Arch. Inst. Razi, 1970, 22, 187-196

Observations on the Incidence, Epidemiology, Control and Economic Importance of Gastro-Intestinal Parasites of Sheep and Goats in Iran (*)

By

K. D. SKERMAN, A. A. SHAHLAPOOR, A. H. ESLAMI and M. ELIAZIAN

Introduction

This paper presents some results of studies done by the Helminthology Section of the Near East Animal Health Institute, Iran Unit*, as part of a United Nations Development Programme/Special Fund Project. The terms of reference for these studies were to investigate the incidence, economic significance and control of gastro-intestinal parasites of sheep and goats in Iran. Emphasis was placed on epidemiology studies, supported by random examinations, to determine the seasonal incidence of worms, so that a schedule of strategic treatments could be planned as advocated by GORDON (1948).

Previously Existing Information

Climatological Data. The mean monthly maximum and minimum temperatures, rainfall and relative humidity recorded at major provincial centres were plotted for easy comparison. Consideration of these data and of the topography of the country led to division of Iran into the following four major climatic zones (Fig. 1) where it seemed likely that differences in parasite problems may be found.

Zone 1. The Caspian zone includes the coastal plains and northern aspects of the Alborz range facing the Caspian Sea. It has a rainfall of 40 to 150 cm per year, with some rain in most months of the year. The relative humidity is high and mean monthly temperatures range from 8° C to 26° C.

Zone 2. The Mountain Plateaux zone includes the southern aspect of the Alborz range, the Zagros range extending from northwest to south-east, and the high country along the eastern borders of Iran. The rainfall ranges from 20 to 50 cm per year falling almost exclusively during late-autumn to spring months. The relative humidity is low and mean monthly temperatures range from minus 5° C to 29° C.

Zone 3. The Persian Gulf Lowlands comprises the low altitude country bordering the Persian Gulf and extending northwards along the basin of the Tigris river bordering

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(*) Reprinted from Veterinary Medical Review "The Reaction of the Host to Parasitism" pp. 141-152, 1967.

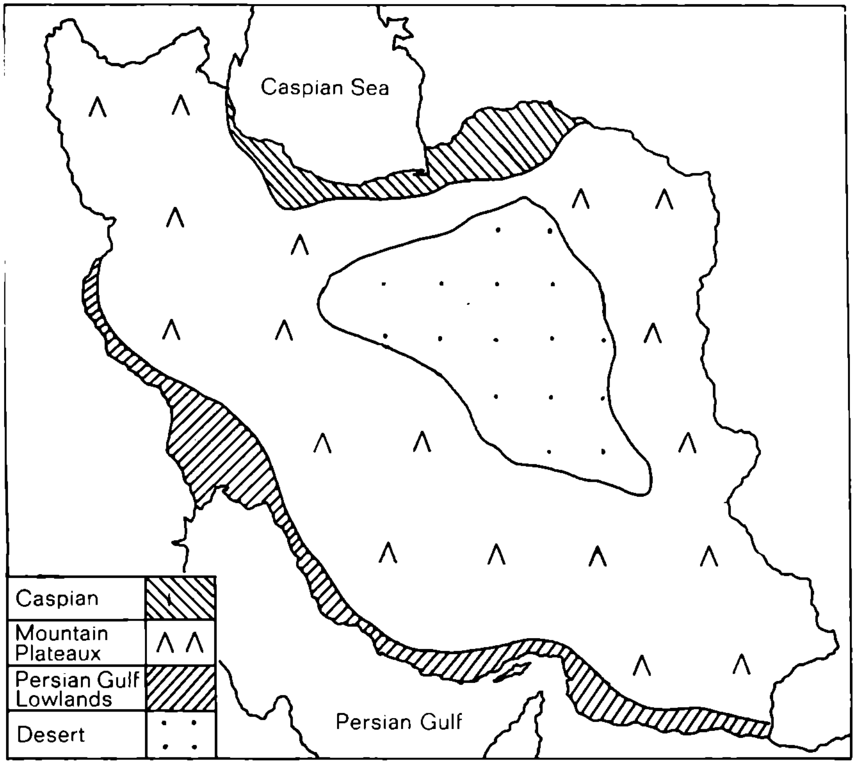

Fig. 1
The major climatic zones of Iran

Iraq. The rainfall of 20 to 30 cm falls during winter and spring. The temperature range is 13° C to 36° C. The relative humidity is high due to proximity to gulf and river waters.

