds of bovines was studied. The higher prevalence of infection was found in summer and rainy season (April-June and July-September) Species-wise analysis revealed that no significant difference in cattle and buffaloes was observed in relation to *Strongyle* infection.

Azam *et al.* (2002) studied the prevalence of parasitic infection in buffalo calves in district Dir and reported that the incidence of *Trichostrongylus* spp. was higher followed by *Trichuris* spp., *Haemonchus* spp., *Strongyloides papillosus*, *Ostertagia* spp., *Toxocara vitulorum*, *Fasciola* spp. and mixed infections.

Borkovcova *et al.* (2002) determined the parasitic spectrum and prevalence in a cattle herd in Czech Republic and the most frequently found endoparasites were GIT nematodes with different degrees of prevalence and very low intensities.

Chowdhury (2002) studied the epidemiology of helminths of livestock in the various parts of Indian sub-continent and found that nematodiases was one of the serious helminthic infection widespread in the sub-continent such as *Haemonchosis*, *Mecistocirrosis*, *Cooperiosis*, *Paracooperiosis*, *Oesophagostomosis*, *Bunostomosis* and *Ascariosis*. Calf ascariosis was found more prevalent in buffalo calves than cow calves in Andhra Pradesh. Seasonal incidences recorded highest for cow calves and lowest for buffalo calves in summer and rainy season, respectively from Uttar Pradesh. The fragmentary reports were also obtained from West Bengal and Madhya Pradesh.

Forbes *et al.* (2002) investigated the sub-clinical parasitism in spring-born single suckled beef calves and showed that their fecal egg counts (FEC) were fairly low in July. By the end of the grazing season, the FEC from untreated control
calves showed higher values. Similarly the suckler cows also showed low egg concentrations in July.

Palampalle et al. (2002) studied the GIT nematodoses in bovines of Marthwada region and found on the basis of faecal culture that *Trichostrongylus, Haemonchus* and *Bunostomum* were the species commonly found in all the host species.

The epidemiology of pulmonary and GIT helminthiases of crossbred Zebu-Friesian calves of 6 to 9 month old, was studied by Pimentel-Neto et al. (2002) who showed the animals bearing a natural infection of *Dictyocaulus viviparus, Haemonchus placei, Trichostrongylus axei, Cooperia punctata, C. spatulata, Strongyloides papillosus, Bunostomum phlebotomum, Oesophagostomum radiatum* and *Trichuris* spp.

Sahoo et al. (2002) studied the prevalence of GIT helminth infection among grazing and stall-fed cattle in a rain fed district of Orissa and found that *Amphistomes* were predominant followed by *Strongyles, Ascaris, Strongyloides* and *Trichuris* spp. Seasonal prevalence showed little variation with highest prevalence during rainy season followed by winter and summer season.

Keyyu et al. (2003) determined the prevalence and intensity of GIT nematode infections in indigenous Zebu cattle in lowland zone of southern highlands of Tanzania and found that highest worm burdens occurred at the end of rainy/early dry season. The immature cattle were found to have highest burdens than the mature cattle, no difference was found between male and female animals.

Lee-KuoHua et al. (2003) evaluated the endoparasitism status in calf, heifer and dairy cattle feces and recovered a total of seven endoparasitic species; *Ascaris vitulorum, Trichuris* spp., *Strongyloides papillosus, Trichostrongylus colubriformis, Haemonchus contortus* and *Oesophagostomum radiatum*. The infection rates were highest in heifers (50.3%) followed by calves (46.0%) and dairy cattle (40.6%).

Soca et al. (2003) studied the incidence of GIT nematodes of young cattle (6-10 months of age) under commercial silvipastoral system conditions and
investigated that 100% of the animals were parasitized by *Haemonchus, Cooperia, Oesophagostomum* and *Ostertagia species* with *Haemonchus* as the most prevalent (61.4%). EPG showed a slight increase in June and September-October during higher rainfall levels and a decrease of 64.6% was observed in EPG during the first sampling until May.

Agarwal *et al.* (2004) studied the prevalence of helminthic infection in domestic animals in Madhya Pradesh. GIT helminthiasis was assessed in cattle, buffaloes, goats and pigs. The infection with *Amphistomes* was found highest followed by *Strongyles*.

