CHAPTER - V
SUMMARY

Small ruminants are reared by the poorest sections of rural population in our country with very small holdings. The small ruminants, sheep and goats, suffer from many diseases. The viral and bacterial diseases are easily diagnosed by their clinical signs but parasitic infection when less in number or in early stages are without clinical signs and thus act as one of the major cause of production and economic loss. The incidence of helminthes infection varies with age, sex, season and agro- climatic conditions. Although, many gastrointestinal nematodes were responsible for parasitic gastro enteritis in small ruminants, Haemonchus contortus was considered to be the most prevalent and pathogenic nematode in sheep and goats, followed by Trichostrongylus spp., Oesophagostomum spp., Bunostomum spp., Cooperia spp. and Strongyloides spp.

The control of these gastrointestinal nematodes has rested firmly on the usage of anthelmintics for many decades. The practice of anthelmintic dosing at regular intervals for control of gastrointestinal nematodes made the parasites resistant. In India, anthelmintic resistance in gastrointestinal nematodes of sheep and goats has emerged as a serious problem that needs to be redressed. The present investigation was undertaken to study the status of anthelmintic resistance and parasitic control practices in the small holder sheep and goat flocks of Cuddalore district. The occurrence of gastrointestinal nematodes and anthelmintic resistance was studied in small holder sheep and goat flocks of six taluks in Cuddalore district. Multiple anthelmintic resistance in gastrointestinal nematodes to benzimidazole, levamisole and ivermectin was detected by a combination of faecal egg count reduction test (FECRT) and in vitro assays. In vitro assays such as Egg Hatch
Assay (EHA) for detection of resistance to Fenbendazole and Larval Development Assay (LDA) to detect resistance against fenbendazole, levamisole and ivermectin were used in the study areas. A survey was also carried out to assess the parasitic control measures adopted by farmers in the six taluks of Cuddalore district and the datas collected were documented.

Epidemiology of the gastrointestinal nematodes affecting sheep and goats was carried out through faecal sample examinations, faecal egg counts, entrails examination and coproculture. The sheep flocks of Cuddalore taluk showed a highest parasitic infection (56.66 per cent) compared to other taluks of Cuddalore district. The sheep flocks of Chidambaram, Kattumannarkoil, Panruti, Vridhachalam and Tittakudi taluks were infected with 41.66, 53.33, 48.33, 55.00 and 48.33 per cent of gastro-intestinal parasitic infection, respectively. The infection rate was higher in goat flock of Cuddalore taluk (55.55 per cent) compared to other taluks. The gastrointestinal parasitic infections in goat flocks of Chidambaram, Kattumannarkoil, Panruti, Vridhachalam and Tittakudi taluks were 38.33, 49.44, 47.00, 51.66 and 51.11 per cent, respectively.

Seasonal prevalence of gastrointestinal nematode infection rate was higher during rainy season especially in north east monsoon (77.03 per cent and 74.07 per cent) followed by winter season (58.88 per cent and 55.55 per cent) in both sheep and goat flocks of Cuddalore district. During the south west monsoon, the parasitic infection rate was 48.61 per cent and 27.77 per cent in sheep and goat flocks, respectively. The prevalence of infection was lower during summer (25.55 per cent and 22.96 per cent) in sheep and goats flocks. The present study indicated that higher parasitic infection was noticed during rainy season followed by winter and summer.
Species wise prevalence of gastrointestinal nematode infection of small ruminants during study period revealed that infection with *Haemonchus* spp. was found to be higher in sheep and goats with 57.34 per cent and 53.03 per cent, respectively. Infection with *Trichostrongylus* spp. was found in 12.36 per cent sheep and 13.82 per cent goats; *Oesophagostomum* spp. (7.52 pre cent and 10.60 pre centt) and *Bunostomum* spp. (9.49 pre cent and 9.28) were prevalent in sheep and goats. Mixed infection with more than one species of nematode also observed in about 13.25 per cent of small ruminants.

The mean faecal egg counts of different small holder sheep flocks of Chidambaram and Kattumannarkoil taluks ranged from a minimum of 400± 70.71 and 540 ±103.68 during summer to a maximum of 2300±103.04 and 2010±103.57 (North east monsoon), respectively. The faecal egg counts in sheep of Cuddalore and Panruti taluks ranged 200± 70.71 and 450± 212.1 during summer and north east monsoon to 1888.88± 135.14 and 2011.11 ±168.11, respectively. The faecal egg counts in sheep of Vridhachalam and Tittakudi taluks ranged a minimum of 350± 212.13 and 466.66 ±147.19 during summer and south west monsoon to a maximum of 1812.5± 139.14 and 1875 ±74.91, respectively.