Zone 4. The Desert zone includes the central salt and sand deserts where rainfall is less than 10 cm per year. It is not used for raising livestock.

Livestock Statistics. Data obtained from the Veterinary Directorate showed that there were approximately 30 million sheep and 12.5 million goats in Iran, and that the vast majority of them were raised in the Mountain Plateaux zone.

Data on Internal Parasites of Sheep and Goats. A list of the internal parasites known to occur in sheep and goats in Iran was available as a result of considerable previous work on identification. (ALAVI, in press). Monthly reports of field veterinarians during 2 years showed that deaths in sheep and goats ascribed to gastro-intestinal worms occurred mainly between mid-winter and mid-spring (Fig. 2).

Materials and Methods

Data relating to worm burdens were obtained by worm egg counts of faecal samples or by post-mortem differential worm counts. The worm egg counts were done by the McMaster method and egg counts for different genera were determined by differential counts of larvae cultured from the same faecal samples. Eggs of *Moniezia spp.* were not counted, but were recorded as present or absent, and, for plotting results, the percentage of sheep in the group that were infected with *Moniezia spp.* was used.

Epidemiology Studies were done to provide data on the occurrence and seasonal incidence of gastro-intestinal worms. They were based on worm egg counts. Flocks were selected in different localities of Iran having regard to climatic zones and livestock distribution. In each flock 20 sheep were chosen from the youngest age-group available, to avoid, as far as possible, using animals with previously acquired immunity. These were identified by numbered eartags and faecal samples were taken from them each month for examination.

Random Examinations were done to augment data from epidemiology studies. These included worm egg counts and post-mortem differential worm counts. Material for these examinations included specimens submitted to the laboratory and specimens taken during field trips from flocks not included in epidemiology studies. Post-mortem material was taken from dead animals, killed for autopsy and viscera obtained from slaughterhouses.

Applied Control Experiments were done to measure the economic value epidemiology studies and according to flock management, especially of using preventive strategic treatments timed according to results of migrations between winter and summer grazing areas. All experiments were controlled experiments, using treated and untreated groups of sheep. Sheep were randomised for groups by sex, age, bodyweight and worm egg counts, Results of experiments were assessed by changes in worm egg counts and bodyweights. Worm egg counts and bodyweights were recorded initially, at the times of treatment and at the conclusion of the experiments. The economic value of treatments was assessed by differences in mean gains in bodyweight between treated and untreated groups of sheep. Additional gains were valued at 35 rials per kg. The economic value of applying a control program was expressed as percent profit over cost of treatments.

Results

Epidemiology Studies .The results of epidemiology studies in three flocks in the Caspian zone (zone 1) and seven flocks in the Mountain Plateaux zone (zone 2) are shown in Figure 2. Initially, results for each worm in each flock in each zone were plotted separately. Although there were substantial differences in levels of worm egg counts between flocks, the patterns of seasonal fluctuations in counts were closely parallel for all flocks within each zone. The similarity was considered sufficient to justify presentation of a median result for all flocks within each zone.

The predominant nematodes were *Ostertagia spp.* and *Trichostrongylus spp.* The number of these were generally higher in zone 1 where they increased during spring and summer. In zone 2 they increased towards the end of winter, reached a peak in mid-spring, declined sharply at the end of spring and remained at low levels through summer and autumn. *Haemonchus contortus* infections were generally low in zone 1. The seasonal fluctuations of this parasite were not marked, although the highest numbers were recorded in spring and summer. In zone 2 there was a small autumn rise in *H. contortus*

