Epidemiology and Rational Use of Levamisole against Gastro-intestinal Nematodes of Sheep in Suriname.

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Abstract

The epidemiology of gastro-intestinal nematodes and the effects of three strategic levamisole treatments were studied in young pasture-grazing sheep on a mixed breeding-fattening sheep farm of average size in East-Suriname. The comparison between treated and non-treated animals over a 11-months period, revealed that allthough levamisole proves to be an excellent anthelmintic, the applied strategy is both technically and economically unsatisfactory. No statistical significant differences between treated and non-treated animals could be measured in parasitic infection and growth rate of animals. Epidemiological monitoring of the control herd indicated that rainfall probably allows survival of infective larvae all year round. As a consequence, both timing and frequency of treatments should be re-examined.

keywords : sheep, levamisole, gastro-intestinal nematodes, epidemiology, Suriname.

1. Introduction.

Small ruminant owners in Suriname are in majority part-timers (civil servants, employees, factory workers), with poor technical skills and with very little or no access to land or credit. A recent I.I.C.A. survey (De Meza et al., 1993) found production results in sheep- and goat-husbandry to be dramatic, but insists on the economic viability of the sector for the future, due to the low(er) level of production-inputs required, the highly efficient feed conversion, the short production cycle and interesting marketing opportunities (especially for mutton).

The economic adjustment programme in Suriname has led to a liberalization of production and trade and the abolishment of government involvement in all production sectors, including the agricultural sector. As a consequence, production costs increased spectacularly, forcing smallholders to look for ways to reduce input costs through locally producable feeds, organic fertilisers and a more economical use of the expensive foreign veterinary drugs.

In line with this change, the present study investigated (1) the epidemiology of gastro-intestinal nematodes in one particular aspect of sheep husbandry (pasture grazing), (2) the effects of three strategic block treatments per year on parasitological and production parameters and (3) the use of anthelmintics in sheep-husbandry in an economic perspective. The trial was carried out on a mixed breeding-fattening sheep farm of average size (less than 10 ha of pasture). These are similar conditions to approximately 85% of sheep farms in Suriname (De Meza et al., 1993).

2. Materials and Methods

2.1. Location and climate

The experiment was carried out on a commercial sheep farm in Meerzorg, in the coastal district of Commewijne, east of the capital of Suriname, Paramaribo. Suriname is part of the very humid equatorial belt. The climate is tropical, with average maximum temperatures in between 29,4° and 32,7° C and average minimum temperatures in between 21,6° and 22,7° C. More than 2032 mm of rain falls per year in coastal areas (2200 mm in Paramaribo), average humidity varies in between 77% and 86% (Kemp, 1995). Four seasons are identified : a short dry season from Februari until April, a long rainy season from April until August, a long dry season from August until November and a short rainy season from November until January (Tjin, 1995).

Three climatological parameters are recorded every 24 hours: daily rainfall (mm/day), daily maximum temperature (°C) and daily minimum temperature (°C). The temperature range is calculated for each day.

2.2. Experimental animals

Seventy sheep of the local Criollo-breed and Criollo x Barbados Black Bellied crosses, are raised on approximately 4 ha of endigued, fenced but unimproved pasture in a citrus-plantation. Pasture rotation is not being applied. Mineral blocks and rice-bran are the common feed-supplements. The sheep are housed at night in wooden sheep pens with concrete floor. All animals are treated regularly against gastro-intestinal nematodes (using levamisole) and against foot-rot (using formalin-dips).

2.3. Experimental design

Twenty-eight young sheep of both sexes, between six months and one year old at the start of the trial were available for the study. They were randomly allocated to 2 groups of 14 each. The groups were allowed to graze on two separated fenced plots of 7.200 m² each (0,72 ha or approximately 1 TLU/ha) and housed at night in separate pens. All animals were ear-tagged and weighed at the start of the study. One group (control herd) was kept as the untreated control group, the other group (treated herd) was given 3 anthelmintic treatments during the observation period which lasted 47 weeks (16 January through 11 December 1995). Treatments were done on 10 April, 10 August and 3 December 1995, corresponding with the expected onset of the long rainy season, the end of the long rainy season and the start of the short rainy season respectively. The animals in the test-herd were treated using the well accepted and commonly available anthelmintic drug levamisole (levamisole hydrochloride 100 mg/ml ad inj., 5 mg kg^{-1} BW i.m.). The animals in the control-herd were not treated.