Hoglund *et al.* (2004) carried out a serological survey to determine the prevalence and geographical distribution of *Dictyocaulus viviparous* in calves in Sweden and found lungworm infected animals throughout the country. There were no significant differences between the regions, although in Southern and South-Western Sweden 70% of the herds were found infected. Furthermore there were no major differences in the seroprevalence in relation to management.

Kumari *et al.* (2004) recorded the incidence of *Toxocara vitulorum* in cow and buffalo calves as 38.33 and 41.66% respectively from Patna, which was found highest during monsoon.

Pandit *et al.* (2004) conducted a survey on GIT helminth parasites of cattle from organized and un-organized sectors in Kashmir valley. The prevalence rate of parasites (nematodes, cestodes and trematodes) was found lowest during August in the animals of organized sector and started increasing from September till April while the animals of un-organized sector showed higher rate of infection ranging from October to April.

Roy *et al.* (2004) studied the prevalence of parasitic infections in bovines of Chattisgrah and found the highest prevalence in grazing bovines (51.39%) as compared to stall-fed (48.24%). Among the nematode parasites; *Strongyle* spp., *Ascaris* spp. and *Trichuris* spp. were encountered and higher prevalence was recorded in monsoon season.
Yadav et al. (2004) studied GIT parasitic infestation profile of bovines in Jammu and found the adult bovines showing higher infection than calves. *Amphistomes* were most prevalent followed by *Strongyle*, *Fasciola*, *Strongyloides*, *Ascaris*, *Trichuris*, and *Moneizia* species and infection was recorded highest during rainy season followed by winter and summer.

Bhattacharyya et al. (2005) presented the seasonal prevalence of helminthic infection in cattle and buffaloes on the basis of their fecal sample examination and found that the incidence was slightly more in buffaloes (72.95%) than in cattle (68.68%). The highest prevalence was reported in monsoon season (82.31%) followed by winter (76.82%), post-monsoon (65.00%) and pre-monsoon (59.42%). *Ascaris* species, *Strongyloides* spp., *Trichuris* spp., *Strongyles* spp., *Haemonchus* spp. and *Bunostomum* spp. predominated in all the seasons.

Halmandge et al. (2005) recorded the overall prevalence of ascariosis as 6% in buffalo calves in the rural areas in and around Bidar and prevalence was found highest in calves of 1-2 month age group mainly during the months of July to January, which was significantly higher in post south-west monsoon season.

Jager et al. (2005) determined the prevalence and intensities of endoparasites in calves and reported *Strongyloides papillosus* as common with a cumulative incidence of 53% in 5th and 9th week after birth and *Strongyles* with 50% prevalence. According to larvae cultivation *Cooperia* spp. and *Ostertagia* spp. predominated in June with 70% and 28%, respectively; *Bunostomum* with 12% in July and *Trichostrongylus* and *Haemonchus* were found sporadically.

Shugufta et al. (2005) investigated the incidence of gastrointestinal nematodes in sheep of Kashmir valley and identified five types of nematodes viz. *Strongyles*, *Trichostrongylus* spp., *Haemonchus* spp. and *Marshallagia* spp. The seasonal prevalence indicated that the overall nematode infection was highest in summer (67.14%) and lowest in winter (44.30%).

Abhishek et al. (2006) conducted a study to determine the prevalence and distribution of helminth infection in calves aged less than 6 months from veterinary college hospital and private cattle farms in Patna, based on faecal examination. Out of 250 calves examined, 182 harboured single or mixed parasitic infections.
Neoascaris vitulorum, Trichuris spp., Strongylodes spp. and Strongyles were present in 38.8, 11.2, 9.6 and 8.8% of the calves respectively, while mixed infection was observed in 16.8% of the calves. The incidence of Neoascaris vitulorum infection decreased as the age of calves increased while Strongyle infection increased with increase in age.

Chamuah et al. (2006) evaluated the seasonal incidence of parasites in mithun (Bos frontalis), which was found highest in monsoon followed by post-monsoon, pre-monsoon and winter season. Strongyloides papillosus was recorded in calves below 1 year of age with their prevalence rate (39.58%), Toxocara vitulorum (31.25%) in calves specifically up to 2 months of age and Trichuris species in age group of calves below 1 year (3.40%) and 1-3 years (1.78%). In Strongyle group the parasites recorded were Trichostrongylus, Oesophagostomum, Haemonchus, Cooperia and Bunostomum spp.