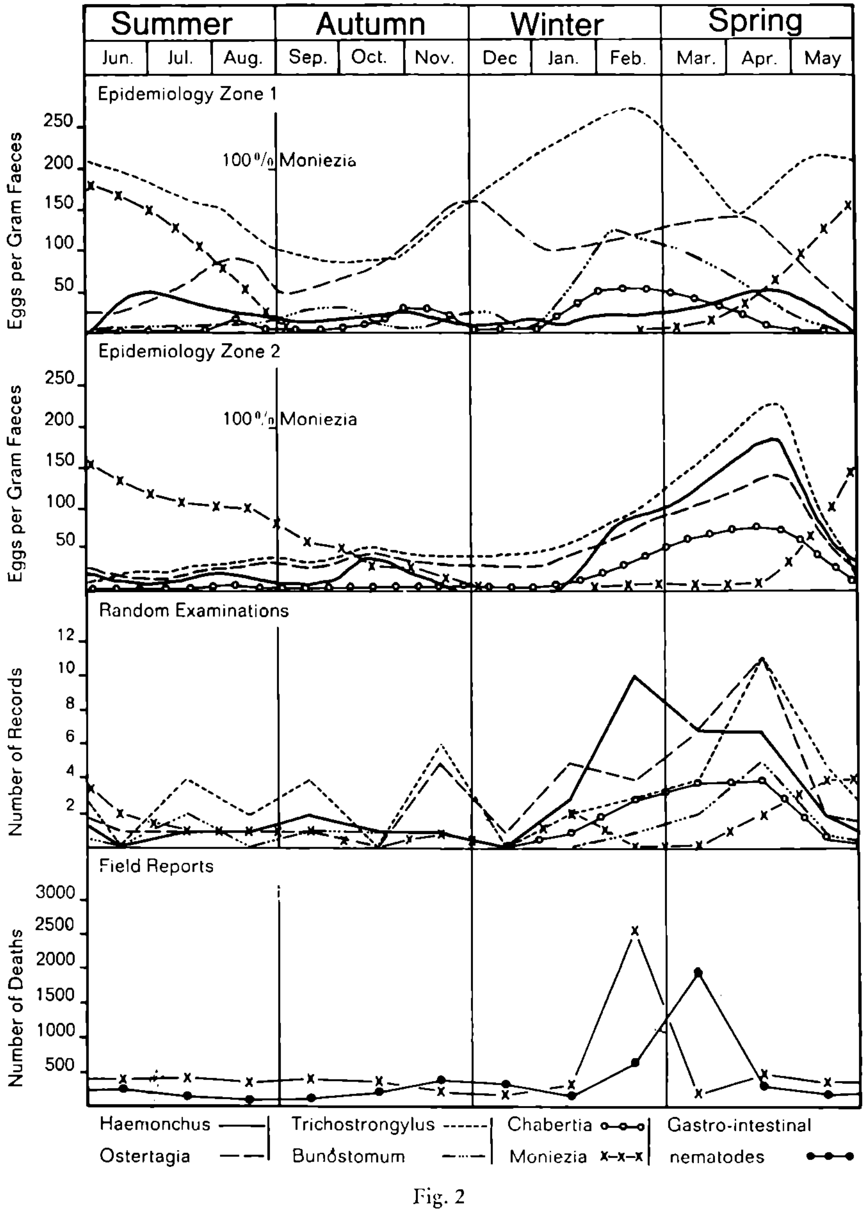

Fig. 2

The seasonal incidence of gastro-intestinal parasites of sheep and goats in Iran derived from three sources of data (Data for *H. contortus* divided by 10 before plotting) burdens, a decline with the onset of winter, a marked rise at the end of winter reaching a peak in midspring, a sharp decline by the end of spring and little infection during summer and early autumn. *Chabertia ovina* infections were highest in late-winter to early spring in zone 1 and in mid-spring in zone 2. *Moniezia spp.* infections followed a similar pattern in each zone, commencing in mid-spring, reaching a peak by the end of spring and declining through summer. Infections persisted longer in zone 2. *Bunostomum trigonocephalum* occurred only in flocks in zone 1 where infections rose during late-winter and declined during spring. Results for *Nematodirus spp.*, are not shown because the egg counts were extremely erratic.

