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Effect of Management Systems on Performance and Parasite Infections of Finishing Lambs in the Gulf Coast Area

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EFFECT OF MANAGEMENT SYSTEMS ON PERFORMANCE AND PARASITE INFECTIONS OF FINISHING LAMBS IN THE GULF COAST AREA

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MANUSCRIPT THESES

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ABSTRACT

An experiment was conducted over a three-year period to determine the effect of three management systems on performance and degree of parasitism of spring born market lambs. One hundred fifty-six Suffolk and Suffolk sired crossbred lambs (60, 48 and 48 in 1977, 1978 and 1979, respectively) were randomly alloted so as to balance the effect of sex, weight and breeding to one of three treatments: (1) pasture plus creep, (2) drylot and (3) an expanded metal floored pen. All lambs were fed a pelleted ration consisting of approximately 50% forage. Lambs were weaned at an average age of 60 days, wormed and isolated on a concrete floor for two weeks prior to the start of the test. Lambs were weighed at the start of the test and every four weeks for 84 days. Fecal samples were collected at the start of the test and at two-week intervals thereafter. Blood samples were collected at each weighing in 1978 and 1979. Fecal egg counts dictated when lambs were wormed. At the termination of the trials in 1978 and 1979, four lambs from each group were slaughtered and worms were recovered from the abomasa.

Lambs fed in drylot gained significantly faster than either lambs fed on expanded metal or on pasture (.24, .21

and .17 kg/day, $P < .05$, for lambs on drylot, on expanded metal and on pasture, respectively). Lambs fed on the expanded metal floor gained significantly faster than those creep-fed on pasture ($P < .05$).

Pastured lambs had consistently higher fecal egg counts per gram of feces and significantly higher worm counts at slaughter than did confined lambs (7.25, 2.81 and 0.98 epg, $P < .05$, for lambs on pasture, in drylot and on expanded metal, respectively). Worm numbers at slaughter were not significantly different for lambs fed in the two confinement groups.

There was a highly significant negative correlation ($r = .60$, $P < .01$) between fecal egg count and packed cell volume.

INTRODUCTION

One of the most important problems facing the sheep producer in any area is internal parasitism. This is especially true in the Gulf Coast region where the mild winters and hot humid summers provide an ideal environment for the proliferation of internal parasites. Another problem in this area is finishing spring lambs through the heat of the summer. This experiment was designed to test the efficacy of three management systems in producing market lambs and in controlling internal parasites, especially Haemonchus contortus, the large stomach worm of sheep. H. Contortus is the only parasite causing primary disease in sheep (Soulsby, 1965). The three systems investigated were pasture grazing plus a pelleted supplement or creep, drylot and an elevated expanded metal pen.

Literature Review

Internal parasites can produce a wide range of deleterious effects including reduced gain, decline in milk and wool production, impaired breeding, death, and condemnation of meat and organs at slaughter (Turner, 1960). Management techniques used to control parasitism include pasture rotation (Gordon and Turner, 1946; Spedding, 1954, 1955, 1956) and the strategic use of anthelminthics (Gibson, 1956; Soulsby, 1965). Kisel et al. (1963) reported that medication alone will not control ovine parasitism if other management factors are neglected.

It has been demonstrated that lambs fed on pasture with access to creep will perform comparably to lambs fed in drylot (Boulware et al., 1976; Ely et al., 1979); however, lambs consuming pasture grass alone may perform acceptably if the pasture is of good quality (Boulware et al., 1976). Good management precludes the sole use of perennial pasture in the Gulf Coast area for lambs during the summer as the quality rapidly declines during the summer months.

Ely et al. (1979) reported that lambs consuming only pasture had significantly lower gains than either lambs on pasture plus a concentrate or lambs fed in drylot. The lambs fed pasture plus concentrate had gains that were comparable to those lambs fed in drylot, but the pastured lambs consumed 48% less concentrate. They concluded that the dietary forage significantly contributed to liveweight gain.

The use of pelleted roughage for fattening lambs can result in increased gains and increased feed efficiency (Cate et al., 1955; Lindahl and Davis, 1955; Weir et al., 1959; Lindahl and Terrill, 1963). Pelleting of roughage can significantly increase the feeding value of roughage by reducing wastage and increasing acceptability of the roughage (Lindahl and Terrill, 1963).

The use of slatted floored pens offers an alternative to the use of drylot as a management system. An advantage of slatted floored pens is that contact with manure is minimized, lambs stay cleaner and parasitism is reduced due to the decrease in autoinfection. This system has been shown to be of value in reducing parasite load and in maintaining worm-free sheep.

