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Date: (Ram Singh)

Place: Ranchi
THESIS ABSTRACT

Title of thesis : COMPREHENSIVE SUSTAINABLE CONTROL OF COMMON G. I. HELMINTHS AND ECTOPARASITES AND ITS ECONOMIC IMPACT IN SHEEP PRODUCTION

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Key words : Comprehensive control, endo and ectoparasites, economic impact, sheep.

The comprehensive sustainable control of both endo and ectoparasitic infections affecting Chhotanagpuri sheep was achieved by implementing chemical and herbal anthelmintic and licidical control packages. The observations taken on different parameters during the period of study have been summarized and concluded herewith:

1. Chhotanagpuri lambs were detected to acquire natural patent coccidial infection from 20th day post birth, whereas patent infection of different G.I. nematodes were observed to affect the animals from 35th day post birth onwards.
2. Fenbendazole+ Praziquantel G.I. nematode control package kept the animals completely parasite free from 10th day onward.

3. The local herbal anthelmintic preparation freed about 90 percent growing lambs naturally infected with G.I. nematodes till 20th DPT.

4. Cypermethrin ECP freed 100 percent growing lambs from lice infestation till 9th DPT onward.

5. The herbal ECP formulation cured clinical lousiness in growing lambs completely from 12th DPT onward.

6. The Chemical anthelmintic packages required repetition approximately after 2 months for long term sustainable control of common G.I. nematodes infected lambs and sheep.

7. The herbal anthelmintic package was required to be repeated at about 55th DPT interval for sustainable G.I. nematode control in lambs and sheep.

8. The chemical and herbal licidical formulation need repetition of application for their sustainable lice control in sheep from 130th and 120th DPT intervals, respectively.

9. The G.I. nematode and lice infested growing lambs had reduced Hb, PCV and TEC values, whereas these parameters were found to get improved at about normal ranges after 15th DPT with chemical and herbal anthelmintics and licidical agents.

10. The G.I. nematodes and lice infested animals had lower growth rate than chemical and herbal anthelmintic and licidical drugs treated animals.

11. Approx. Rs. 360 net gain was observed after application of herbal NCP and LCP control packages in G.I. nematode and lice infested sheep.
Likewise, approx. Rs. 406 per animal net economic gain was obtained after application of chemical NCP and LCP application upto 10 months.

12. The chemical and herbal anthelmintics NCP (250.80) and LCP (263.62) subjected animals were found to have their 1st oestrus cycle earlier than G.I. nematode and lice parasitized (310.06) sheep.

**CONCLUSION:**

1. The long term therapeutic control packages applications against the common G.I. helminths and ectoparasite infestation were found useful for economical sheep production.

2. Though, the herbal anthelmintic and licicidal formulations showed delayed efficacies during trials, they can be of more utility for the farmers in remote rural areas.

3. For obtaining higher economic gain from sheep farming, it was found essential to implement the comprehensive sustainable parasite control packages from early stage of life in growing lambs.
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INTRODUCTION

The sheep husbandry plays a significant role in the national economy. The production and marketing of wool and mutton contributes to a very large extent towards rural economy particularly in the areas where sheep husbandry is the primary occupation of small and marginal farmers. Sheep farming provides much needed relief to the economically weaker people of the society who have adopted it as a primary or subsidiary occupation for their livelihood security.

In spite of the fact that sheep is a major source of individual and state exchequer, inadequate attention and support has not been given by the government or non-government agencies for the improvement of its rearing in different conditions. Sheep has been found to suffer from a variety of health problems at all stages of production. Several parasitic infections are known to cause serious health hazards for the animals being raised under different system of management (Gupta et al., 1985, Bedarkar et al., 2000). Some of the gastrointestinal parasites and a few ectoparasites commonly victimise sheep of all ages (Jithendran et al., 1998). The clinical and sub-clinical helminthic infections cause great economic losses in terms of meat and wool production (Gupta et al. 1987, Niphadkar et al., 1986).
Among the various gastrointestinal helminths affecting sheep, *Haemonchus contortus* has been recognized as a parasite of considerable economic importance (Siham *et al*., 1997). The direct or indirect harms caused by some of the intestinal nematodes and ectoparasites like lice, flies and ticks can not be ignored.

A number of antiparasitic agents have been reported useful in controlling the common G.I. and ectoparasites (Singh *et al*., 1994, Yadav *et al*., 1996). But the continuous uses of these anthelmintics have resulted in resistant strains of helminths (Yadav 1990, Singh *et al*., 2003).

Therefore, the situation warrants to implement strategic control measure for the important ecto and endoparasites affecting sheep. Recently, Das (2001), and Lakra (2004) have suggested to implement simultaneously the endo and ectoparasites control packages for their effective control and economical goat production. Available literature indicates that there is lack of such information for achieving sustainable parasite control for economical sheep production.

Thus, there is an urgent need to assess the economic impact of parasitic infections in sheep. The health and production losses caused by the common endo and ectoparasites affecting goats have been pointed out to some extent by Lakra (2004), and Sinha (2004). Similar strategic measures are yet to be evaluated in
sheep for knowing the impact of parasitic infections on the different health and production characters.

Therefore, keeping in view the above facts, the present study was planned to implement long term comprehensive therapeutic management of common gastrointestinal and ectoparasites together from early postnatal life of the animals and to assess their impact on the health and production characters in sheep under semi-intensive farming with the following objectives:

1) To determine the approximate time of acquiring endo and ectoparasitic infections during early postnatal life.

2) To achieve comprehensive sustainable control of common G.I. and ectoparasites in growing lambs and sheep by using chemical and herbal parasite control packages.

3) To observe the effect of G.I. and ectoparasite infections and their comprehensive control on the health parameters in growing lambs and sheep.

4) To estimate the impact of common endo and ectoparasites and their comprehensive control on the growth performance in growing lambs and sheep.
As per the objectives defined the literature pertaining to know the time of acquiring patent endo and ectoparasitic infections in lambs in early life after birth. The efficacies of endo and ectoparasite control packages in sheep, haematological alterations during infestations and treatment in sheep, and the effects of endo and ectoparasite infestations and treatment on the economics of production in sheep and other animals have been consulted and compiled herewith.

A. DETECTION OF FIRST TIME PATENT INFECTIONS OF IMPORTANT ENDO AND ECTOPARASITES DURING EARLY POST-NATAL LIFE IN SHEEP AND OTHER ANIMALS:

There appeared to be very limited informations on the detection of first time patent infections of different endo and ectoparasites in sheep. Therefore, a few references in this regard pertaining to other animals have also been included for comparative discussion of the present findings.

Agyei (1990) observed the first patent infections of *Eimeria* spp. oocysts, *Strongyloides papillosus* eggs, Strongylate nematode eggs and the segments and eggs of *Moniezia* spp. tapeworms in the faecal samples of lambs on 20th, 46th, 57th and 59th days after birth.

Kumar (2007) identified that the *Toxocara vitulorum* prenatal and postnatal acquired infection in buffalo calves was during 10th to 28th day after birth.
Toxocara canis first patent infection in pups was noted between 23rd and 40th days after birth (Douglas and Baker, 1959).

B. EFFICACIES OF ENDO AND ECTOPARASITE CONTROL PACKAGES IN SHEEP AND OTHER ANIMALS:

a. Efficacies of Chemical Anthelmintics:

Kennedy and Todd (1975) stated that lambs severely parasitized by Haemonchus, Ostertagia, Trichostrongylus, Cooperia, Oesophagostomum and Nematodirus spp. were treated with Fenbendazole at 3.5, 5.0 or 7.5 mg/kg b.wt. at the three dose levels. The efficacies against these genera, except Haemonchus and Nematodirus were 100 percent.

Selim et al. (1977) treated sheep, cattle, goats and camels naturally infected with gastro-intestinal nematodes by Fenbendazole @ 5 mg/kg body weight (sheep and goats) and 7 mg/kg b.wt. (cattle and camels) and found complete elimination of eggs from the faeces for at least 30 days.