The mean faecal egg counts of different small holder goat flocks of Chidambaram and Kattumannarkoil taluks ranged a minimum of 250±50.00 and 200±70.71 during summer to a maximum of 2166.66± 190.90 and 2722.22 ±91.47 during north east monsoon, respectively. The faecal egg counts in goats of Cuddalore and Panruti taluks ranged 225±55.27 and 333.33±108.01 during summer to 2488.88 ± 123.04 and 2088.88±92.60 during north east monsoon, respectively. The faecal egg counts in goats of Virudhachalam and Tittakudi taluks
ranged a minimum of 150±70.71 and 300±70.71 during summer to a maximum of 1988.88 ±103.74 and 1844.44 ±58.92 during north east monsoon, respectively.

During the winter season, the sheep and goat flocks of Cuddalore taluk revealed relatively medium faecal egg counts of 966.66±73.02 and 822.22±55.27 (January), respectively. In summer, egg counts were lower compared to winter and rainy seasons.

The examination of entrails to recover the adult gastrointestinal nematodes revealed the presence of *H. contortus* and *O. columbianum* in all the six taluks of Cuddalore district. In addition, *B. trigonocephalum, S. papillosus, T. ovis* were also recovered in animals slaughtered from Chidambaram and Tittakudi taluks. In goats, *H. contortus, O. columbianum* were predominantly recorded in all the six taluks of Cuddalore district. In addition, *T. ovis* was collected from Chidambaram and Vridhachalam taluks, and *S. papillosus* was recovered from Cuddalore taluk.

The respective mean values of FECR after treatment with fenbendazole, levamisole and ivermectin in sheep flocks of all the six taluks of Cuddalore district were 50 -91 per cent, 93 – 96 per cent and 94- 97 per cent. The gastrointestinal nematodes showed resistance to fenbendazole and susceptibility to levamizole and ivermectin.

The respective mean values of FECR after treatment with fenbendazole, levamisole and ivermectin in goat flocks of all the six taluks of Cuddalore district were 74 - 91 per cent, 90 – 97 per cent and 94- 98 per cent. The gastrointestinal nematodes showed resistance to fenbendazole and susceptibility to levamizole and ivermectin.
The pre and post treatment coproculture revealed the preponderance of *Haemonchus* spp., (60 - 72 per cent), *Oesophagostomum* spp., (6 - 20 per cent), *Trichostrongylus* spp., (2 - 4 per cent) and *Bunostomum* spp., (2 - 3 per cent) in all resistant sheep and goat flocks. The most prevalent helminth species of larvae detected in this study was *Haemonchus* spp.

The EHA was conducted using different concentrations of fenbendazole in sheep and goat flocks of all the six taluks of Cuddalore district. The respective ED$_{50}$ values ranged from 0.014 to 0.329 µg / ml and 0.049 to 0.571 µg / ml.

The LDA was conducted in the small holder sheep and goat flocks in all the six taluks, Chidambaram, Kattumannarkoil, Cuddalore, Panruti, Vridhachalam and Tittakudi of Cuddalore district and LD$_{50}$ values were computed and compared with FECRT and EHA. The respective LD$_{50}$ values were 0.283, 0.177, 0.320, 0.349, 0.146 and 0.368 µg FBZ/ml; however, the sheep flocks of Chidambaram, Panruti, Vridhachalam and Tittakudi taluks had the LD$_{50}$ values of 1.173, 1.254, 1.741 and 1.489 µg LEV/ml, respectively, indicated that these flocks were resistant to levamisole. The sheep flocks of Kattumannarkoil and Cuddalore taluks, were found to be susceptible to levamisole with the LD$_{50}$ values of 0.897 and 0.642 µg/ml respectively. The sheep flocks of Chidambaram, Kattumannarkoil, Cuddalore, Panruti, Vridhachalam and Tittakudi taluks had the LD$_{50}$ values of 0.012, 0.102,0.030, 0.053, 0.22 and 0.192 ng IVM/ml, respectively.

The goat flock of Tittakudi taluk had LD$_{50}$ value of 0.257 µg/ml indicated the susceptibility to fenbendazole by LDA. The goat flocks of Chidambaram,
Kattumannarkoil, Cuddalore, Panruti and Vridhachalam taluks had the LD$_{50}$ values of 1.115, 0.205, 0.120, 0.113 and 0.096 µg fenbendazole / ml, respectively. The goat flock of Kattumannarkoil taluk was found to be resistant to levamisole with the LD$_{50}$ value of 1.031 µg/ml. All the other goat flocks of Chidambaram, Cuddalore, Panruti, Vridhachalam and Tittakudi taluks had the LD$_{50}$ values of 0.400, 0.536, 0.516, 0.583 and 0.555 µg/ml, respectively, indicated that these flocks were susceptible to levamisole by LDA.