Watson (1962) reported that lambs born and reared on slatted floors remained free of most gastrointestinal parasites, except Strongyloides sp. and Eimeria sp. These two parasites have minimal effect on lamb performance, and they are not economically important. The lambs reached an acceptable market weight in 16 to 18 weeks.

Noland et al. (1963) compared the performance of lambs fed on slatted floors to that of lambs fed in a conventional drylot. They found that lambs fed on the slatted floors tended to gain weight faster and to consume less feed than lambs fed in the drylot.

Mansfield et al. (1967) reported that parasite-free

lambs could be successfully produced from infected ewes by management alone on elevated slotted floors. They found that lamb performance was satisfactory compared to that of lambs managed under similar conditions in drylot.

Arehart et al. (1969) compared the performance of lambs allowed different areas on slotted floors. Lambs were allowed 0.37, 0.56, 0.74 and 0.93 m^2 per head. There was no significant effect of space allowance on performance.

It has been reported that the elapsed time between acquisition of Haemonchus contortus infective larvae and patency of the infection (detection of eggs in the feces) is about three weeks (Radhakrishnan et al., 1972; Bradley et al., 1973) and that infection of a clean pasture can occur in two weeks or less after infected sheep have grazed it (Colglazier et al., 1968). The eggs of H. contortus develop in two days to 21-28 days depending on the ambient temperature, and the infective larvae become fully mature in an average of 15 days (Soulsby, 1965).

The three most important factors affecting the degree of stomach worm infection in sheep are season of the year, age of the animal and the genetic constitution for resistance or susceptibility to infection (Gregory et al., 1940).

Lambing season has been shown to have an effect on the degree of parasitism in the resulting lambs (Crofton, 1954; Crofton, 1958; Knight and Scales, 1962; Knight et al., 1973). A precipitous increase in fecal egg output occurs

in post-parturient ewes about six weeks after lambing (Crofton, 1954). By this time the lambs are usually consuming a considerable amount of forage especially if the ewes are heavily parasitized and are not producing normal amounts of milk. The lambs are therefore susceptible to parasitic infection. Crofton (1958) reported that in a spring lambing flock, the post-parturient rise in egg output is followed by a logarithmic increase in egg output by the lambs.

Knight et al. (1973) noted certain trends in the development of parasitic infection in spring lambs: early lambs developed better and acquired fewer worms than did late lambs in years of heavier than average rainfall, but not in years of subnormal rainfall; lambs developed severe haemonchosis in wet years regardless of time of birth; even in dry years some lambs required treatment to control haemonchosis.

Age of the lamb will also have an effect on the degree of parasitic infection. Knight and Rogers (1974) studied lambs at four ages: 3, 6, 9 and 21 months of age. They found that there was a reduction in average egg and worm counts that could be directly correlated with increased age, although the worm numbers in the 3-, 6-, and 9-month old lambs did not differ significantly from each other. The 21-month-old lambs had significantly fewer worms than did the other groups.

These results may be due in part to the self-cure reaction reported by Stewart (1950), Soulsby and Stewart (1960), Malczewski (1971) and Bradley et al. (1973). This reaction may be elicited by the administration of infective larvae. It is thought to be immunologic in nature and to occur in response to the exsheathing fluid released by the infective larvae (Soulsby and Stewart, 1960; Soulsby, 1965).

Stewart (1950) reported that intake of infective larvae by infected sheep was followed by a definite drop in egg count. In some lambs this decrease in egg count was sustained and appeared to be due to the elimination of the greater part of the existing infection. Occasionally the decline in egg count was transient and the previous level was resumed within a week. In thse cases egg production was evidently suppressed and the infection was not eliminated.

Breed differences in resistance to internal parasitism have been reported by many researchers (Gregory, 1937; Gregory et al., 1940; Loggins et al., 1965; Radhakrishnan et al., 1972; Bradley et al., 1973; Knight et al., 1973). However, it appears that these differences are not important when good management is practiced.

Norman and Hohenboken (1979) studied crossbred sheep from Cheviot, Dorset, Finn or Romney sires X Suffolk or Columbia-type dams. They found no economically important differences among breeds when preventative health management procedures were used.

Yazwinski et al. (1979) studied Dorset, Barbados, Dorset X Barbados, Dorset X Landrace and Rambouillet X Landrace crossbred lambs and found no significant differences among breeds in fecal egg counts in H. contortus. The lambs were wormed at the start of the experiment and no other anthelminthics were administered for the duration of the trial.