Vihan and Sahni (1979) treated 4 groups of nematodes infected growing lambs with four different anthelmintics viz. Thiabendazole (@ 66.9 mg/kg), Tetramisole (@ 50 mg/kg), Parbendazole (@ 750 mg/kg) and with Morantel Citrate (@ 15 mg/kg) and observed that Parbendazole was found to be the most effective in reducing the egg counts over a period of 99 days followed by Tetramisole, Thiabendazole and Morantel Citrate.
Twenty four young sheep and goats experimentally infected with 3000 *Strogyloides papillosus* larvae were treated one month later with 2.5 percent febantel suspension at 5 mg/kg body weight and another third received 2.5 percent Fenbendazole suspension at 5 mg/kg. The efficacies of the two drugs were, 85.0 and 39.1 percent, respectively (Grimbeek and Terblanche, 1980).

Gupta *et al.* (1981) observed very high anthelmintic activity of Fenbendazole against common gastrointestinal nematodes in sheep given orally @ 2.2 mg/kg body weight for 3 days.

Lambs in three groups of 12 being grazed on pastures contaminated with *Haemonchus contortus, Ostertagia circumcinata* and *Trichostrongylus colubriformis* and subsequently treated after 8 weeks with Fenbendazole (7.5 mg/kg) and Albendazole (3.8 mg/kg). Both the anthelmintics were nearly 100 percent effective against the parasites (Kerboeuf *et al.*, 1982).

Megomedov (1984) reported that Fenbendazole (as 22.2 %, Panacur granules) administered at the doses of 5, 7 or 10 mg/kg body weight along with feed given to lambs, it was found 70, 90 and 100 percent effective, respectively against natural *Nematodirus* and 100 percent against *Bunostomum* spp.

Beriajaya *et al.* (1986) reported that sheep reared by traditional farming method in West Java when treated with various anthelmintics against gastrointestinal nematodes or left as untreated control, the faecal egg count decreased in the treated groups, although
repeated reinfection of *Haemonchus* spp. occurred between treatments. The mortality rate declined also in treatment groups.

Niphadkar *et al.* (1986) reported that Albendazole 2.5 percent suspension was found 100 percent effective against the common gastrointestinal *Strongyle* nematodes in sheep. It removed the ova of *Trichuris* spp. completely in 45 percent of the treated animals. Dosage up to 100 mg/kg body weight given orally had no toxic effect.

Albendazole (Vermitan) at 5 mg/kg, when given as drenches to lambs with natural *Moniezia expansa* and *strongyles* infestation showed very high effectiveness against both parasites. (Schuster *et al.*, 1987)

Handayani and Gatenby (1988) stated that the anthelmintic treatment with Albendazole at every 4 week intervals given to lambs reduced 28 percent mortality, 85 percent faecal EPG counts along with improved body weight gain by 21-29 gm per day in comparison to untreated lambs.

Ahmad *et al.* (1990) observed that Albendazole @ 5 mg/kg b.wt. orally given to sheep infected with gastrointestinal nematodes (*Strongyle* and *Trichuris* spp.) was found to be 100 and 72 percent effective on seventh day post-treatment on the basis of faecal egg counts.

Gill *et al.* (1990) studied the comparative efficacies of anthelmintics against moneiziasis in naturally infected sheep after treatment with Albendazole (5 mg/kg b.wt.), Niclosamide (100 mg/kg b.wt.), Mebendazole (50 mg/kg b.wt.), and Fenbendazole (5 mg/kg b.wt.). The drugs showed 95.12, 100, 92.68 and 85.36 percent effectiveness on 7th day post-treatment. The efficacy evaluation of anthelmintics indicated
that Niclosamide was the most effective (100 %) anticestodal drugs in sheep followed by Albendazole, Mebendazole and Fenbendazole.

Maiti et al. (1990) successfully treated common gastrointestinal nematodes affecting sheep with single oral dose of Albendazole @ 15 mg/kg body weight. The efficacy of the drug was assessed on the basis of absence of parasitic eggs in the faecal sample and clinical improvement.

Yadav and Clarkson (1990) evaluated the ovicidal and larvicidal effects of Albendazole bolus and suspension @ 7.5 mg/kg in sheep naturally infected with gastrointestinal nematodes and found that the EPG counts in the treated faecal samples were significantly reduced.

Gundlach et al. (1991) evaluated the Albendazole and Luxabendazole the broad spectrum benzimidazole derivatives for treatment of helminthosis in sheep and reported that the efficacy of Albendazole at 7.5 mg/kg body weight was 98.6 percent against gastrointestinal nematodes.

Mohamed et al. (1993) used Albendazole in the treatment of sheep infected with gastrointestinal nematodes and reported that the drug given as 2.5 percent i/v suspension at 1.5 ml/5 kg body weight was 100 percent effective.

Ahmed et al. (1994) compared the efficacy of Morantel Citrate @ 10 mg/ kg and Fenbendazole @ 7.5 mg/kg body weight orally against gastrointestinal nematodiasis in sheep and observed that the efficacies that of Fenbendazole (99.66 %) and Morantel Citrate (87.5 %) were higher than Neem seeds (35.29 and 40.0 %).
Singh et al. (1994) treated sheep naturally infected with common nematodes with four anthelmintics viz. Ivermectin (1%, 1ml/50 kg, s/c), Nitroxynil (34 %, w/v, 1.5 ml/50 kg, s/c) Fenbendazole (5 mg/kg orally) and Tetramisole (30 %, w/w, 15 mg/kg orally). On the basis of EPG, they observed these drugs 100 percent, 99.11 percent, 98.76 percent and 98.12 percent effective, respectively in reducing the ova output of nematode worms on 14th day post treatment.

Yadav et al. (1996) treated sheep naturally infected with Haemonchus contortus with 5 anthelmintics, Fenbendazole (@ 5 mg/kg), Thiophanate (75 mg/kg), Levamisole (7.5 mg/kg), Ivermectin (0.2 mg/kg) and Closantel (10 mg/kg) and found that the efficacies of Fenbendazole and Thiophanate were 65 and 39 percent, respectively in sheep. Levamisole, Ivermectin and Closantel were also found cent percent effective after 10 days post treatment.

Alam and Samad (1997) compared the efficacies of a single dose of Levamisole (7.5 mg/kg), Mebendazole (7.5 mg/kg) and Fenbendazole (10 mg/kg) in 20 sheep (aged between 7 and 20 months) having natural gastrointestinal nematode infections. All three treatments caused a 100 percent reduction in EPG of infected sheep and a significant increase in body weight compared to the untreated control.

Muraleedharan et al. (1997) evaluated the efficacy of low dose levels of Albendazole against Haemonchus contortus infection in sheep. A total of 79 sheep treated orally with different doses of Albendazole (5.0, 3.5, 2.5, 1.5 and 1.0 mg/kg b.wt.) indicated that the dose of 1.5 mg/kg body weight of Albendazole was 100 percent effective, where
as the dosage rate of 10 mg/kg body weight was only 98 percent effective. It was concluded that although the low dose level could reduce the cost of treatment, the possible development of resistance would have to be considered.

Sheep infected with *Moniezia expansa* were treated orally with a combination of Fenbendazole (5 or 7 mg/kg) and Rafoxanide (5 or 7 mg/kg), resulted in 72.8 and 96.6 percent effective against *M. expansa* at the low and high doses, respectively. Both doses of the preparation were 100 percent effective against gastrointestinal nematodes except *Trichuris* spp. Sheep treated orally with 7.5 mg/kg Fenbendazole combined with 10 mg/kg Closantel the combination expelled all Trichostrongylidae (Tinar *et al*., 1998).

**b. Efficacies of Herbal Anthelmintics:**

Bose *et al.* (1961) reported that the seeds of *Carica papaya* are useful as a potent anthelmintic against a number of helminths parasites in goats.

Woppell (Indigenous preparation as Kamla powder) in one or two doses of 2 gm/kg body weight was given to goats experimentally infected with 4000 *Haemonchus* spp. larvae and was observed that the drug did not completely cure the animal but faecal egg counts reduced considerably. (Kumar *et al*., 1973). Further, they also noted that the efficacy of drug increased when given in repeated doses.

The alcoholic extract of *P. granatum* showed encouraging anthelmintic activity as revealed by a dose dependent inhibition of
transformation of egg to filariform larvae of *H. contortus* in sheep. (Prakash et al., 1980).