When considered necessary, salvage treatments were done on individual animals in which case these animals were removed from the trial.

Both herds were treated four weeks prior to the start of the trial with ivermectine (ivermectine 10 mg/ml ad injectionem, 200 μg kg^{-1} subcutaneously) in order to clear all existing parasitological infestations which might interfere with results.

2.4. Parasitological data

Four grams of faeces were sampled every fortnight from each animal. Coprological examination included quantitative analysis (eggs per gram faeces or e.p.g.) using the MacMaster method (Hansen et al., 1995) as well as partial qualitative analysis (morphology of Trichuris eggs; Thienpont et al., 1979). In addition, coproculture (Hansen et al., 1995) was carried out on mixed samples for each of the two groups, followed one week later by differentiation of L_3-larvae (MAFF, 1986).

2.5. Production data

Each animal in the trial was weighed once a month, using a pendulum-balance (maximum weight-capacity 50 kg). Daily growth rates were calculated according to the interval (in days) since the last weighing.

2.6. Data processing

Egg count data were logarithmically transformed into ln(epg + 1) in order to calculate the geometric mean for each group. Average daily growth rates (kg/day) and average liveweight (kg) were calculated for each group. Weekly rainfall (mm/week), average weekly minimum and maximum temperature (°C) and average weekly temperature range (°C) were calculated.

The anthelmintic efficacy of levamisole is assessed by applying the Faecal Egg Count Reduction test (FECRT) as described by the World Association for the Advancement of Veterinary Parasitology (Coles et al., 1992); the FECRT defines the reduction (R) in egg shedding (%) as :

$$R = 100 \left(1 - \frac{X_c}{X_t} \right)$$

in which X_t is the arithmetic mean epg of the treated herd after treatment and X_c the arithmetic mean epg of the control herd, 10 days after treatment.

Anthelmintic treatment is considered to be effective if the percentage reduction in arithmetic mean faecal egg count is above 95% (Coles et al, 1992). If group mean egg counts are below 150 epg, objective assessment of resistance will not be reliable.

The effect of the strategic scheme on production results is evaluated by comparing average liveweight and daily growthrates of both groups. Statistic evidence is calculated using varians analysis (single classification).

The economic justification of this treatment scheme is calculated by comparing the liveweight gain in the test-group (compared to the control-group) with the cost of treatment.

3. Results

Within six weeks after the onset of the trial the first severe cases of parasitic gastro-enteritis (PGE) began to occur in both groups. Several animals had to be dosed and treated symptomatically in order to avoid death. Several animals succombed to PGE despite treatment. Throughout the trial, six animals of the control group and three animals of the test-group had to be removed from the trial due to mortality or treatment (Table 1). Their faecal egg counts varied from 5.600 to 64.000 epg at the time of treatment/death.

Table 1. Herd-composition and mortalities throughout the trial.

Group	Animals	Sex (n)		Breed (n)		Mortality or
	(n)	Male	Female	Criollo	Criollo x BBB	salvage treatment
Controls	14	8	6	3	11	6
Test	14	6	8	9	5	3
Total	28	14	14	12	16	9

In order to respect the economic consequences of lifesaving treatment or mortalities, the liveweight at the time of removal from the trial itself, was considered the hypothetical slaughterweight at the end of the trial.

3.1. Epidemiological results

Temperatures in 1995 followed the usual pattern with fairly stable minimum daily temperatures (at night) and variable daily maximum temperatures (during the day). The highest mean temperatures (up to 32°C in February 1995 and 29°C in September 1995) and highest temperature ranges (up to 21°C in February 1995) were observed during the dry seasons.

1995 was a relatively dry year, compared to the previous and the following year. During the trial 1.756 mm of rain was recorded. Maximum daily rainfall was recorded in March and June. Throughout the year, there was not one 2-week period without rainfall. Statistical transformation of rainfall-data enabled us plot a polynomial of the fourth order (Figure 1), clearly describing the annual cycle of four seasons ($R = 0,66$; $p < 0,05$).