The goat flocks of Cuddalore district were found to be susceptible to IVM with the LD$_{50}$ values ranging from 0.002 to 0.29 ng/ml. The goat flocks of Chidambaram, Kattumannarkoil, Cuddalore, Panruti, Vridhachalam and Tittakudi taluks had the LD$_{50}$ values of 0.005, 0.011, 0.029, 0.028, 0.002 and 0.013 ng ivermectin / ml, respectively.

The survey conducted by questionnaire method in Cuddalore district revealed that 38.33 per cent reared sheep and 61.66 per cent reared goats. The rearing of sheep was higher in Panruti and Vridhachalam taluks (44 per cent and 43 per cent respectively) when compared to Tittakudi, Cuddalore, Kattumannarkoil and Chidambaram taluks (38, 37.5, 36.5 and 31 per cent). Status of goat farming in Chidambaram taluk was 69 per cent followed by 63.5 per cent in Kattumannarkoil taluk, 62.5 per cent in Cuddalore taluk, 62 per cent in Tittakudi taluk, 57 per cent in Vridhachalam taluk and 56 per cent in Panruti taluk.

Management practices such as flock size, rearing experience of the farmers, housing system, system of management and type of feeding for small holder sheep and goat flocks of Cuddalore district were also documented. The sheep flock size of 5 -10 animals reared by 18.05 pre cent; 10 - 20 animals reared by 34.99 pre cent
and 20 – 30 animals reared by 46.94 pre cent of farmers in Cuddalore district. The mean value of rearing experience revealed that 31.94 pre cent of sheep farmers have up to 5 years, 41.10 pre cent have 6 -10 years and 26.97 pre cent have more than 10 years in Cuddalore district. The survey also revealed that 87.49 pre cent of sheep farmers provided thatched house for the animals, 82.49 pre cent reared by semi intensive system and 92.22 pre cent of sheep farmers provided grazing in Cuddalore district.

The goat flock size of 5 -10 animals were reared by 37.49 pre cent; 10 - 20 animals reared by 54.71 pre cent and 20 – 30 animals reared by 7.77 pre cent of farmers in Cuddalore district. The mean value of rearing experience revealed that 36.10 pre cent of goat farmers have up to 5 years, 48.65 pre cent have 6 -10 years and 14.99 pre cent have more than 10 years in Cuddalore district. The survey also revealed that 85.55 pre cent of goat farmers provided thatched house for the animals, 69.99 pre cent reared by semi intensive system and 66.38 pre cent of goat farmers provided grazing in Cuddalore district.

Control measures of parasitic infections adopted by small holder sheep and goat farmers in Cuddalore district were also documented. The infection was more in rainy season as reported by 80 per cent of farmers and the sheep flocks were drenched with anthelmintics more than 2 times in a year. Sheep farmers in Chidambaram (46.66 per cent), Kattumannarkoil (53.33 per cent), Cuddalore (40 per cent), Panruti (60 per cent), Vridhachalam (38.33 per cent) and Tittakudi (25 per cent) drenched 2 times in a year. About 61.66 per cent of farmers in Vridhachalam and 63.33 per cent farmers in Tittakudi drenched their flocks.
3 times in a year. With respect to season, about 65 per cent of farmers in the district drenched their flocks during south west monsoon (June to September); about 33 per cent farmers drenched during north east monsoon (October to February).

Sheep farmers selected the deworming drugs based on their own experience and as per the advice of the local veterinarian. In Kattumannarkoil, Panruti and Vridhachalam taluks, 70 per cent of the farmers selected the drugs based on their own experience. In Chidambaram and Cuddalore taluks, 40 per cent of the farmers selected the drug for deworming as per the advice of veterinarian. Dose calculation of drug for drenching sheep was mainly done using the body weight of each animal. In Cuddalore district 90 per cent of the farmers calculated the dose of drug based on individual animal’s body weight.

The survey indicated that the type of anthelmintic used for drenching sheep and perception of best drug by the farmers were same. About 73.33 per cent farmers in Chidambaram taluk, 63.33 per cent in Kattumannarkoil, 68.33 per cent in Cuddalore taluk, 83.33 per cent in Panruti taluk, 75 per cent in Vridhachalam taluk and 65 per cent in Tittakudi taluk were using benzimidazole for drenching and perceived benzimidazole was the best drug for deworming of sheep. With respect to Levamisole, 13.33 per cent farmers in Chidambaram, 20 per cent in Kattumannarkoil, 15 per cent in Cuddalore, 6.66 per cent in Panruti, 13.33 per cent in Vridhachalam and 20 per cent in Tittakudi were using and perceived Levamisole as a drug of choice for deworming of sheep flocks. Very few farmers (3 – 8 per cent) in the district
used ivermectin for drenching. Around 10 per cent of farmers used other
drugs or combination of two drugs for deworming of sheep.