Jain and Nagi (1986) reported the seeds of *Butea monosperma* when given orally were found to be effective in cases of round worm and thread worm infection in sheep and goat but was ineffective in case of tape worm.

The aqueous extract of fruit rind of *P. granatum* was evaluated *in-vitro* for its anthelmintic activity against earthworm, tapeworm and roundworms. It was found to be more active on tapeworm than the earthworm and roundworm. The effect was 5-7 times lower than that of reference substance Piperazine citrate. Preliminary qualitative test showed the presence of tannins and carbohydrate which were probably responsible for the reported activity. (Hukkeri et al., 1993).

Sharma (1994) reported the herbal anthelmintic preparation “Jantana” 100 percent effective against gastrointestinal nematodes in sheep after 15 days of treatment.

The helminths infecting sheep were *Dictyocaulus, Ostertaiga, Chabertia, Strogyloides, Haemonchus* and *Trichostrongyloides* spp. were treated with Kamala (*Mallotus philippinensis*) fruit and Fenbendazole for their anthelmintic activity. (Jost et al., 1996)

Jawale et al. (2000) reported the anthelmintic activity of *Artemesia maritime* and *Butea frondosa* against *Haemonchus contortus*. There was complete cessation of motility and mortility of the worms. The effects were concentration dependant.
Hounzangbe-Adote *et al.* (2001) tested the antiparasitic efficacy of sun dried or oven dried Papaya seed powder at the doses of 100, 200 or 400 mg/kg live weight. The efficacy rate of Papaya seed on *Strongyles* was highest (>80 percent) 10 days after treatment in experimental sheep at the dose of 200 mg/kg live weight.

Onyeyili *et al.* (2001) studied the anthelmintic activity of *Nauclea latifolia* stem bark aqueous extract in sheep with parasitic gastroenteritis due to mixed nematodes species, the doses of the extract being 400, 800, 1600 mg/kg p.o. for 5 consecutive days. The faecal egg count in infected animals was significantly reduced to 93.8 percent with 1600 mg/kg of the extract as compared to 5 mg/kg of Albendazole (94 %). The extract also resulted in improved haemoglobin and leucocyte values in worm infected sheep.

Muraleedharan *et al.* (2003) reported the anthelmintic effect of Neemrich 180-EC an oil based product extracted from Neem (*Azadirachta indica*) seeds, was tested against *Haemonchus contortus* in goats. Oral administration of Neemrich 180-EC at the dose rate of 1.0, 1.5 and 2.0 ml /10 kg body weight was found 49.4, 45.6 and 92.9 percent effective, respectively based on faecal egg count reduction on day 14 post treatment. Raje and Jangde (2003) observed that decoction of *Nicotiana tobacum* completely reduced the motility of *Haemonchus contortus* after 16.00, 12.00, 8.05 and 6.20 hr. of exposure in concentration of 1, 4, 7, and 10 percent, respectively.

Ademola *et al.* (2005) observed the efficacy of ethanolic and aqueous extracts of *Spondias mobin* against different ovine
gastrointestinal nematodes. The *Spondias mobin* extract drenched @ 500 mg/kg b.wt. was found to reduce the faecal egg count upto 15.0, 27.5, 65, 65 and 100 percent against *Haemonchus*, *Trichostrogylus*, *Oesophagostomum*, *Strongyloides* and *Trichuris* spp., respectively on day 12 post treatment.

Rohilla and Mathur (2007) Investigated that the Anthelmintic-18 when administered in sheep and goats @ of 10 gm twice daily for 3 days orally, its efficacy was found to be 100 percent on 7th and 15th day post treatment against *Strongyloides*, *Strongyle*, *Chabertia*, *Trichostrongylus* and *Trichuris* spp.

Sahoo and Tripathy (2007) reported that the lemongrass oil administered @ 0.1 ml/kg b.wt. orally against natural gastrointestinal helminthic infections in goats showed 58.18, 89.28 and 95.96 percent effectiveness on 3rd, 7th and 14th day post treatment, respectively.

c. Efficacies of Chemical Licicides:

Sen and Fletcher (1962) mentioned that the various forms of sarcoptic mange were amenable to the treatment by one of the acaricidal sulphur preparation viz. Sulphur 2part, potassium carbonate 1 part and lard 8 parts.

Miller *et al.* (1985) found that Angora goats could be protected upto 18 weeks after treatment with Diflubenzuron, Fenvalerate or Phenthoate from *Bovicola limbata*.

Rasmisz and pletrak (1986) observed that Butox, at 0.5 ml/litre water (equivalent to 25 ppm. Deltamethrin) was 100 percent
effective against the lice and mites in sheep. The mode of application was either washing down or spraying.

Moreau et al. (1987) reported excellent efficacy of Deltamethrin against Linognathus (98.4 %), Haematopinus (99.5%) and Damalinia bovis (94.2%) in cattle on day 30 post application.

Himonas and Liakos (1989) found that Cypermethrin sprayed at a dose rate of 1 ml/5kg b.wt. on goats naturally infected with Bovicola caprae (53% prevalence) and Linognathus stenopsis freed 100 percent lice of the animal on 14th and 28th days after treatment.

Sinha et al. (1989) observed that tick infesting cattle, buffaloes, sheep, goats and dogs could be killed with the spray of Pestoban in 1:20 dilution once a day for consecutive three days. The single application of the drug in 1:50 dilution diminished the lice, mites and fleas population but not the sarcoptic mites in goats.

Khurana et al. (1992) reported synthetic pyrethroids, Cypermethrin and Deltamethrin highly effective against H. anatolicum anatolicum and H. marginatum lisaci under in-vitro trials.

Kamboj et al. (1993) evaluated the therapeutic efficacy of Amitraj (0.05 %), Deltamethrin (0.05 %) and Ivermectin injections (400 µg/kg body weight) given at weekly intervals. Amitraz (3 treatments), Deltamethrin (3 treatments) and Ivermectin (1 treatment) cured 93.33, 80 and 71.43 percent having localized mange lesions and 90.47 percent (seven treatment), not effective and 50 percent (4 treatments), respectively having generalized mange lesions in sheep.
Mitra et al. (1994) treated an outbreak of Sarcoptic mange in goats and reported that the rate of recovery from the disease was the best in the Amitraz applied animals than Deltamethrin, Teeburb and Himax lotion treated ones.

Johnson et al. (1995) reported that most of the lice infesting sheep were killed after 20 hours of Deltamethrin dipping or spray. The number of surviving lice had increased with the sampling time after treatment and it was dependent on the residual effects of the drugs.

Mohd-Rashid (2001) found that Deltamethrin dip or spray diluted at a rate of 2 ml/litre water, 25 ppm. applied to sheep and goats naturally infested with lice and fleas made them completely free of infestation 2 weeks of the first application.

Olaechea et al. (2004) reported that six percent Cypermethrin pour on solution used against Melophagus ovinus in naturally infested sheep cured 100 percent animals on day 14 after treatment.

Alves- Branco et al. (2005) evaluated the pesticide mixture Cypermethrin + Chlorpyrifos + Citronella against Damalinia ovis (Bovicola ovis) on naturally infested sheep and found that the mixture had 100 percent efficacy upto 28 days post-treatment.

d. Efficacies of Herbal licicides:

Nadkarni (1954) observed that the karanj seed oil possessed antiseptic, antiparasitic and stimulant properties for animal skin ailments.
Chopra et al. (1956) also mentioned the efficacy of the karanj seed oil for animals skin diseases.

Kale and Panchgoankar (1969) observed karanj oil more effective against sarcoptic mange in goats than sulphur ointment 1:8 benzyl benzoate 25 percent emulsion and malathion 1 percent aqueous suspension.

Shastri (1975) observed highly encouraging results after 6-7 topical applications of Karanj oil (Pongamia pinnata) at an interval of 3 days in heavily mange infested goats.

Dymock et al. (1980) observed that the oil of karanj was a good remedy for scabies and other skin diseases.

Sinha et al. (1982) reported that mange mite infestations in goats could be cured by applying mixture of malathion (0.5%) and Karanj oil on alternate days for 8 weeks.