Keyyu et al. (2006) determined the prevalence of GIT nematode infection in commonly grazed traditional cattle, zero-grazed small-scale dairy cattle and intensively grazed large-scale dairy cattle through the examination of helminth eggs in feces. The prevalence of GIT nematodes was found higher in traditional dairy cattle followed by large scale dairy and small-scale dairy cattle and a significant difference in fecal egg counts (FEC) among age groups was observed. Calves had the highest FEC, weaners/yearlings were intermediate and adults had the lowest FEC. There was no difference in FEC between male and female animals. The common GIT nematodes recovered from larval cultures were Cooperia species (39.8%), Oesophagostomum species (35.9%), Haemonchus species (21.6%) and Trichostrongylus species (2.55). Other GIT nematodes identified through egg morphology were Trichuris species, Capillaria species and Strongyloides species.

Morgan et al. (2006) evaluated the epidemiology of parasitism in farmed ruminants in the changed agricultural context in Kazakhstan and reported that the host-age, sex and region/season are significant predictions of fecal egg prevalence for different parasites.
Moyo *et al.* (2006) examined the GIT of cattle for nematodes. *Trichostrongylus axei* (100%), *Haemonchus placei* (100%) and *Cooperia pectinata* (100%) were the most prevalent species. During the dry season large numbers of adult *T. axei* than *H. placei* were found in the abomasum while as *Cooperia* spp. were mainly found throughout the year. This confirmed that *H. placei* mainly survived the dry season as inhibited larvae. The low worm burdens that were recovered during the wet season was attributed to anthelmintic treatment applied by the farmers.

Regassa *et al.* (2006) studied the epidemiology of GIT parasites of ruminants in Ethiopia and showed the overall prevalence of GIT parasites as 69.6% in cattle. The nematode parasites identified were *Ascaris, Strongyles*, lungworms and *Trichuris* of which *Strongyles* were most prevalent. A significant higher prevalence rate was encountered during the wet season than the drier ones while non significant differences were found in the degree of EPG between the seasons. Higher prevalence rates were recorded in younger cattle while no association was recognized between degree of EPG and age of the animals.

Swai *et al.* (2006) undertook the prevalence of GIT parasites in Maasai cattle in Tanzania and found that nematode infection rates were influenced by the age and haemoparasite profile of the study animal and also suggested that the infections were usually sub-clinical.

Mahieu *et al.* 2007 monitored 247 calves from 112 Creole cows of Guadeloupe for *Toxocara vitulorum* infection from year 2002 to 2005. The fecal egg count peaked 49 days after calf birth, and then decreased. No clinical symptom related to *T. vitulorum* infection was observed, and no effect on the calf growth rate was shown. It was concluded that, despite the high prevalence of *T. vitulorum*, the production loss remained under the level of detection, and no drenching was needed for well-fed animals.

Monica *et al.* (2007) conducted post-mortem inspections on 51 calves to investigate acquisition and spectrum of gastrointestinal parasites in peri-urban
livestock production in Mali. Generalized linear models with herd as a repeated effect were used to test the influence of management, age and season of birth on parasite numbers and diversity. Parasite number and burden increased with age. In the age class 4–13 months animals carried already up to eight different gastrointestinal parasite species. Parasite spectrum found included 11 nematodes. The most frequent parasite species found were *Haemonchus placei* (age class 0–1 month: 7%, 1–4 months: 38%, 4–13 months: 69%), *Cooperia pectinata* (0%, 33% and 44%) and *C. punctata* (0%, 33% and 38%). Calves born during the rainy season had higher parasite burden and species diversity than calves born during the dry season. Calves kept under modernized management excreted more *Strongyloides papillosus* eggs than calves kept under traditional management. Calves acquired most of the parasites occurring in adult bovines within first year of their life.

The prevalence of gastrointestinal helminthiasis in ruminants was carried out by Raza et al. (2007) in Pakistan. For this purpose, 100 fecal samples were collected from sheep, goats, cattle and buffaloes. The overall prevalence of helminthiasis was 51% in cattle with nematodes being the most common helminthes. The prevalence of helminthes was higher in young animals compared with adult animals and the prevalence of helminths also varied in different age groups with *Toxocara vitulorum* being higher in calves than in adults.