Random Examinations. Data obtained by examination of random batches of faecal samples and by post-mortem examinations from flocks not included in epidemiology studies are shown in Table 1. These results show that the worms most prevalent in sheep and goats in Iran were *Ostertagia spp.* and *Trichostrongylus spp.*

An indication of seasonal occurrence of different worms was obtained from these random examinations by noting the months in which records showed worm counts or egg counts in excess of levels arbitrarily chosen for each genus. The seasonal trends thus displayed are incorporated in Figure 2.

Applied Control Experiments. When the epidemiology studies reported above were completed, a tentative program of strategic treatments for worm control was adopted. The data relating to seasonal incidence of worms derived from epidemiology studies, random examinations and field reports (Fig. 2) indicated that the period of danger from nematode infections was from the end of autumn to the middle of spring. Management factors that needed consideration were migratory movements of flocks, lambing times and standards of nutrition. The majority of sheep and goats are owned by nomadic tribes, migrating to mountain pastures about mid-spring and returning to winter quarters about the end of autumn. Most lambs are born about the end of winter. The standard of nutrition is best in spring, declines during summer and is very low at the end of autumn, with the result that most flocks enter the winter in poor condition.

Three treatments with a broad-spectrum anthelmintic were planned, the first at the end of autumn, the second in mid-winter and the third in early spring. This decision was related mainly to the management factors spanning the period of highest worm burdens. Recommendations were that the precise times of treatments be adjusted, when feasible, to give the first treatment just prior to movement into winter quarters, the second about 4 weeks before lambing, and the third just prior to the spring migration.

Results of 10 applied control experiments to test the value of these recommendations are shown in Table 2. The predominant nematodes in each experiment were *Ostertagia spp.* and *Trichostrongylus spp.* In each experiment treated sheep made better weight gains than untreated sheep. The difference in mean gains was significant (Student's «t» test) in the seven experiments in which the mean worm egg count of untreated sheep exceeded 165 e. p. g. faeces, excepting in Experiment 1 where the standard of nutrition was excellent. In all experiments, the additional gains, expressed as profits over costs of treatments, represented a sound financial investment in treatments.

In Experiment 5 the control group was inadvertantly treated with phenothiazine by the owner during the experiment, but gains in the treated group were still significantly better.

Table 1
The Incidence of Gastro-intestinal Worms of Sheep and Goats in Iran Determined by Faecal Worm Egg Counts and Post-mortem Worm Counts in Random Examinations

	Lambs up to 12 months		Sheep over 12 months		Goats	
	Egg Counts	Worm Counts	Egg Counts	Worm Counts	Egg Counts	Worm Counts
Total number examined	713	20	2176	97	377	40
Percent positive on eggs counts	26	—	37	—	59	—
Number examined for genera	282	20	867	97	265	40
	Percent positive for different genera					
Haemonchus	22	20	49	49	45	40
Ostertagia	51	28	45	77	42	70
Trichostrongylus	52	35	54	55	51	45
Chabertia	21	5	27	51	41	38
Oesophago-stomum ⌀	4	0	6	6	5	15
Bunostomum	1	5	9	18	6	0
Cooperia	0	0	1	1	0	0
Nematodirus	18	55	12	65	4	65
Moniezia	18	20	6	37	1	8

— = Less than 100 e.p.g. faeces registers as negative
⌀ = Oes. venulosum

In Experiment 3, five of the 20 untreated sheep died, the deaths being attributed to nematodes. These mortalities are not accounted for in the financial assessment in Table 2.

Discussion

Some of the gastro-intestinal worms found in sheep and goats in Iran during the present study are not mentioned in the results. A complete list of helminths known to occur in sheep and goats in Iran has been published by SHAHLAPOOR (1965) who added *Skrjabinema ovis* and *Trichostrongylus spp.* to the list previously compiled by ALAVI (in press).