Manurung (1991) treated twenty naturally Sarcoptes scabiei infested goats with Karanj oil and Sulphur and found the mixture very effective in elimination of mites.

Narladkar et al. (1995) reported that goats infested with mange mites were cured off the disease with 1:10 v/v dilution of Pestoban containing the extracts of the plants, Cedrus deodara, Azadirachta indica and Embelia ribes. Efficacy of the treatment was assessed on the disappearance of mites from the lesions, healing of the lesions and reappearance of normal hair growth.

Maske and Bhilegoankar (1996) studied the efficacy of Amitraz (300 ppm in water) against Linognathus stenopsis on naturally
infested goats near Nagpur and observed that 18 goats with very high density of lice (20-35 lice per 25 cm² area) were cured completely after 24 hours but the treated goats were found to have reinfested within 22 days.

Das (1997) reported the efficacy of AV/EPP/14, a herbal ectoparasiticide containing the extract of Cedrus deodara, Pongamia glabra (P. Pinnata), Azadirachta indica, Eucalyptus globules and Acorus calamus against Sarcoptes scabiei infestation in goats. Repeated topical applications, twice a day for 7 days successfully controlled the sarcoptic mange infestation, 5 days after treatment in mild and after 7 days in moderate to severely infested goats.

Hirudkar et al. (1997) suggested that Sarcoptes scabiei infestation in sheep could be effectively controlled by Himax (Herbal preparation) and Neem oil.

Chhabra et al. (1998) reported that therapeutic value of Azadirachta indica (Neem) had been universally recognized in a variety of skin disorders including scabies.

Kalamkumar et al. (2000) studied acaricidal activity of custard seed oil, neem seed oil and pyrethrum against Boophilus microplus, Hyalomma a. anatolicum and Rhipicephalus haemophysaloides in-vitro and in-vivo and observed that the custard seed oil and pyrethrum were 100 percent efficacious, whereas neem oil showed only 60-75 percent effectiveness.

Kumar et al. (2003) reported that the topical application of undiluted seed extract of Himalyan shrub (Zanthoxylum alatum) and its
1:1 dilution against tropical hen louse caused 100 percent ectoparasite mortality within 12 hours.

C. I. HAEMATOLOGICAL CHANGES DURING G.I. HELMINTHS INFECTION AND TREATMENT IN SHEEP:

Lengy (1962) infected 6 months old lambs with about 75,000 metacercariae of *P. microbothrium* and observed decreased haemoglobin from 12-10g percent, haematocrit from 37 to 32 percent and erythrocytic count from 11.67 to 8.68 million /cumm. The leucocyte count rose sharply upto 5th week but became normal by the 7th week.

Horak and Clark (1963) marked significant increase in Hb concentration, erythrocyte count and packed cell volume during terminal stages of severely infected sheep with lethal dose of (1, 70,000 or more) metacercariae of *P. microbothrium*.

Svanbaev *et al.* (1969) noted that the erythrocyte count had lowered from 10.0 to 7.0 million/cumm and haemoglobin from 12.2 to 8.0 gm percent in lambs experimentally infected with coccidia oocysts.

Chapman (1974) reported increased haemoglobin and haematocrit values of lambs suffering from coccidiosis which resulted due to haemoconcentration following plasma loss.

Contraras *et al.* (1976) observed significant reduction in values of Hb and PCV in goats naturally infectecd with gastrointestinal nematodes belonging to the species of *Haemonchus contortus*.

Ansora (1977) found that the infection of *H. contortus* among three groups of lambs aged 2.4 to 4.5 and 5 to 6.5 months and their dams
having severe parasitism had marked normocytic, normochromic anaemia with low PCV, RBC count and Hb values. A significantly high correlation between EPG and RBC count was also found.

Grzebla et al. (1978) found decreased red cell counts and PCV in sheep infected with gastrointestinal nematodes. Sheep infected with liver fluke had severe hypochromic and microcytic anaemia.

Bezubik et al. (1980) studied haematological parameters of sheep infected with a polish strain of *H. contortus* and reported fall in Hb and haematocrit value beginning 1 to 2 weeks after infection and the lowest levels were seen till the end of observation period of 11 weeks when leucocytes were within the normal ranges.

Ahmad and Ansari (1989) studied the effects of haemonchosis on haematology in sheep during natural and experimental infections and found depletion in R.B.C., PCV and Hb. Values.

Panzoo and Bali (1989) observed that buffaloes, goats and sheep experimentally infected with *Gastrothylax crumenifer* were having significantly reduced haemoglobin and mean total erythrocyte count in sheep but the total leucocyte and eosinophil counts were observed to be raised during infection in the animals.

Mottelib et al. (1992) observed decreased TEC, Hb and PCV along with anaemia, emaciation and diarrhoea in sheep infected with *Trichostrongylus, Haemonchus, Ostertagia, Oesophagostomum* and *Trichuris* spp.
Ghulam et al. (1995) found significantly lower TEC, Hb, PCV, MCV and TLC in Lohi sheep experimently infected with *Haemonchus contortus*.

Ndao et al. (1995) from Senegal reported a negative correlation between haematocrit levels, number of worms and EPG of faeces during rainy seasons in small ruminants.

Hayat et al. (1996) reported that TEC, Hb and PCV had decreased significantly in lambs experimentally infected with *Haemonchus contortus* and *Trichostrongylus colubriformis*.

Mishra et al. (1996) studied the effects of parasitic gastroenteritis on haematological parameters in lambs at Bhubaneswar and found the involvement of immature paramphistomes in reduction of Hb, PCV and TEC values during infection.

Maiti et al. (1999) reported that the sheep affected with gastrointestinal parasites had significantly lower TEC, Hb, lymphocyte values and higher eosinophil count in DLC as compared to the apparently healthy group.

Gorakh Mal et al. (2000) observed significant decrease in TEC, TLC, Hb, neutrophil and monocyte and the biochemical parameters revealed non-significant increase in the activity of GPT, CPK, LDH, Urea, Glucose, and TSP in camel infected with mange. Globulins, Ca, P, Chloride and Magnesium and non-significant decrease in ATP, GOT, albumin, A/G ratio, Na, K, Iron and Iron binding capacity.

Reddy and Choudhuri (2000) observed significantly lowered value of Hb (%), PCV (%) and TEC (million/cumm) which got recovered as
8.43 ± 0.15, 25.33 ± 0.96, 8.20 ± 0.35 in lambs naturally infected with *Moniezia* spp. The corresponding values observed in healthy control lambs were 9.98 ± 0.30, 33.17 ± 1.36 and 10.16 ± 0.25.

Arora *et al.* (2003) observed that there was a negative correlation between EPG and haematological values in sheep showing a gradual decline in Hb values i.e. 7.25 ± 0.016 g/dl at 400-800 EPG to 6.71 ± 0.05 g/dl at 2000-2400 EPG in sheep.

Hossain *et al.* (2004) reported that Total erythrocyte count (TEC), Haemoglobin (Hb) content and Packed cell volume (PCV) decreased significantly in sheep naturally suffering from gastrointestinal nematodiasis and paramphistomiasis.

Pandmaja *et al.* (2006) observed decreased values of Hb, TEC and PCV in sheep having mixed helminthic infection.

Sarkar *et al.* (2006) reported that *Haemonchus contortus* infected corriedale sheep had reduced Hb, PCV and TEC values before treatment and those were found to increase significantly upto about normal ranges 15th day after treatment.

II. HAEMATOLOGICAL CHANGES DURING ECTOPARASITE INFESTATION AND TREATMENT IN SHEEP AND OTHER ANIMALS:

Sinha and Prasad (1978) reported lowered values of the haemoglobin and leucocytes but preponderance of any of the white cells was not marked in goats affected with mange. However, considerable increase in the ESR was reported by the authors.
Prasad (1984) reported low haemoglobin, haematocrit and total erythrocyte counts in goat infected with *Sarcoptes scabiei*.

Yousif *et al.* (1989) reported decreased values of haemoglobin and packed cell volume in sheep infested with sarcoptic mites.