Jimenez et al. (2008) analysed the influence of area, farm, host (breed, age) and ecological factors on the presence of lungworm infection in dairy cattle. No significant influence of area and host factor on *Dictyocaulus viviparus* was determined, whereas variable farm within area was highly significant (P<0.001). However, ecological factors showed significant association to seropositive animals. The result indicated a high *D. viviparous* seroprevalence in the analysed farms and that the ecological factors were significantly related to lungworm infection.
Wymann et al. (2008) determined the effects of season, age, breed, management type, parasite control and oocyst counts on periurban cattle. A Bayesian model was used with a negative binomial distribution and herd and individual effects, to account for the clustering of calves in herds and the repeated sampling. Eggs of Strongyloides papillosus (Age class 0–1 month: prevalence 39%, 2–3 months: 59%, 5–6 months: 42%), Strongyles (14%, 24%, 36%), coccidian oocysts (37%, 68%, 64%) and at low prevalence, eggs of Toxocara vitulorum, Moniezia spp., Trichuris spp. and Paramphistomum spp. were found. Effects of season and age were also recorded. Reported utilisation of parasite control was high (92%) but monthly recorded use was significantly lower (61%).
2.2. Review on Hemato-Biochemical studies

Bremner (1966) gave the infection of three species of gastrointestinal nematodes viz. *Haemonchus placei*, *Oesophagostomum radiatum* and *Bunostomum phlebotumum* to 3-4 month old calves. A blood volume of 200-300 ml. was taken from the jugular vein to determine the relative influence of these worms on the concentration of blood haemoglobin and total serum proteins weekly in all the calves.

Harness *et al.* (1970) compared the blood pictures of three groups of calves infected with *Haemonchus placei* larvae with their control group of six calves. The infected calves showed a transient oligocythaemia.

Viana *et al.* (1973) studied some biochemical values in crossbred (Holstein × Zebu) calves (Group A) and compared the results with Gp B subjected to helminth control. They reported total proteins, albumin and albumin/globulin ratio significantly lower and globulin higher in Gp A as compared to their healthy counterparts. The helminth genera found in the descending order of their frequencies were *Cooperia* spp., *Haemonchus* spp., *Oesophagostomum* spp., *Trichuris* spp., *Bunostomum* spp., *Trichostrongylus* spp., *Strongyloides* spp. and *Monezia* spp. in Gp A. The author (1974) studied that 5-10 month old Cross-Bred calves naturally acquiring GIT helminthiasis had significantly lower RBC counts, Hb values, cell volumes and leukocyte counts than antihelmintic treated calves. *Cooperia* spp. was the most prevalent nematode found followed by *Haemonchus* spp., *Oesophagostomum* spp., *Trichuris* spp., *Bunostomum* spp., *Strongyloides* spp., *Monezia* spp. and *Trichostrongylus* spp.

Sandoval *et al.* (1977) studied the parasitoses, hematology and growth in pre-weaning calves on a farm in Aroa valley and found the levels of infection by *Strongyloides papillosus*, *Strongylidae* and *Toxocara vitulorum* decreased with age and fluctuated with rainfall. The hematological values were found within the physiological range.
Anosa (1978) studied the seasonal variations in the blood picture of White Fulani calves naturally exposed to helminthiasis and reported the lowest values of PCV (28.9%) in the late rainy season when helminth egg counts were highest, and highest values (35.8%) in the early rainy season, when egg counts were moderate. In the dry season, although egg counts were the lowest, the red cell values were just within the normal limits at this time (31.9%). The PCV values of 0-3 month old calves were always higher than those between 3-12 months.

Anosa et al. (1980a) reported that 3 month old pure-bred calves reared indoors had low *Strongyle* and moderately high Ascarid and Strongyloid egg counts in May but in January no parasitic eggs were detected in feces. These animals showed consistently high red cell values (PCV of 37.6 % in May and 32.8 % in January). The calves 3-12 month old had very high *Strongyle* feecal egg counts in both May and January, *Strongyloid* much higher in May than in January, these animals showed a marked depression of their red cell values (PCV in May of 24.9 % and in January 24.3%). Anosa et al. (1980b) studied the hematological parameters of helminth infested cattle in Nigeria and the effect of age and breed on their hematology. They observed that helminth infestation was greatest in calves 3-12 month old of all the breeds studied viz: Introduced breeds [German Brown Swiss (GB) and German Holstein (GH)] and Indigenous breeds [N’dama (ND), White Fulani (WF) and N’dama×Brown Swiss (NDB)]. Erythrocyte and leucocyte counts were found highest in calves 0-3 month old, low in 3-12 month old but subsequently improved in adult ND, NDB and GH and remained low in adult cattle of introduced breeds. Leucocyte counts were found higher in indigenous breeds than the introduced breeds. The overall incidence of helminthic infection was found highest in the introduced breeds and lowest in the indigenous breeds.