From week 5 until the first treatment (week 12), geometric mean egg counts varied from 182 epg to 4.950 epg in the control group and from 970 epg to 2.980 epg in the test group.

After the first treatment and until the end of the trial, geometric mean egg counts varied from from 111 epg to 6.450 epg in the control group.

Geometric mean faecal egg counts for the short and long dry season are significantly higher than those in the short and long rainy season (p = 0,049), which indirectly indicates that there is some kind of seasonal influence related to rainfall.

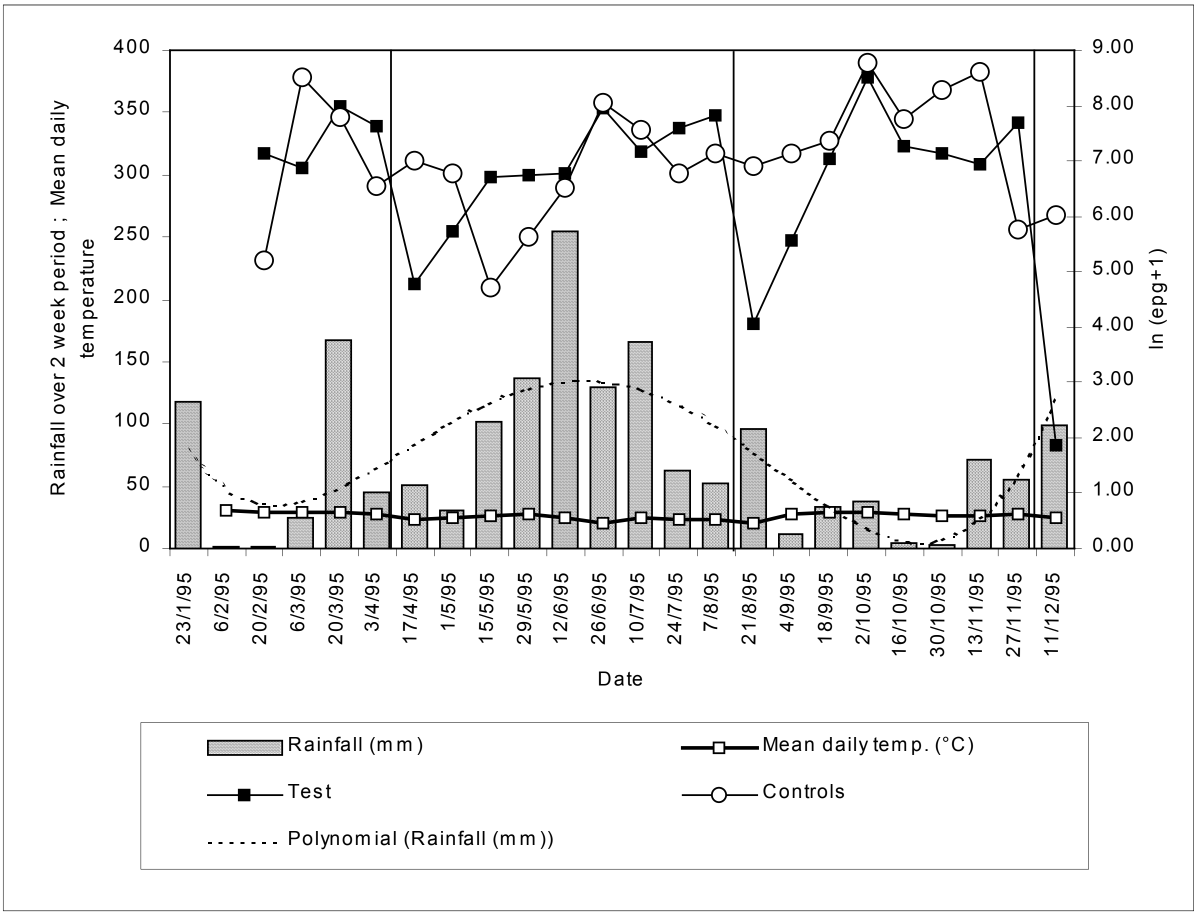

Figure 1. Geometric mean egg counts for the test- and the control-herd in relation to climatological data recorded during the trial period (16/01/95 – 11/12/95). The vertical lines indicate the time of treatment.