Ahmad *et al.* (1995) reported decreased TEC and Hb values but increased PCV in sheep, infected with *S. scabiei*. Further, they noted that the MCV, MCH, MCHC values were unaffected while TLC counts were significantly higher in infected sheep.

Parija *et al.* (1995) found macrocytic anaemia with marked reduction in Hb, PCV and TEC and simultaneous increase in TLC and MCV values in Black Bengal goats naturally infested with Sarcoptic mange.

Dalpati and Bhowmik (1996) reported that haematobiochemical changes were haemoglobinaemia, erythrocytopoenea, low PCV and leucocytosis due to eosinophilia and lymphocytosis in the mange infested goats. Parasitized animals also had significant reduction in blood glucose and serum protein levels.

Neog *et al.* (1996) observed lower haemoglobin and packed cell volume of all the goats infected with sarcoptic mange, which were around the lower physiological limits.

Dalpati *et al.* (1997) reported that *Demodex* spp. infested goats showed reduction in haemoglobin, total erythrocyte count and packed cell volume indicating anaemia.
Hirudkar et al. (1997) observed decreased values of PCV, Hb and TEC but increased values of TLC in lambs heavily infected with *S. scabiei*.

Umesh and Sharma (2003) reported that the Haemoglobin (Hb), Total erythrocyte count (TEC), and Total protein were significantly lowered in ectoparasites affected sheep.

**D. IMPACT OF G.I. HELMINTHS AND ECTOPARASITES AND THEIR TREATMENTS ON THE ECONOMICS OF PRODUCTION IN SHEEP AND OTHER ANIMALS:**

Mostofa et al. (1956) observed a significant economic loss due to gastrointestinal nematodiasis in small ruminants which was evidenced by stunted growth, decreased milk production, loss of working ability, morbidity and mortality.

Vasquez and Marchinares (1971) presumed huge economic losses due to gastrointestinal parasites in sheep breeding farms. The parasites infected lambs had reduced body weights.

Akerejola et al. (1979) stated that endoparasitic infections were the major problem affecting productivity in sheep and goats having mixed infection of *Haemonchus, Trichostrongylus* and *Oesophagostomum* spp. in Nigeria with *Fasciola gigantica* or *Paramphistomum* spp. occasionally resulted in heavy mortality in animals grazing in swampy area. Body weight gain was significantly reduced in infected animals.

Kerboeuf et al. (1982) observed that the lambs infected with *Haemonchus contortus, Ostertagia circumcinata* and *Trichostrongylus*
*colubriformis* were treated with Fenbendazole (7.5 mg/kg) and Albendazole (3.8 mg/kg) and weight gains were greatly improved.

Beriajaya *et al.* (1986) observed that significant increase in weight gains were observed when treated with various anthelmintics against common gastrointestinal nematodes in sheep.

Handayani *et al.* (1986) reported that *Sarcoptes scabiei* was the cause of poor health condition in goats resulting in significantly retarded growth rate due to infection.

Ochodnicky *et al.* (1987) stated that the Fenbendazole treated sheep were significantly heavier than the control sheep. Their average daily weight gains were 38 percent higher and the weight of the half carcass was also significantly higher.

Singh *et al.* (1987) reported the over all economical loss in livestock due to various disease on selected holdings. The losses due to gastrointestinal parasites were 11.23 percent of total livestock during 1981. The losses were more for marginal farmers, in animals below three years of age and in females. These losses could be reduced if better animal health coverage was adopted.

Handayani and Gatenby (1988) stated that anthelmintic treatment with Albendazole at every 4 week intervals to lambs reduce 28 percent mortality, 85 percent faecal EPG alongwith improved body weight gain by 21-29 gm per day in comparison to untreated lambs.
Yousif et al. (1988) reported that the sheep infected with *Marshallagia* and *Nematodirus* and treated with Ivermectin showed improvement in weight gain and normal wool growth after treatment.

Clarkson (1990) estimated that sheep infected with liver flukes if not treated, would suffer a total loss of $8272 per annum due to reduction in lamb carcass and fleece weight. He also pointed out that the losses could be reduced if the animals were treated in time.

Rahman and Collins (1990) reported that the daily body weight gained was significantly lesser in kids infected with *Trichostrongylus colubriformis*. Rate of growth in kids was also dependent upon the degree of infection i.e. worm load.

Mottelib et al. (1992) reported that weight loss and diarrhoea in sheep infected with *Trichostrongylus, Haemonchus, Ostertagia, Oesophagostomum and Trichuris* spp infections.

Tembely et al. (1995) observed that daily weight gain in lambs was significantly higher in Fenbendazole (@ 10 mg/kg body weight) administered group. It did not check the mortality but reduced the nematode eggs in faeces. Similar findings were also observed when Fenbendazole was administered with Amprolium.

Hayat et al. (1996) reported that body weight decreased significantly in lambs experimentally infected with *Haemonchus contortus* and *Trichostrongylus colubriformis*.

Howalader et al. (1996) reported that does infected with *Haemonchus contortus* significantly lost their body weights at an average of 4.13 kg in 5 weeks.
Mostafa et al. (1996) found that gastrointestinal nematodiasis in small ruminants caused significant economic losses due to diarrhoea, stunted growth and decreased milk production, emaciation, loss of working ability and mortality.

Sanyal et al. (1996) reported parasitic gastroenteritis dominated by haemonchosis was a major constraint to profitable sheep and goat production in India. Frequent use of anthelmintic would be essential to control the nematodes particularly in intensive and semi-intensive system of management.

A significant increase in body weight was observed in young and adult sheep after treatment of G.I. nematodes with Levamisole, Mebendazole and Fenbendazole (Alam and Samad, 1997).

Naidu (1998) studied the economics of production in organized sheep farms considering the expenditure on feed cost and health coverage. The health coverage with medicine, Anthelmintic and Tickicidal agents costed 56.86, 35.2 and 7.23 percent of total expenditure, respectively during the year 1991-1996. The average cost of treatment per sick sheep varied from Rs. 17 to 23 during different years and the average annual expenditure in terms of rupees was Rs. 19 per sheep.

Hosseini et al. (1999) reported that sheep infected with gastrointestinal nematodes when treated with Ivermectin showed improvement in body weight gain of 2.6 kg higher in the treated groups as compared with control group.
Hannan et al. (2001) reported that ectoparasite infected, treated goats gained significantly (P < 0.01) higher body weight as compared to pretreatment body weight.

Umesh and Sharma (2003) stated that the live weight gains and wool yield were significantly higher in healthy sheep as compared to those infected with ectoparasites.

Das et al. (2005) observed that the kids naturally infected with G.I. nematodes were found to have significantly reduced growth rate resulting in decreased body weight gain. The economic losses due to G.I. nematodiasis in goats could be reduced, if suitable parasite control measures were adopted during gestation period in goats.

Singh et al. (2005) reported that the long term application of Deltamethrin and neem oil, karanj oil and camphor mixture against lice and Ivermectin and Pestoban control packages against mange were found to cure the infestation and lead to increased body weight gain.
Sustainable comprehensive control of common G.I. helminths and lice was achieved by giving suitable chemical and herbal anthelmintic and licidical packages to naturally infected growing lambs aged about 2-3 months, maintained at Ranchi Veterinary College small ruminants instructional farm unit on semi-intensive farming condition. Any other erroneous infections were managed therapeutically.

**A) TO DETERMINE THE APPROXIMATE TIME OF ACQUIRING ENDO AND ECTOPARASITIC INFECTIONS IN LAMBS DURING EARLY POST NATAL LIFE:**

To know the time at which the lambs would be acquiring natural infection with different common G.I. helminths in early post natal life, twenty new born lambs were selected for the purpose. The faecal samples of these lambs were examined individually from a day or two after birth at every 3-5 days intervals upto 100 days. For this the rectal faecal samples collected from the individual animals were examined in the laboratory on the same day as per the method of Soulsby (1982). The samples left unexamined were preserved in refrigerator at 4° to 6°C for examination on the next day.

The helminth eggs identified during the examination (100 days) were speciated on the basis of their morphological features as illustrated by Soulsby (1982).