Rodriguez et al. (1980) studied 1.5 month old Holstein calves which were infected with *Haemonchus L*3 larvae and monitored their hematology, which revealed a rise only in neutrophils and a fall in lymphocytes at day 2 and 8 after infection.

Over et al. (1981) gave the infection of *Ostertagia ostertagia* and *Fasciola hepatica* metacercaria to the calves at the beginning of 3 months of age and
monitored the infection for up to 217 days by faecal egg counts, serum enzymes, hematology, serology and weight gains.

Mourad et al. (1985) reported that the effect of GIT parasitism infection on blood picture was more marked in buffaloes than in cattle.

Kaufmann et al. (1986) reported that Ostertagia ostertagia and Trichostrongylus axei were most frequent in young calves. They showed that the cattle harbouring more than 3000 adult Trichostrongylus axei had significantly lower serum calcium levels and hypoalbuminaemia including dysproteinaemia and increased alpha-globulin fractions, compared to worm free animals.

Shoo et al. (1986) found that in the calves which were given Haemonchus contortus larvae, their serum pepsinogen concentration rose quickly.

Gregorovic et al. (1987) collected and examined blood samples in spring and autumn from cows and found anaemia in 23.7% of cows, eosinophilia in 51.8% and hypoproteinaemia in 59.7%. The anaemia was considered to be mainly due to the parasite; Trichostrongylus spp., which contributed 62.2% on faecal sample examination.

Kaufmann (1987) examined the young cows after slaughter and reported Ostertagia ostertagia (84.2%) and Trichostrongylus axei (64.3%) as the most important nematode parasite present. Eggs in feces were detected only in 8.6% of the cattle and animals with heavy worm burdens showed significantly lower serum calcium level, dysproteinaemia with hypo-albuminaemia and increased globulin fractions.

Nooruddin et al. (1987) studied the outbreak of trichuriasis in young calves of 2-12 months of age and found that the infected calves revealed poor condition, reduced appetite, abdominal distension, weakness and varying degree of diarrhoea and dehydration. The affected calves had low haemoglobin content, packed cell volume, total leucocyte count and total protein.

Wiggins et al. (1987) reported that the calves infected continuously with Ostertagia larvae had significantly higher faecal egg counts, eosinophil counts, plasma pepsinogen values and significantly lower lymphocyte counts.
Singh *et al.* (1988) examined some biochemical constituents of serum in Sahiwal and crossbred cattle and reported that total serum protein quantity increased with advancing age. The mean values of serum globulin quantity also increased from 6 to 18 months followed by a decrease at 24 months of age.

Garcia *et al.* (1990) assessed the relationship between helminthes and different blood parameters in grazing calves aged between 5 and 9 months. They measured the number of GIT parasite eggs and larvae per gram of feces and also PCV, Hb, total proteins and albumin levels were measured and generally low correlation between blood parameters and parasitic burden was found. *Hemonchus* spp. and *Cooperia* spp. showed the most significant variables.

Grodzki *et al.* (1990) examined the blood and fecal samples from black and white calves of 1-10 days of age and observed a significant gradual decrease in aspartate (AST) and alanine (ALT) aminotransferases and also in alkaline phosphatase in the blood serum. In the feces, highest activity occurred between 4-5 days for ALT and no significant relation between activities of the examined enzymes in blood serum and feces was found.

Aumont *et al.* (1991) reported *Strongyloides papillosus* and *Toxocara vitulorum* in 2 month old calves and then found *Haemonchus placei*, *Trichostrongylus* spp. and *Cooperia* spp. as dominant nematodes. They found Brahman cross (Brahman × Creole) calves as the most heavily infected. There was no clear relationship between 3rd stage larvae (L₃) population size on pasture and worm burden in calves, except during the 2nd month of life. The pathological effects of sub-clinical parasitism were confirmed by a lower PCV and albuminaemia in parasitized calves.