The anthelminthics commonly employed by sheep producers have varying levels of efficacy. There is some evidence that H. contortus has a degree of immunity to phenothiazine (Drudge et al., 1957a, b; Leland et al., 1957; Levine and Garrigus, 1961; Colglazier et al., 1968). Tetramisol is highly effective against adult and larval H. contortus (Gibson, 1966; Lyons et al., 1968; Colglazier et al., 1969). There is some conflict over the efficacy of thiabendazole against H. contortus. Conway (1964) and Drudge et al. (1964) reported that thiabendazole had little effect on H. contortus. However, other studies indicate that it is an effective anthelminthic (Gibson, 1964; Gordon, 1964; Colglazier et al., 1969).

MATERIALS AND METHODS

One hundred fifty-six lambs were studied over a three-year period (60, 48 and 48 lambs in 1977, 1978 and 1979, respectively). The lambs were taken from the L. S. U. sheep flock and were weaned at an average age of 60 days. The breeds involved were Suffolk, Louisiana Native, Rambouillet, Hampshire and Barbados. The lambs were primarily Suffolk and Suffolk sired crossbreds, although some Barbados sired crossbred lambs were included. The lambs were randomly allotted into three groups in a manner so as to balance on the basis of weight, sex and breeding. One group was placed on a one hectare common bermudagrass summer pasture (Cynodon dactylon) and had access to a grain creep. A second group was self fed on a concrete slab drylot with space allowance of 5.6 m^2 per lamb in 1977 and 7.0 m^2 per lamb in 1978 and 1979. The third group was self fed on an elevated expanded metal floor with space allowance of .53 m^2 per lamb in 1977 and .67 m^2 per lamb in 1978 and 1979. All lambs were fed ad libitum the pelleted ration shown in tables 1 and 2. All lambs were wormed and isolated on a concrete floor for two weeks prior to the start of the test. They were wormed again at the start of the test with 29 ml of Tramisol[1] per

[1]American Cyanamid, Inc. Princeton, N. J.

TABLE 1. COMPOSITION OF THE PELLETED RATION

Ingredient	NRC reference number	% of ration
#2 yellow corn	4-02-935	38.06
Dehydrated bermudagrass hay	1-00-703	42.81
Soybean meal (44% crude protein)	5-04-600	4.76
Molasses	4-04-696	9.51
Salt[a]		4.76
ASP-250[b]		0.10

[a](NaCl)

[b]Aureomycin, sulfamethazine and penicillin to supply 1 mg Aureomycin/kg ration, 1 mg sulfamethazine/kg ration and 0.5 mg penicillin/kg ration.

TABLE 2. APPROXIMATE COMPOSITION OF THE PELLETED RATION

Item	Amount, as fed
Dry matter, %	83.14
Crude fiber, %	12.61
Ether extract, %	2.45
Nitrogen-free extract, %	54.78
Crude protein, %	9.21
Digestible protein, %	6.36
Digestible energy, kcal/kg	2640.0

head (thiabendazole[2] was used for this worming in 1978). Tramisol and thiabendazole were alternately used in anthelminthics. Lambs were wormed when the fecal egg counts exceeded 3,000 eggs per gram (epg).

All lambs were weighed at the start of the test and every four weeks thereafter for 84 days (70 days in 1979). Fecal samples were collected per rectum at the start of the trial and at two week intervals thereafter. Blood samples were collected from the jugular vein at each weighing in 1978 and 1979. Feed consumption was recorded for each group.

Fecal samples were prepared according to the centrifugation flotation technique using a sugar solution of specific gravity 1.20 (Williams and Knox, 1976). Samples were examined microscopically at 10X for the presence of eggs of gastrointestinal nematodes, tapeworms and coccidial oocysts. Based on eventual necropsy results, the worm parasites present were: Haemonchus contortus, Trichuris ovis and Moniezia expansa. H. contortus eggs were counted as eggs per gram of feces (epg). Since some egg counts were zero, epg was converted to $\log_{10}$. M. expansa and T. ovis were indicated as present or absent; coccidia were recorded as light, moderate or heavy infections.

Blood samples were analyzed by the clinical pathology laboratory at the L. S. U. School of Veterinary Medicine for percent hemoglobin, packed cell volume (PCV) and number

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[2]Merck, Inc. Rahway, N. J.

of red blood cells.