The time and type of helminth eggs being acquired were recorded and the percentage of natural acquisition of different G.I. helminths was determined by the formula.
Percent acquisition = \[\frac{\text{No. of positive animals detected on a particular day}}{\text{Total No. of animals examined on the same day}}\]

Similarly, for knowing the patent ectoparasite infestation, the whole body surfaces of these lambs were examined individually from the first week of age after birth on every 3-5 days intervals up to 100 days.

**For comprehensive sustainable control of common G.I. helminths and ectoparasites:**

Twenty four Chhotanagpuri lambs aged about 2-3 months naturally infected with both common G.I. nematodes and lice were segregated in separate groups for rearing on almost balanced feed with usual grazing and then subjected to sustainable endo and ectoparasite control packages. The unrelated infections or illness were therapeutically managed as and when detected. The detail protocols of the trials have been illustrated in table -1 below.
Table 1. Schedule for the comprehensive control of common G.I. helminths and lice by chemical and herbal control packages in growing lambs

<table>
<thead>
<tr>
<th>Groups (No. of animals)</th>
<th>Nature of infection</th>
<th>Drugs used, doses and route of administration</th>
<th>Day of treatment</th>
<th>Period of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (8)</td>
<td>Naturally infected with <em>H. contortus</em>, <em>Strongyloides papillosus</em>, <em>Oesophagostomum</em> spp, <em>Trichuris ovis</em>, <em>Trichostrongylus</em> spp and others, and <em>Damalinia ovis</em> and others.</td>
<td>Fenbendazole + Praziquantel 200 mg/30 kg b.wt., orally  Cypermethrin 2ml/litre of water, topical + Supportive drugs</td>
<td>0 (Day on infection detected)</td>
<td>10 months</td>
</tr>
<tr>
<td>II (8)</td>
<td>(-do-)</td>
<td>Herbal anthelmintic: Mercury, Sulphur, Ajmond, Bayavidanga, Kuchla, Palas seed, Jira, Pumpkin seed, Arecanut and Black til 300-500 mg/kg bwt. Twice daily for 5-6 days + Herbal licicide: Neem oil, Karanj oil, camphor and Sulphur Topical daily for 5 days + Supportive drugs</td>
<td>(-do-)</td>
<td>10 months</td>
</tr>
<tr>
<td>III (8)</td>
<td>(-do-)</td>
<td>No treatment</td>
<td>-</td>
<td>10 months</td>
</tr>
</tbody>
</table>

Supportive drugs: - Liver stimulants, antidiarrhoeal, appetizers, minerals, vitamins, antibiotics, and other drugs used as per requirements.
A total of 24 growing lambs naturally infected with common G.I. helminths, such as *Strongyloides, Oesophagostomum, Haemonchus, Trichostrongylyus, Chabertia, Bunostomum, Trichuris, Ostertagia* and *Marshallagia* spp. helminths and *D. ovis, L. ovillus* spp. lice were selected in this trial.

They were divided into three groups, each consisting of 8 lambs. Group I animals were treated with Fenbendazole + Praziquantel and Cypermethrin control packages, Group II animals were treated with Herbal anthelmintic and licicide control packages while Group III animals were maintained as infected untreated control.

All the treated animals in different groups were also given supportive therapy like liver stimulant, antidiarrhoeal, appetizers, minerals, vitamins, antibiotics and other drugs as per requirements.

**Observations recorded:**

1. Pre and post treatment EPG twice weekly up to 20 days then fortnightly upto 10 months.
2. Live and dead lice count on every 3rd day upto 15th day and then at monthly intervals upto the end of experiment.
3. Haematological observations (Hb, PCV and TEC) on zero day before treatment and then fortnightly upto 3 months and then monthly till the end of experiment.
4. Body weight gain pre and post treatment fortnightly till the end of experiment.
DETAIL TECHNICAL PROCEDURES:

B) EFFICACY OF G.I. PARASITE CONTROL PACKAGE (PCP):

I. Estimation of egg per gram (EPG):

The EPG of each animal infected with G.I. helminths was done on 0 day before treatment twice weekly up to 20 days and then fortnightly after treatment up to the end of experiment by Stoll (1930) dilution method.

The percent efficacies of the drug were calculated by the formula as follows.

\[
\text{Percent efficacy} = \frac{\text{Pre treatment mean EPG} - \text{Post treatment mean EPG}}{\text{Pre treatment mean EPG}} \times 100
\]

C) EFFICACY OF LICE CONTROL PACKAGE (LCP):

The efficacy of the drugs applied against lice were assessed by counting the live and dead lice on one side of the complete body surface of all the animals on different days of observations.

The percent efficacy was calculated by the formula as follows:

\[
\% \, \text{Efficacy on } n^{\text{th}} \text{ day} = \frac{\text{No. of lice on one side of the body before treatment} - \text{No. of lice on one side of the body at the } n^{\text{th}} \text{ day of treatment}}{\text{No. of lice on one side of the body before treatment}} \times 100
\]
DRUGS USED:

i) FOR COMMON G.I. HELMINTHS:

a) The combination of Fenbendazole 150 mg and Praziquantel 50 mg, manufactured by Intas Pharmaceuticals Ltd. as Fentas plus used as a broad spectrum anthelmintic against Tapeworms, Roundworms, Hookworms, Whipworms and others infecting small ruminants. 

Fenbendazole inhibit polymerization of tubulin in the parasite and blocks the glucose uptake. It interferes with enzyme fumerate reductase and thus energy production in the parasite. Energy levels of the parasites diminishes and death results.

Praziquantel initiates rapid muscular contraction by altering the ionic balance of muscle cell, cause vacuolation, spastic paralysis of worms and disruption of its tegument.

b) Herbal anthelmintic:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>100mg</td>
</tr>
<tr>
<td>Sulphur</td>
<td>200mg</td>
</tr>
<tr>
<td>Ajmond (Trachyspermum roxburghianum) seed powder</td>
<td>300 mg</td>
</tr>
<tr>
<td>Bayavidanga (Embelia ribes) seed powder</td>
<td>400mg</td>
</tr>
<tr>
<td>Nux-vomica (Strychnous nux-vomica) seed powder</td>
<td>400mg</td>
</tr>
<tr>
<td>Palas (Butea monosperma) seed powder</td>
<td>600mg</td>
</tr>
<tr>
<td>Pumpkin (Cucurbita maxima) seed powder</td>
<td>3000mg</td>
</tr>
<tr>
<td>Jira (Cuminum cyminum) seed powder</td>
<td>4000 mg</td>
</tr>
<tr>
<td>Arecanut (Areca catechu) powder</td>
<td>3000mg</td>
</tr>
<tr>
<td>Black Til (Sesamum indicum) seed power</td>
<td>3000 mg</td>
</tr>
<tr>
<td>Total</td>
<td>15 gm</td>
</tr>
</tbody>
</table>

The above raw herbal ingredients were procured from the local market and sun dried then all these were ground up in mixer grinder
separately to make them fine powder and were mixed in the ratio indicated above.

**ii) FOR LICE CONTROL:**

a) One of the synthetic pyrethroids (Cypermethrin) in recommended doses.

Synthetic pyrethroids are contact poisons producing muscular excitations and convulsions by its effects on nerve cell membrane, delaying depolarization leading to rapid paralytic action on parasites. They have prolonged action to bring about knock-down and kill effect.

b) Herbal licicide:

- Neem (*Azadirachta indica*) seed oil - 50ml
- Karanj (*Pongamia glabra*) seed oil - 50ml
- Camphor (*Camphor officinarum*) - 10 gm
- Sulphur - 10 gm

The commercially available oil of neem and karanj were mixed in 50:50 ratio and to this camphor (10 gm) and sulphur (10 gm) were added to make a oily suspension mixture.

This herbal acaricide was applied with cotton or soft cotton cloth on the whole body of sheep.