Identification of nematode eggs and of infective strongylid L_3 larvae following coproculture, revealed Haemonchus spp. and Trichostrongylus spp. as being the main strongylids involved. Haemonchus (presumably H. contortus) represented 32 - 97% of infectious larvae, while Trichostrongylus spp. represented 2 - 33% of infectious larvae. Other species encountered were Cooperia spp. (0 – 35%), Oesophagostomum spp. (0 - 12%) and Strongyloïdes spp. (0 - 4%).

No significant differences between nematode species in the treated herd and the control herd were found. The aging of animals towards the end of the trial did not appear to influence the intensity of infection and/or relative importance of the nematode species involved.

3.2. Results of the strategic treatment scheme

Figure 1 presents the evolution of ln (epg + 1), plotted against bi-weekly rainfall-data (mm/two weeks) for the test group and the control group and for the duration of the trial.

All test-animals were treated with levamisole on 10 April, 10 August and 3 December 1995 (vertical lines in figure 1).

Geometric mean epg's for the test-group in between treatments varied from 118 epg to 2.900 epg from the first treatment until the second treatment and from 57 epg to 4.900 epg from the second treatment until the third treatment.

Geometric mean epg's of the test group were not significantly different from those recorded for the control group (p = 0,65)

The efficacy of levamisole as an anthelmintic drug proved to be satisfactory. The Faecal Egg Count Reduction Test which was performed after each of the three block treatments, revealed satisfactory reduction percentages (>95%), except for the first treatment. This suboptimal result (89,75%) was not reproduced afterwards.

Production-data of the treated group as a result of this strategic treatment scheme are presented in figures 2 and 3, as compared to the results in the control group.

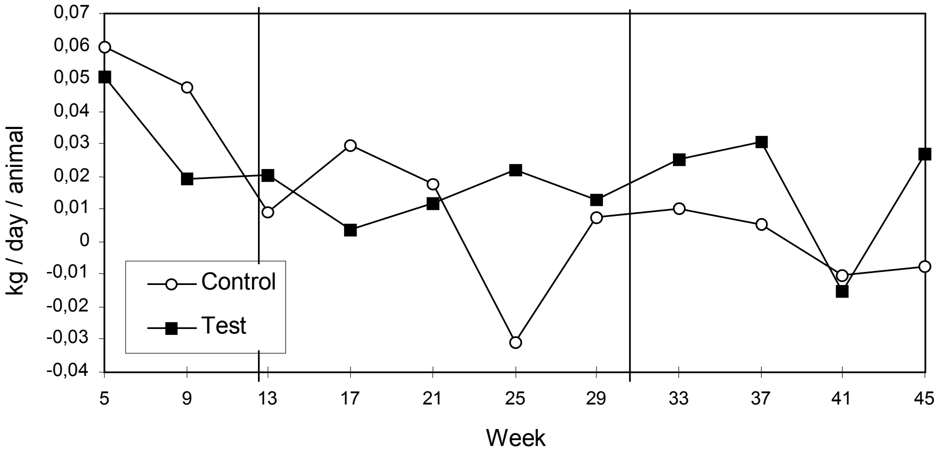

Figure 2. Average daily growth rates (kg/day/animal) for the test herd and the control herd. The vertical lines indicate the time of treatment.