Gennari *et al.* (1991) investigated the pathophysiology of *Haemonchus placei* infection in Friesian calves and found a significant reduction in the mean haematocrit values and reduced weight gains in the infected calves compared with the controls. A significant increase was also detected in the plasma and blood volumes of infected calves although the blood and albumin loss via the gastrointestinal tract recorded in this study was similar in both groups.
Grodzki et al. (1991) investigated changes in certain biochemical parameters in the blood serum from Holstein-Friesian calves with diarrhea in the 1st 10 days of life and reported these parameters same in both healthy and sick animals except an increase in alkaline phosphatase, GPT (alanine aminotransferase) and GOT (aspartate aminotransferase) activities were observed in diarrheic calves.

Pradhan et al. (1991) examined fecal samples of calves aged below 6 months and found 61.66% of the samples positive with the majority of infection caused by nematodes. The infected calves showed significant decrease in Hb, PCV and TEC along with lowered total serum protein, albumin and globulin levels when compared with controls. Eosinophilia was noted in infected calves but there was no significant difference in total leucocyte counts between the two groups.

Radhakishan et al. (1991) studied the hematological and biochemical parameters of neonatal diarrheic buffalo calves that revealed significant elevation of PCV, TLC and DLC counts showed increased values of neutrophils and lymphocytes, the total proteins were found decreased.

Bhongade et al. (1993) reported that helminth worm infected cattle had low levels of Hb, blood glucose and total protein. After anthelmintic therapy EPG of these animals was reduced.

Nakanishi et al. (1993) examined hematological, biochemical and histological changes in the calves experimentally infected with *Strongyloides papillosus*. No changes were observed in blood cell counts except for a transient eosinophilia but a decrease in blood glucose was observed.

Raina et al. (1993) recorded the biochemical values in healthy non-descript Kashmiri and Jersey cows at a height of 2275 meters and reported no significant difference between the two genetic groups but total cholesterol, total protein, globulin, amylase and total bilirubin to be lower and albumin, A: G ratio, inorganic phosphate, ALP and creatinine to be higher in non-descript cows than Jersey bovines.
Waghmare et al. (1993) reported that helminth infested buffalo calves (1-4 months of age) had sub-optimal levels of blood glucose, total proteins, and albumin in serum and the faecal examination showed mixed infection (>1500 epg) of *Neoascaris vitulorum* and *Strongyloides papillosus* infection.

Alam et al. (1994) studied infected and non-infected buffaloes and found sub clinical GI parasitic infections of *Ascaris*, *Strongyloides*, *Strongylidae* and certain trematode species which did not cause anemia in infected animals. Blood hemoglobin concentrations were also same in both groups (11-14g/100ml).

Sciavicco et al. (1997) studied two groups of calves for a period of 18 months, one was given anthelmintic treatment while the other group were a control and no significant difference between the two groups were found after carrying out their hematological examination, fecal egg count and larval nematode cultures. But there was increase in TLC, neutrophil and eosinophil count and decrease in lymphocyte count during the rainy season in both the groups. There was also a reduction in fecal egg count with age of cattle and significant differences between the 2 groups were observed from the rainy season onwards. The larvae recovered from fecal culture belonged to *Cooperia*, *Haemonchus*, *Oesophagostomum*, *Trichostrongylus* and *Bunostomum* with *Cooperia* as most predominant species.

Raman et al. (1999) studied the hemato-biochemical changes in crossbred calves (*Bos taurus × B. indicus*) which were experimentally infected with *Haemonchus contortus* and reported significant reduction in PCV and Hb values with lymphopenia, neutrophilia and mild eosinophilia.

Kumar et al. (2000) reported significantly higher plasma Albumin:Globulin ratio (P<0.05) in heifers maintained at 270m altitude compared to those at 1700m altitude whereas higher globulins were recorded in heifers maintained at 1700m altitude.

Patil et al. (2000) reported that total serum proteins increased significantly up to 12 month age in Gir calves and 9 months of age in crossbred calves. No specific trend was observed regarding serum albumin concentration during growth in Gir and crossbred calves. Higher serum globulin conc. was observed in crossbred calves aged 0-3M than Gir calves of same age group. Serum A: G ratio
showed significant decreasing trend with increasing age in both Gir and crossbred calves.