**D) ESTIMATION OF HAEMATOLOGICAL PARAMETERS:**

The different haematological parameters were estimated before treatment on zero day and then fortnightly upto 3 months and then at monthly intervals till the end of experiment in respect of Hb (g %), PCV (%), and TEC (10⁶/ cumm).
i) Collection of blood:

For assessing the different haematological changes the blood samples were collected from the experimental lambs from jugular vein in sterile vials having the anticoagulant EDTA @ 1-1.5 mg/ ml of blood. The blood samples collected were carried to the laboratory and stored in refrigerator at 4°C. Then the different haematological parameters were examined within few hours of blood collection. However, some of the blood samples remained unexamined, stored in refrigerator and examined on the next day.

ii) Estimation of Haemoglobin (Hb g %):

Haemoglobin content of each blood sample of common gastrointestinal helminths and ectoparasites affected and treated animals were estimated by cyanmethaemoglobin method with the help of a digital haemoglobinometer (Systronics, Ahmedabad) or in a Automated Haematology Analyzer (Transasia, Japan).

iii) Estimation of Packed Cell Volume (PCV %):

PCV of all the blood samples were carried out with the help of microhaematocrit centrifuge as per the method of Jain (1986) or in a Automated Haematology Analyzer (Transasia, Japan).

iv) Estimation of Total Erythrocyte Count (TEC x 10^6/ cu mm):

TEC was done in counting chamber of haemocytometer as per the method of Schalm et al. (1975) or in an Automated Haematology Analyzer (Transasia, Japan).
E) WEIGHT GAIN:

The weight gain/ loss in growing lambs before treatment and simultaneous treatment in different groups were recorded fortnightly using spring balance till the end of experiment.

F) ECONOMICS OF PRODUCTION:

The impact of G.I. helminths and ectoparasites on the economic characters of production in parasite free and parasitized growing lambs were studied by estimating the gain/ loss in weight of lambs.

The net gross weight gained by parasitized growing lambs were deducted from the total gross weight gained by parasite freed growing lambs.

\[
\text{Average gain or loss in body weight of lambs} = \frac{\text{Total average gross weight gain or loss by parasite free growing lambs}}{-\text{Total average gross weight gain or loss by parasitized growing lambs}}
\]

Also the economical value in rupees were calculated in all the treatment groups by considering the cost of mutton Rs.120/kg. live weight in local market.

G) AGE AT PUBERTY:

It was known by noting the duration of onset of first oestrus cycle in growing lambs.

STATISTICAL ANALYSIS:

Statistical analyses of the data collected during the study of different parameters were done by using standard formulae and methods described by Snedecor and Cochran (1968).
DISCUSSION

DETECTION OF FIRST PATENT INFECTIONS OF ENDO AND ECTOPARASITES DURING EARLY POST- NATAL LIFE IN LAMBS:

The acute/clinical and chronic G.I. parasitic infections are the commonest affection in young and adult sheep. The conditions are diagnosed either by clinical manifestations or by the detection of eggs in the faecal specimen. The clinical parasitosis is usually identified at the time when the parasites have already caused sufficient degree of pathogenesis leading to reduced growth and health status. This probably only due to lack of knowledge as to when the animals acquire patent infections of different parasites during early period of life after birth. There is scanty information on the detection of approximate time at which the different endo as well as ectoparasites first patent infection occur during early post-natal life.

The report of Agyei (1990) has indicated that *Eimeria* spp. patent infection occurred first on 20th day after birth in lambs, the other G.I. parasitic infections like *Strongyloides*, *Strongyles* and *Moniezia* spp. were detected first to appear in the faeces of animals on 46th day onward after birth.

Likewise, Kumar (2007) detected *T. vitulorum* prenatal infection in buffaloes and cow calves to appear during 10th to 28th days after birth. The *T. canis* first patent infection in pups was noted during the 23rd to 49th days after birth (Douglas and Baker, 1959).

The findings of the present investigation indicated that the *Eimeria* spp. infection was confirmed as the first patent G.I. parasite infection in lambs on 20th day after birth. The common nematodes namely *Strongyloides*,
Oesophagostomum, Haemonchus, Trichostrongylus, Chabertia, Bunostomum, Paramphistomum, Trichuris, Ostertagia and Marshallagia spp. first patent infections were observed on 35\textsuperscript{th}, 40\textsuperscript{th}, 45\textsuperscript{th}, 50\textsuperscript{th}, 60\textsuperscript{th}, 70\textsuperscript{th}, 75\textsuperscript{th}, 80\textsuperscript{th} and 85\textsuperscript{th} days after birth, respectively.

Among the various ectoparasites infecting sheep, Damalinia ovis lice infestation was first found on 60\textsuperscript{th} day after birth in growing lambs. Since, there were no references about the detection of first patent infection of any of the ectoparasites in animals, the finding of the present study could not be compared with. The idea of investigating the first patent infection of either endo or ectoparasites in lambs came to our mind as to when the suitable sustainable control measures against the different parasitic infections should be implemented so that the animal could be kept in healthy condition and thus would be beneficial in reducing the economic losses caused by the different endo and ectoparasitic infections. One can expect optimum growth and production from the particular livestock. When they remain almost in healthy conditions from the early stage of their life. Therefore the animal owners should be suggested to implement strategic control measures against different parasitic infections from early stage of animal’s life.

COMPREHENSIVE CONTROL OF G.I. HELMINTHS AND LICE INFESTATION IN GROWING LAMBS WITH CHEMICAL AND HERBAL ANTHELMINTIC AND LICICIDAL PACKAGES:

Several endo and ectoparasitic infections are being naturally acquired by the animals resulting in considerable economic losses by way of reduction in growth rate and decreased reproductive potential. Therefore, it
seemed imperative to implement long term sustainable control of both internal and external parasites at the same time could be achieved by using suitable chemical and herbal anthelmintic and licicidal control packages. The use of supportive therapy was also included in this study with the idea that the damages caused by the infecting parasites could be repaired earlier by restoring the normal infection of the different vital organs and also the harmful effects if any caused by the parasites could be neutralized.

Eight growing lambs of about 2-3 months having natural common G.I. helminths and lice infestation were treated with chemical anthelmintic i.e. Fenbendazole + Praziquantel and chemical licicide i.e. Cypermethrin. All animals were found completely negative EPG of G.I. helminths on 10th day post treatment onwards. The lice affected animals became negative for *Damalinia ovis* infestation from 9th day post treatment with Cypermethrin.

For achieving comprehensive sustainable control of endo and ectoparasite these animals were repeated similar packages at intervals as and when reinfection was detected so that they could be kept parasite free upto the entire period of observations.

When the results of G.I. helminths chemical control packages were compared with the findings of Selim *et al.* (1977), Grimbeek and Terblanche (1980), Kerboeuf *et al.* (1982), Megomedov (1984), Ahmed *et al.* (1994), Alam and Samad (1997) and Tinar *et al.* (1998), it was observed very high degree of similarity. But none of the above workers have reported the long term use of endo and ectoparasite chemical anthelmintic and licicidal
packages simultaneously. The observation of the present study was found very useful in maintaining animals in almost normal health what was found essential for economical sheep rearing.

However, similar trials of comprehensive sustainable control of both types of parasites using chemical drugs for a larger population of sheep at different ages under different helps in farming condition would help in confirming the results of the present study.

In the second set of experiment the control of G.I. helminths and lice infestations in growing lambs was carried out by using herbal anthelmintic and licicidal control packages. The herbal anthelmintic could eliminate most of the G.I. helminths by 20 DPT as also reported by Prakash et al. (1980), Jain and Nagi (1986), Sharma (1994), Jost et al. (2001), Raje and Jangde (2003), Adenola et al. (2005), and Rohilla and Mathur (2007). Though the herbal anthelmintic preparation was found to be a slow acting drug but the preparation could be an alternative anthelmintic for the poor farmers residing in remote rural areas, where such herbal plant products are abundant in villages.

The herbal licicide was found to cure completely all the treated animals by 12 DPT. The control of lice in sheep by herbal licicides has also been reported by Manurung (1991), Das (1997), Hirudkar et al. (1997), Kalamkumar et al. (2003). The control of G.I. helminths infecting lambs with herbal anthelmintics was found to be apparently safe because none of the treated lambs showed any apparent side effect.
For achieving sustainable long time comprehensive control of endo and ectoparasites infesting lambs, the growing lambs were repeatedly given the same chemical and herbal anthelmintic and licicidal control packages as and when reinfection of these were detected. There is no such information in the literature for comparing the long term comprehensive control results of different parasites affecting sheep. However, Lakra (2004) and Sinha (2004) have found very high beneficial effects of long time G.I. helminths and lice control in goats.