At the conclusion of the trials in 1978 and 1979, four lambs from each group were slaughtered, and the abomasum and small intestine of each animal were removed intact. The contents of the abomasum and small intestine were rinsed into buckets with enough water to make 7 liters. After the abomasum was washed and rubbed to remove all adhering material, it was soaked in an additional 7 liters of water for two hours; this was done to encourage the nematode larvae to emerge from the mucosa. The contents of each bucket were agitated and a one liter aliquot was removed to a bottle. The contents of the bottle were allowed to settle, 100 ml were decanted and 100 ml of 37% formaldehyde were added to make a 10% formalin preservative solution. This solution was allowed to settle, the formalin was decanted and the sediment was washed with tap water. Two 100 ml aliquots were taken from each bottle of abomasal contents and were examined for H. contortus.

An analysis of variance was performed on average daily gain (ADG) to test the effects of management system, year, sex and all interactions. Mean differences were tested by Duncan's Multiple Range Test. An analysis of variance was performed on epg of H. contortus to test the effects of sampling date and treatment. Correlations between epg and PCV were computed by treatment and by sex.

In 1977, three lambs on pasture were killed by feral dogs. Another lamb on pasture and a lamb in the expanded

metal pen died of unknown causes. In 1978, six lambs on pasture were killed by feral dogs. Two lambs in the expanded metal pen died: one of pneumonia and one of unknown causes and the post mortem examinations were negative for any parasites except tapeworms. In 1979, one lamb in the expanded metal pen died of unknown causes on the third of July; it was not necropsied as it had reached an advanced state of decomposition due to the high ambient temperature.

RESULTS AND DISCUSSION

The results of the analysis of average daily gain (ADG) are shown in tables 3 and 4. Average daily gain was significantly different among all treatment groups and between sexes. There was no significant year effect and all interactions were nonsignificant. The lambs fed in drylot gained faster ($P < .05$) than did either the lambs on the expanded metal or the lambs on pasture (table 5), and the lambs on the expanded metal floor gained faster ($P < .05$) than those on pasture (.24, .21 and .17 kg/day for lambs fed in drylot, on expanded metal and on pasture, respectively). Colglazier et al. (1968) have reported that haemonchosis and heat stress are contributing factors to decreased weight gains in lambs on pasture. Lindahl et al. (1963) have reported that lambs fed in drylot gained significantly faster than those on pasture. However, Ely et al. (1979) found that lambs fed on pasture with access to creep made comparable gains to lambs fed in drylot; they concluded that forage made a significant contribution to lamb weight gain. The estimated average amount of forage consumed by the pastured lambs was determined by calculating the maintenance energy required using the equation:

$$\text{Digestible energy in Kcal for maintenance} = 140 \times (\text{average weight in kg})^{3/4}$$

TABLE 3. ANALYSIS OF VARIANCE FOR AVERAGE DAILY GAIN

Source	Degrees of freedom	Mean squares, ADG
Treatment	2	0.111**
Sex	1	0.072**
Treatment X sex	2	0.002
Year	2	0.007
Treatment X year	4	0.011
Sex X year	2	0.002
Treatment X sex X year	4	0.006
Error	121	0.005

**$P < .01$

TABLE 4. EFFECT OF MANAGEMENT SYSTEM ON AVERAGE DAILY GAIN OF LAMBS

Treatment	N	Mean ADG, kg
Pasture	47	0.1719[a]
Drylot	44	0.2428[b]
Expanded metal	48	0.2056[c]

[a,b,c]means bearing different superscripts are significantly different ($P < .05$, Duncan's Multiple Range Test).

The digestible energy of the ration required to produce one gram of gain was calculated from the averaged feed and gain data on the confined lambs. This value was used to calculate the digestible energy required to produce one gram of gain for pastured lambs. The difference between the calculated digestible energy required to produce the

TABLE 5. EFFECT OF MANAGEMENT SYSTEM ON AVERAGE DAILY GAIN AND ON AVERAGE FEED INTAKE

Item	Pasture	Drylot	Expanded metal
Total feed, kg	5860.0	8723.0	7308.0
Total gain, kg	686.9	1031.3	868.0
ADG/lamb, g	182.0[a]	248.0[b]	213.0[c]
ADF/lamb, kg	1.55	2.10	1.80
Feed/gain	8.5	8.5	8.4
Adjusted lamb days	3784.0	4164.0	4072.0

[a,b,c]Means bearing different superscripts are significantly different ($P < .05$, Duncan's Multiple Range Test).

gain and the digestible energy provided by the average amount of the pelleted ration that the lambs actually consumed was used to estimate the average daily forage intake per lamb. It was estimated that each lamb consumed an average of .17 kg bermudagrass per day on an as fed basis. It appears that the pastured lambs utilized very little forage and that the creep ration was responsible for the major part of the maintenance needs and weight gain of these lambs. Apparently the most important contribution made by the pasture grass was a steady source of infective Haemonchus contortus larvae.