Mengi (2001) reported that the Hb, PCV and TEC in haematuric cows were significantly lower than healthy controls. Erythrocytic indices; MCH and MCHC were also significantly lower in haematuric cows without any significant change in MCV values.

Bharti et al. (2002) studied the hematological parameters in calves and cows during pre and post anthelmintic treatment and observed reduced hematological profiles during nematode infection. Anthelmintic treatment markedly improved hematological values in both infected cows and calves.

Singh et al. (2002a) observed a slightly higher edge of hematological parameters in experimental Crossbred calves fed dried poultry litter and dried temple waste. Singh et al. (2002b) determined the higher levels of serum enzyme profile in bovine calves infected with Setariosis. Singh et al. (2002c) observed significant reduction in haemoglobin, PCV, TEC and erythrocyte indices in the calves transplanted with adult Setaria digitata worms. Lymphocytosis, neutropenia and eosinophilia and elevated TLC were also observed in them.

Al-Shami (2003) investigated the hematological and biochemical profile of Hassawi cattle breed in Saudi Arabia and found that the breed showed similar picture of blood values except a minor deviation in WBC. The means of biochemical values were within the normal ranges recorded for other breeds of cattle.

Katoch et al. (2003) studied the hematological and biochemical parameters of anaemic cattle and revealed some therapeutic measures. The anaemic cattle showed reduction in Hb, PCV, TEC, TLC and also significantly low erythrocyte indices (MCV, MCH and MCHC) but differential leukocytes were within normal range.

Kumar et al. (2003) conducted an experiment on Crossbred calves and estimated the fluctuations in the values of serum Alkaline Phosphatase and blood urea nitrogen with increasing age.
Rajkhowa et al. (2003) studied the hemato-biochemical values in calves suffering from GIT nematodes. Those with high fecal egg counts were given a single dose of anthelmintic and showed haemoglobin values increased significantly after treatment, PCV returned to normal values and mean value of total protein was increased and significant differences were observed for the pre and post treatment values in total erythrocyte count, total leukocyte count, albumin and globulin values.

Kumar et al. (2004) estimated the concentration of total serum proteins, albumin, globulin and A:G ratio in female calves of different age groups and reported that the calves exposed to environment rich in micro-organisms showed five times increase in serum globulin concentration on day 7-14.

Rajkhowa et al. (2004) found that haemoglobin values of calves affected with Ascaroses were significantly lower than control ones.

Dhami et al. (2005) evaluated the haemoglobin content and certain blood biochemical constituents of Holstein-Friesian cattle in relation to different age groups and reported that Hb content was lowest in young calves and increased with age to reach the highest level at puberty. Total protein content, which was lowest in 1-2 week old calves, increased gradually with age until maturity.

Nath et al. (2005) reported that most of the blood parameter values like blood glucose, serum total protein, albumin and globulin of indigenous cattle of Lakhimpur district of Assam were comparatively less than those reported by other authors.

Ozdemir et al. (2005) studied the variations in some haemato-biochemical parameters in dairy cows due to different seasons and found that their mean erythrocytic count (MEC), haematocrit ratio, Hb concentration corresponded to those of physiologically healthy animals. No difference in MEC due to season was reported. Statistically significant differences were detected between different seasons in relation to haematocrit, Hb levels, alkaline phosphatase activity of experimental and control groups.
Bricarello et al. (2007) evaluated the different degrees of resistance in cattle to natural gastrointestinal nematode infection. The resistant group showed lower fecal egg count and worm burdens than the susceptible groups. There were no significant differences between groups regarding packed cell volume, weight gain and total serum protein values (P>0.05) and higher mean eosinophil blood counts. The nematodes *Cooperia punctata* and *Haemonchus placei* were predominant. This study provided further evidence that Nelore cattle are responsive to nematode infections.

Amin et al. (2008) studied the effects of anthelmintics against natural gastrointestinal nematodes in cattle and their hematological parameters (TEC, Hb, PCV and TLC), biochemical parameters (ALT and AST) and clinical parameters (body weight) were accordingly measured. They reported that the nematode infected cattle after treatment showed increased Hb content, TEC and PCV as compared to non treated group whereas significantly decreased TLC in treated cattle than non-treated cattle. Also there was a significant reduction in EPG counts of feces in former cattle. The alanine (ALT) and aspartate (AST) aminotransferase levels were not significantly changed in the cattle.