Therefore, the findings of the application of sustainable comprehensive control of G.I. helminths and lice affecting sheep appeared to be highly useful in sheep production. However, the results of the study are required to be verified after on farm trials under field conditions of sheep rearing.

HAEMATOLOGICAL OBSERVATIONS DURING CHEMICAL AND HERBAL ANTHELMINTIC AND LICICIDAL CONTROL PACKAGES APPLICATIONS IN SHEEP:

Haematological profiles of growing lambs during common G.I. helminths and lice infestation and chemical and herbal anthelmintics and licicides treatment were carried out to monitor the health status of the infected and treated animals which were found essential for assessing the effectiveness of chemical and herbal anthelmintics and licicides against common G.I. helminths and lice infestation in lambs, respectively.

The marked reduction in Hb, PCV and TEC values in G.I. helminths and lice infested lambs in present study might have occurred due to blood loss, less feed intake and utilization, suppressive effects on the host
haemopoietic system by the toxic substances secreted or excreted by the G.I. helminths and sucking of blood and tissue fluid by the lice and due to constant irritation caused by the lice leading to deficiency of essential nutrients.

The haematological observations of the present findings were found to be in almost agreement with the findings of Ansora (1977), Grzebla et al. (1978), Ahmad and Ansari (1989), Ahmad et al. (1995), Hayat et al. (1996), Hirudkar et al. (1997), Maiti et al. (1999), Arora et al. (2003), Umesh and Sharma (2003), Hossain et al. (2004) and Pandmaza et al. (2006).

The return of different haematological values towards the normal ranges on different post treatment days indicated that the removal of G.I. helminths and lice infestation facilitated proper digestion, absorption and metabolism of feed nutrients as well as stoppage of blood loss and release of toxic materials by the parasites.

The detection of the status of different haematological parameters during parasitic infections and treatments were also found helpful in determining the nature and duration of specific and supportive therapeutic measures to be given to the animals for maintaining the optimum health and production under different farming situations.

**IMPACT OF PARASITE CONTROL PACKAGE (PCP) APPLICATION ON THE ECONOMICS OF PRODUCTION IN SHEEP:**

**Weight gain in growing lambs:**

For assessing the economic impact of parasitic infections and their control in sheep, the gross weight (kg) gained in growing lambs during
common G.I. helminths and lice infestation and simultaneous treatments with chemical and herbal anthelmintic and licicides were estimated by taking the weight gain in growing lambs for about a period of 300 days.

The total gross weights gained by chemical and herbal anthelmintics and licicides treated animals were 130.72 and 127.92 kg, respectively and the net weight gained by these two treated groups were 29.52 kg and 26.72 kg.

The present observation were almost found to be supported by the findings of Vasaquez and Marchinares (1971), Kerboeuf et al. (1982), Beriajaya et al. (1986), Ochodnicky et al. (1987), Mottelib et al. (1992), Tembely et al. (1995), Alam and Samad (1997), Hannan et al. (2001) and Singh et al. (2005). However, the present findings were superior over all the above reports in the sense that none of these workers have used sustainable comprehensive parasite control packages. Net profit in terms of rupees was obtained by deducting the specific and supportive treatment expenditure from the amount received from the book value of net gross weight gained by the animals and these values were Rs. 406.55 and Rs. 360.17 per animal in chemical and herbal control packages applied groups, respectively. These findings therefore, clearly showed that considerable economic losses would have to be born by the sheep owners if the endo and ectoparasite control packages were not used for sustainable comprehensive control of parasitic infection in sheep. However, more correct data could be obtained by measuring the economics of PCP packages applications involving large
number of animals at different stages of production under different farming situations.

**DETECTION OF FIRST OESTRUS (PUBERTY) IN SHEEP:**

Puberty is the age at which the reproductive organ becomes functional and fit to bear the load of reproduction. In sheep it has been affected by many reasons. Parasitic infections usually cause deficiency of minerals, vitamins and hormones affecting normal function of the different reproductive organs resulting in delayed oestrus or anoestrus in cattle, buffalo and pigs. Maksimovic (1984), Dabas *et al.* (1987), Singh (1987), Ali *et al.* (1991), and Tiwari *et al.* (2001). Therefore, controls of different parasitic infection by application of long time PCP were implemented to observe the effect of parasite control on reproductive maturity. The results obtained showed beneficial effect on the normal reproductive function in sheep. It was observed in the present study that the parasitized animals puberty period were longer than parasite freed animals. The above authors have also reported that minerals, vitamins etc. supplemented animals came in oestrus earlier than parasitized untreated cattle, buffaloes and pigs. In the present study the maturing sheep were kept parasite free with supportive treatment having minerals and vitamins. Different parasite control packages were administered in three groups of sheep for monitoring growth and maturity. The chemical and herbal anthelmintic and licicidal control packages treated animals matured earlier showing the onset of first oestrus before than parasitized untreated sheep.
SUMMARY AND CONCLUSION

The comprehensive sustainable control of both endo and ectoparasitic infections affecting Chhotanagpuri sheep was achieved by implementing chemical and herbal anthelmintic and licicidal control packages. The observations taken on different parameters during the period of study have been summarized and concluded herewith:

1. Chhotanagpuri lambs were detected to acquire natural patent coccidial infection from 20th day post birth, whereas patent infection of different G.I. nematodes were observed to affect the animals from 35th day post birth onwards.

2. Fenbendazole+ Praziquantel G.I. nematode control package kept the animals completely parasite free from 10th day onward.

3. The local herbal anthelmintic preparation freed about 90 percent growing lambs naturally infected with G.I. nematodes till 20th DPT.

4. Cypermethrin ECP freed 100 percent growing lambs from lice infestation till 9th DPT onward.

5. The herbal ECP formulation cured clinical lousiness in growing lambs completely from 12th DPT onward.

6. The Chemical anthelmintic packages required repetition approximately after 2 months for long term sustainable control of common G.I. nematodes infected lambs and sheep.
7. The herbal anthelmintic package was required to be repeated at about 55 day interval for sustainable G.I. nematode control in lambs and sheep.

8. The chemical and herbal licicidal formulation need repetition of application for their sustainable lice control in sheep at 130 and 120 days intervals, respectively.

9. The G.I. nematode and lice infested growing lambs had reduced Hb, PCV and TEC values, whereas these parameters were found to get improved at about normal ranges after 15th DPT with chemical and herbal anthelmintics and licicidal agents.

10. The G.I. nematodes and lice infested animals had lower growth rate than chemical and herbal anthelmintic and licicidal drugs treated animals.

11. Approx. Rs. 360 net gain was observed after application of herbal NCP and LCP control packages in G.I. nematode and lice infested sheep. Likewise, approx. Rs. 406 per animal net economic gain was obtained after application of chemical NCP and LCP application upto 10 months.

12. The chemical and herbal anthelmintics NCP (250.80) and LCP (263.62) subjected animals were found to have their 1st oestrus cycle earlier than G.I. nematode and lice parasitized (310.06) sheep.
CONCLUSION:

1. The long term therapeutic control packages applications against the common G.I. helminths and ectoparasite infestation were found useful for economical sheep production.

2. Though, the herbal anthelmintic and licicidal formulations showed delayed efficacies during trials, they can be of more utility for the farmers in remote rural areas.

3. For obtaining higher economic gain from sheep farming, it was found essential to implement the comprehensive sustainable parasite control packages from early stage of life in growing lambs.


Alves-Branco, F-de-P.J.; Sapper, M-de-F.M.; Toma, S.B.; Cassol, D.M.S. and Alves-Branco, L.R.F. (2005). Efficacy of pesticide mixture Cypermethrin (15.0g), Chlorpyriphos (25.0g) and Citronella (1.0g), applied as an immersion bath or as an aqueous spray in Corriedale sheep naturally infested with the *Damalinia ovis* in Rio Grande do sul. *A-Hora-Veterinaria, 24* (144): 29-34.


Photograph 8: Showing characteristics eggs of common G.I. helminths infecting lambs / sheep