Control measures of parasitic infections adopted by small holder goat
farmers in Cuddalore district revealed that goats were the main source of income
for small and marginal farmers in the district and all the farmers were aware
of production loss due to parasitic infection in goats. The perception of gastro-
intestinal parasitic problem was more in rainy season (63 – 85 per cent), followed
by winter (13 – 26 per cent) and summer (1- 15 per cent). Most of the goat
farmers (46 – 58 per cent) drenched their goats two times in a year in all
taluks of Cuddalore district except in Vridhachalam and Tittakudi taluks
where 20 per cent farmers drenched two times in a year and around 60 per cent
farmers drenched their flocks three times in a year. In Chidambaram,
Kattumannarkoil, Cuddalore and Panruti taluks, 35 – 40 per cent of goat farmers
drenched their flocks three times in a year. About 3- 11 per cent goat farmers
in the district drenched the flock more than three times in a year. The GIN infection
was perceived more in rainy season; 20 – 35 per cent farmers drenched their goats
during north east monsoon, 36 – 50 per cent in south west monsoon, 13 – 26 per
cent in winter and about 1 – 11 per cent farmers in summer.

With respect to selection of suitable drug for deworming, an average of
60 per cent of small holder goat farmers in Cuddalore district selected the
drugs based on their own experience and about 35 per cent of the farmers
followed the advice of local veterinarian. Majority of the small holder goat
farmers in Cuddalore district calculated the dose of deworming drugs based on body weight of the individual animal.

It was inferred that the Benzimidazole was the best drug for deworming goats. The drug was used by 46 per cent of farmers in Chidambaram, 51 per cent in Kattumannarkoil, 48 per cent in Cuddalore, 83 per cent in Panruti, 60 per cent in Virudhachalam and 91 per cent of the farmers in Tittakudi taluks. With respect to Levamisole, 36 per cent farmers in Chidambaram, 30 per cent in Kattumannarkoil, 35 per cent in Cuddalore, 6.66 per cent in Panruti, 16 per cent in Vridhachalam and 20 per cent in Tittakudi used as a drug of choice for deworming their goat flocks. Around 10 per cent of the goat farmers in the district used ivermectin for drenching and about 6 per cent of the farmers used combination of drugs for drenching their flocks.

CONCLUSION

- The gastrointestinal nematode infection represented a severe health problem in small holder sheep and goat flocks of Cuddalore district.

- The gastrointestinal nematode infection rate was higher in rainy season especially during north east monsoon when compared to all the other seasons in both sheep and goat flocks of Cuddalore district.

- The most prevalent nematodes was *Haemonchus* spp. which cause haemonchosis and parasitic gastro enteritis in sheep and goats.

- A serious threat for anthelmintic resistance was found against fenbendazole in nematodes of sheep and goats in Cuddalore district.
• The anthelmintic resistance against fenbendazole in all the sheep and goat flocks were confirmed by *in vivo* and *in vitro* techniques.

• A suspected resistance was found against levamisole in some flocks of sheep and goats in Cuddalore district.

• It was concluded that ivermectin was found to be effective against gastrointestinal nematode infection in sheep and goats.

• A lack of awareness by the farmers about anthelmintic resistance and not adopting proper control measures lead to increase in the resistance of GINs against traditional drugs like benzimidazole.

**RECOMMENDATIONS**

Following recommendations are given on the basis of the present study:

- Regular screening of animals for the presence of gastrointestinal nematode infections should be carried out to understand the disease potential in sheep and goat flocks.

- Based upon epidemiological principles, the sheep and goat flocks should be dewormed at least two times before south east and north west monsoons.

- To launch effective anthelmintic resistance management programme with a multi-pronged approach to address all the inherited, operational and medicinal factors.

- Overcrowding of animals in the flocks should be avoided and good sanitary conditions should be provided.
- Alternative grazing between ruminants (cattle and sheep) may be practised to minimize the infective larvae in the pasture.

- Mass education awareness programme should be launched using both print and electronic media and short courses on the worm control practices emphasizing the ethical use of anthelmintics and other approved management procedures.

- Alternatives to chemical control also have viable effect in the treatment of GINs in sheep and goats and they must be incorporated to avoid resistance.