The epidemiology studies were based on worm egg counts of faecal samples taken at monthly intervals throughout the year. There are objections to this procedure because the presence of immature worms is not detected and adult worms may produce few or

Table 2
Evaluation of Strategic Treatments for Control of Gastro-intestinal Parasites of Sheep in Iran. "Applied Control" Experiments

Experiment Number	1	2	3	4	5	6	7	8	9	10
Located in Zone Number	1	1	1	2	2	2	2	2	2	2
Duration (months)	4	4	4	5½	4	5	5½	4½	6	6
Period of Year	Jan-Apr	Jan-Apr	Jan-Apr	Nov-May	Nov-Mar	Nov-Apr	Oct-Apr	Dec-Apr	Nov-May	Nov-May
Animals										
Number per group	20	20	20	15	16	10	17	8	20	16
Initial age (months)	10	10	10	10	9	10	12	9	10	10
Initial condition	VG	VP	P	G	F	F	E	G	G	G
Standard of nutrition	E	P	P	F	F	F	G	F	F	F
Mean worm egg counts (e. p. g.)										
Initial, all animals	130	440	450	46	40	45	60	180	30	34
Subsequent highest, control group	616	647	306	60	?	88	408	428	165	320
Subsequent highest, treated group	11	52	26	54	40	22	22	12	70	110
Anthelmintics used (Number of doses)	Tbz(3)	Tbz(3)	Tbz(3)	Ptz(3)	Ptz(3)	Tbz(3)	Tbz(2)	Tbz(3)	Tbz(3)	Tbz(3)
Mean bodyweight data (kg)										
Initial, all animals	21.0	23.0	15.0	30.0	24.5	20.3	32.5	28.0	30.0	18.0
Gain, treated group	8.4	12.8	6.2	6.4	4.4	4.1	3.5	4.8	10.2	11.5
Gain, control group	7,4	9.6	3.7	5.0	2.6	3.5	0.3	2.3	6.5	9.2
Economic assessment										
Additional gain due to treatment (kg)	1.0Ø	3.2***	2.5***	1.4Ø	1.8Ø	0.6Ø	3.2***	2.5*	3.7***	2.3**
Value at 35 rls. per kg (rls.)	35	112	80	49	63	21	112	87.5	129.5	80.5
Cost of treatments (rls.)	18	18	18	7.5	7.5	18	12	18.0	18.0	18.0
Nett profit per head (rls.)	17	94	62	41.5	55.5	3	100	69.5	111.5	62.5
Percent profit on cost of treatments	94	522	344	553	740	17	833	386	619	345

G = good, E = excellent, F = fair, P = poor, V = very poor, Tbz = thiabendazole, Ptz = phenothiazone, Ø = not significant,
* = significant, P less than 0.05, ** = highly significant, P less than 0.01, *** = very highly significant, P less than 0.001

no eggs. However, BANKS (1958) and HELLE (1964) found that egg counts satisfactorily reflected changes in worm burdens in similar studies. In the present studies no instances of arrested development of larvae have been noted and it is considered that results do reflect the times at which sheep became infected. The seasonal patterns of infection in flocks within each climatic zone have been very similar, but the results reported are from studies in two years only. More studies over a number of years are needed before data on epidemiology can be accepted as reliable.

Seasonal trends extracted from data from random examinations supported results of epidemiology studies, but this data must be viewed with reserve because it derives mainly from field trips at irregular intervals.

In view of the number of mortalities ascribed to parasites in Iran it was expected that worm egg counts would be higher than the levels found in epidemiology studies. A general deficiency of the work was that most of it was done in flocks belonging to the wealthier owners in village areas. In these flocks the standard of nutrition was usually better than average for Iran which may account for the low worm burdens recorded. On the other hand low worm burdens may be due to sherpherding of flocks onto new pasture areas almost daily. It is also probable that many of the mortalities ascribed to parasites are due primarily to malnutrition as a result of lack of pastures in the winter months.

An unexpected finding in the Mountain Plateaux zone, was that, when observations commenced about the end of spring, using young lambs at 3 to 4 months of age, very few nematodes were found in them. Appreciable burdens of nematodes were not acquired until the following winter when lambs were 9 to 10 months of age. Deliberate comparisons were made on several occasions between lambs and sheep over 12 months old within the same flocks. Almost invariably the older sheep had higher worm burdens. In the first 2 to 3 weeks of life lambs are confined and have comparatively little contact with their mothers and no contact with other sheep. When they are put out to pasture they are shepherded separately from the rest of the flock. Apparently this protects them from infection during the first spring. It is believed that with the onset of the hot, dry summer there is little survival of larvae on the pastures, so that the lambs do not acquire appreciable worm burdens until the following autumn-winter season. This may have important implications since the majority of sheep are reared in the Mountain Plateaux zone and the low infections acquired by lambs in their first 6 to 9 months may be insufficient to promote a useful immunity. Treatment during this time is unlikely to be of value and may mitigate further against development of immunity. In the wetter Caspian zone lambs do acquire significant burdens of nematodes during their first 6 months of life.