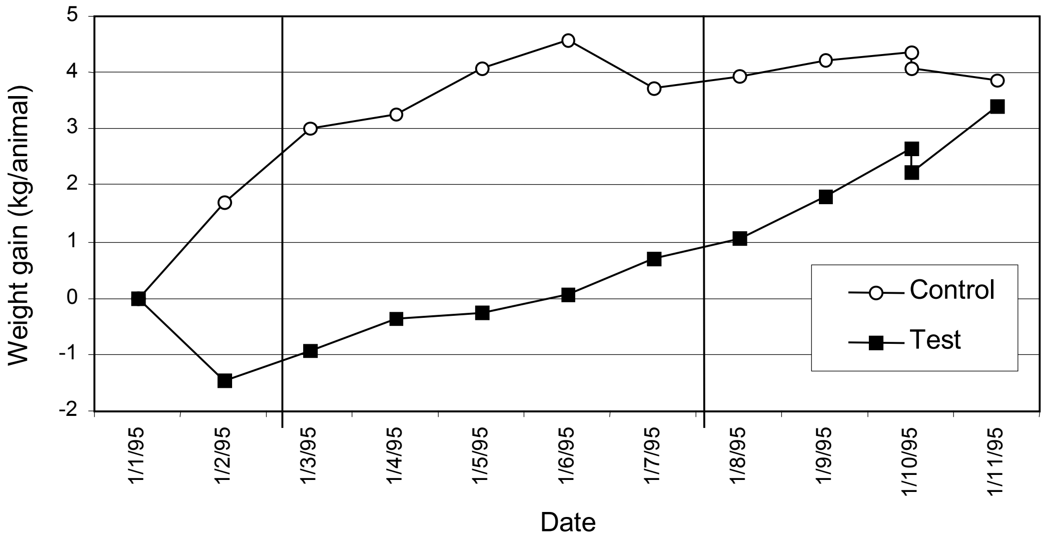

Figure 3. Average cumulative weight gain (kg/animal) for the test herd and the control herd. The vertical lines indicate the time of treatment.

As could be expected from the parasitological data, production results in the test-group are poor and are statistically no better than in the control group (p = 0,39). Average liveweight at the end of the trial (taking into account the liveweight of the 9 animals at the time of their removal during the trial) is 17,42 kg/animal for the test-group and 15,71 kg/animal for the control group. Taking into account the average liveweight at the start of the trial, liveweight gains for the duration of the trial are 3,42 kg/animal for the test-group and 3,86 kg/animal for the control group. Calculated daily weight gains are 11,1 g /animal/day for the test-group and 12,5 g /animal/day for the control-group. Taking into account the weight of the animals that were removed from the trial as a revenue, three treatments a year resulted in an additionnal 3 kg of liveweight for the test-group which is hardly enough to cover for the cost of the treatments.

4. Discussion

4.1. Epidemiology

The results of the parasitological examinations are in accordance with earlier or related trials involving the epidemiology of gastro-intestinal nematodes in sheep in the tropics, usually in Africa and Asia. The relative importance of Haemonchus revealed through faecal egg counts is in accordance with what most authors found in similar climatological and environmental conditions. The only available information regarding Haemonchus spp. in Suriname relates to calves (Kuil, 1965) and dairy cattle (Bastiaensen, 1995). Both authors demonstrated the dominance of Haemonchus (placei) through coproculture. While the use of faecal egg counts as a means of monitoring gastro-intestinal nematode infections might be somewhat contested in cattle, the use of this technique in sheep may be justified if using young animals (less than 12 months old), for which McKenna (1981) found that correlation between egg counts and worm burdens was significant.

The scale at which this trial was designed did not allow us to statistically confirm the observed inverse relationship which appears to exist between season (dry or wet) and egg shedding. Following an increase of rainfall, egg-shedding tends to decrease and vice-versa; this observation turns out to be the opposite of what we expected to happen and explains in part the poor results of the strategic treatment scheme which was applied. Several similar trials in the humid tropics led to the same problem in linking climatological factors to faecal egg counts or worm counts (Salas et al., 1988[a]; Salas et al., 1988[b], Van Aken et al., 1990, Dorny et al., 1992). In Sierra Leone, Asanji (1988) recorded that in young sheep and goats, the two annual peaks in relative density of Haemonchus coincide with the rainy and the dry season.