Date on the seasonal incidence of worms obtained by epidemiology studies and random examinations were closely comparable in defining the main seasons for nematode infection as winter and spring. Reports on field mortalities supported these findings in respect to nematodes but there was a striking disagreement in respect to *Moniezia spp.* (Fig. 2). Whereas the present studies showed that infections of *Moniezia spp.* were acquired in spring to early summer, the number of deaths ascribed to *Moniezia spp.* by field veterinarians was highest in winter. It is considered that these deaths were probably due to undetected burdens of the small trichostrongylids or to other causes, especially malnutrition. In two anthelmintic evaluation experiments in which treatments effectively removed *Moniezia spp.* there was no improvement in growth rate of treated lambs compared with untreated lambs (SKERMAN, SHAHLAPOOR and ESLAMI (unpublished). These experiments were done in the Mountain Plateaux zone where lambs infected with *Moniezia spp.*, but without the complication of concurrent nematodes infestations, were available.

The ultimate objective of the work was to advise farmers on control measures. It was considered that recommendations should not be made before it had been shown that a profit could be expected over and above the cost of applying the recommendations. Application of the recommendations in ten applied control experiments (Table 2) showed that when worm burdens increased as expected and nutritional standards were not above the average for Iran, the treatments resulted in significant additional gains in bodyweights, and a high rate of financial return to the farmer. Mortalities were prevented in one flock (Expt. 3) in which one quarter of the untreated sheep died.

Sheep and goats are sold on a liveweight basis in Iran and the lowest price paid at the Tehran slaughterhouse during 2 years was 40 rials per kg. The financial assessment of results at 35 rials per kg is therefore conservative and takes no account of probable increase in milk and wool production. BRUNSDON (1964) has recently demonstrated spectacular increases in wool production due to the control of gastro-intestinal parasites.

The results shown in Table 2 illustrate the influence of cost of treatment on profits. For example, if the cost of treatment in Expt. 5 were doubled, the nett value per sheep would be reduced from 63 to 48 rials and the percent profit on cost of treatment would fall from 740% to 320%. In these assessments the cost of labour for treating sheep was ignored because it is negligible in Iran.

The value of strategic treatments in reducing contamination of pastures with worm eggs and larvae is also evident in Table 2. Calculations based on results of worm egg counts in Expt. 2 show that the 20 untreated sheep passed about a billion (10^9) more worm eggs than the 20 treated sheep during the experiment.

From the results of these and other controlled experiments it is concluded that mixed nematode infestations, not including *Haemonchus contortus*, adversely effect the productivity of flocks under Iranian conditions when the worm egg counts exceed about 200 e. p. g. faeces.

Further work is needed on the number and timing of strategic treatments. It may well be that equally satisfactory control might be achieved with fewer treatments at less cost. Observations are continuing and are being extended into zone 3, where initial results indicate a quite different pattern of seasonal incidence of gastro-intestinal parasites.

Summary

Preliminary results of epidemiology studies and random examinations to determine the prevalence and seasonal incidence of gastro-intestinal parasites of sheep and goats in Iran are reported. The value of strategic treatments for control of the gastro-intestinal nematodes, timed according to these results and according to flock management was assessed in ten experiments. Worm egg counts in treated sheep reduced to and maintained at low levels throughout the experiments. Economic assessment based on increased gains in bodyweights of treated sheep showed that the costs of treatments were recouped with high profits when the exepcted seasonal rise in worm egg counts occurred in the untreated controls.

Acknowledgements

We are greatly indebted to the Director-General and field veterinarians of the Veterinary Directorate, Ministry of Agriculture, Iran, for assistance in doing the field work. Laboratory facilities were provided by the Razi Institute, Hessarak. Previously existing information was freely given by the Veterinary Faculty, University of Teheran and by the Meteorological Department.

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