The increased egg-shedding a few weeks after the onset of the dry season(s) might be a result of a higher pasture infection. Indeed, the dry season as it is defined in Suriname, is probably hardly dry enough, nor long enough to limit the chances of survival of infective L_3-larvae on pasture. As can be seen from rainfall-data, even the dry season supports in between 26 mm and 38 mm rain / month. This rainfall in combination with a mean relative humidity of at least 77% is still enough to enable the pasture transmission of Haemonchus (Okon et al., 1982; Fakae et al., 1988). One might thus conclude that favourable conditions for the development and survival of free-living stages of the parasite exist throughout the year, as observed in other tropical very humid countries like Sri Lanka (Van Aken et al., 1989), India (Gupta et al., 1986) and Malaysia (Dorny et al., 1992). On the other hand, one generally observes a net reduction of grass-growth due to the dry season, which leads ultimately to less available pasture for the sheep and a concentration of infective larvae on the remaining pasture. Unfortunately, the pasture-infection rate was not examined. An increase of this pasture infection rate a few weeks after the onset of the dry season thus remains a hypothesis. In the same way, the onset of the rainy season(s), would be followed by an immediate dilution of the infective larvae on the pasture in which grass growth is now increasing fast. Ikeme (1987) in Malaysia refers to a similar type of dilution as the « washing off » of larvae from the pastures as a result of heavy rains. The increase of egg-shedding as it is observed later on in the (long) rainy season (as from 29 May on) might be explained by the traditional epidemiological relationship between egg-shedding and rainfall : as grass has now become abundant, grass growth will have but limited influence on the dilution of infective larvae, while repeated cycles of infestation and subsequent egg-shedding in sheep will soon accumulate high numbers of infective larvae on the pasture.

Taking into account that 1995 was a rather dry year, there is hardly any doubt that in the district of Commewijne in general, such an accumulation of infective larvae on the pasture will lead to increasing numbers of parasitic gastro-enteritis and mortalities despite the ageing and supposed immunity development of the animals, unless this cycle is stopped through an effective strategic block treatment scheme.

4.2. Strategic treatment scheme

The applied strategic treatment scheme proved to be unsatisfactory. The scheme was not able to avoid PGE-related mortalities and production results in the treated herd were no better than for the control herd. Such results can be related to the anthelmintics (and related resistance problems), to the frequence and timing of these treatments or to a combination of both these effects.

Since levamisole proved to be an excellent anthelmintic, there is little or no reason to assume that the poor performance of the scheme be a result of anthelmintic insufficiency. Levamisole-efficacy has previously been confirmed for cattle in Suriname by Ronoredjo and Bastiaensen (in press).

The observed epidemiological interactions between rainfall and egg-shedding on the other hand might to some extent explain the inefficiency of the treatment scheme which was applied. If one assumes that no more than three block treatments a year are economically justified, it is to be expected that an alternative timing of these block treatments might result in an improved efficacy of the scheme. However, even when applying such an improved scheme there is reason to doubt that three treatments a year would be sufficient to avoid mortalities, let alone significantly improve production results. One has to bear in mind that the animals in the test group were actually treated four times in less than a year (when taking into account the ivermectine treatment before the beginning of the trial), without any improvement of their health, nor production.

The production results realised during this trial in both groups can hardly be considered beneficial. Post weaning daily growth gains of 11,1 - 12,5 grams/animal/day coincide with what Raghavan G.V et al. (1992) consider to be achievable with minimal feed intake (browsing alone) in Asia. Productivity of tropical African ovine breeds as reviewed by Payne (1990), indicates daily growth rates in between 40 and 80 grams/animal/day to be normal.

Since there appears to be no convincing epidemiological relationship between egg shedding and climatological parameters, it is most likely that such strategic treatments will continue to fail and that frequent treatment will be necessary to significantly improve survival and daily weight gain. Further research will have to focus on complementary control strategies, such as pasture rotation, biological control and genetic resistance in order to avoid the development of anthelmintic resistance and achieve economically acceptable production results.

Acknowledgements

The author would like to acknowledge the contributions of Mr. Swamipersad Mohan (technical assistant), Mr. and Mrs. Sam Ramautar (smallholders) in Suriname as well as the Flemish Organisation for Technical Assistance and Development Cooperation (VVOB) in Brussels (Belgium), which financed the trial. Special thanks to Dr. G. Hendrickx (FAO), Prof. Dr. J. Vercruysse, Dr. P. Dorny (Ghent University) and Dr. D. Bradley (Trinity College Dublin) for their valuable advice and critical reviews.

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