The difference in performance between the two groups of lambs fed in confinement contradicts much of the work done in this area. Watson (1962), Noland et al. (1963) and Mansfield et al. (1967) have reported that there was no significant difference between performances of lambs fed in drylot and of those fed on slatted floors. Arehart et al.

(1969) reported that space allowance per lamb had no statistically significant effect on the performance of lambs fed on slotted floors.

There are several factors that may have contributed to the difference found in this study. In the work of Watson (1962) and Mansfield et al. (1967) it was reported that the lambs were born and raised on the slatted floors and that these pens were located within a barn. In this study the lambs were born on pasture and were not placed on the expanded metal floor until after weaning. The expanded metal pen was located in the pasture area, so that exposure to the weather may have been another factor. The lambs confined on the expanded metal floor were apparently stressed more than were the lambs in the drylot. The lambs on expanded metal exhibited nervous behavior by stamping their feet and huddling together in the presence of people. In 1979, two lambs escaped from the pen on a night when dogs were present in the pasture. A combination of these factors may be responsible for the reduced gains of the lambs fed on the expanded metal floor. The fact that these lambs had a higher mortality rate than the lambs fed in drylot partially supports this conclusion. A reasonable explanation might be that the more closely confined lambs suffered some additional stress, since the drylot was located in the same part of the pasture as the expanded pen. The lamb area per head was approximately 10 times for the lambs fed in the drylot compared

compared to those fed on the expanded metal floor. This may be an important influence on lamb performance and further study is indicated to determine the optimum space allowance for lambs fed under these conditions.

Rearing lambs on an elevated expanded metal floor has advantages in keeping the animals clean and in preventing infection by internal parasites, but the pen should be located in a barn or other shelter and the lambs should be accustomed to the pen from birth to minimize stress.

The effect of sex on average daily gain is shown in table 6. Wether lambs gained faster ($P < .05$) than ewe lambs (.23 and .19 kg/day for wethers and ewes, respectively). Andrews and Ørskov (1970) found a highly significant sex difference in rate of gain of finishing lambs, with males gaining faster than females. They reported that this difference significantly increases with age.

The overall mortality rate for the three years was 9.0%; predation by feral dogs was the primary cause (5.8%). Death losses by treatment were: (1) pasture, 19.2%; (2) drylot, no losses; (3) expanded metal pen, 7.7%. One lamb died of pneumonia, and it is probable that the other lambs not killed by dogs died of overheating. Colglazier et al. (1968) reported that dog attack and overheating were the major causes of the 4% mortality rate in that study.

No overall analysis was performed on fecal egg counts for H. contortus as the lambs were wormed

TABLE 6. EFFECT OF SEX ON AVERAGE DAILY GAIN OF LAMBS

Sex	N	Mean ADG, kg
Ewes	84	0.1922[a]
Wethers	55	0.2270[b]

[a,b]Means bearing different superscripts are significantly different ($P < .05$).

periodically. An analysis was performed on a within-sampling-date basis to determine whether or not there was an effect on eggs per gram of feces (epg) due to management system and date of sampling. The results of the analyses of variance are shown in tables 7, 9 and 11. The least squares means are shown in tables 8, 10 and 12. Least squares means were used because it was not always possible to obtain a fecal sample from each animal at each sampling time. There was a highly significant interaction effect between management system and sampling date on epg in all three years.

TABLE 7. ANALYSIS OF VARIANCE FOR AVERAGE EPG OF *HAEMONCHUS CONTORTUS* IN 1977

Source	Degrees of freedom	Mean Squares, EPG
Date	3	3963190.26**
Treatment	2	3085623.37**
Date X treatment	6	1087891.56**
Error	203	

**P < .01.

TABLE 8. LEAST SQUARES MEANS AND STANDARD ERRORS FOR AVERAGE EPG OF *HAEMONCHUS CONTORTUS* BY MANAGEMENT SYSTEM AND SAMPLING DATE IN 1977

	TREATMENT					
	Pasture		Drylot		Expanded metal	
Date	LSM	SE	LSM	SE	LSM	SE
29 June	220.2^{a}_{a}	± 93.78	95.9^{a}_{a}	± 93.78	18.4^{a}_{a}	± 101.72
13 July	2.4^{a}_{a}	± 98.85	94.6^{a}_{a}	± 96.22	87.9^{a}_{a}	± 108.29
10 August	211.4^{a}_{a}	± 101.72	60.2^{a}_{a}	± 96.22	163.3^{a}_{a}	± 98.85
08 September	1498.3^{b}_{a}	± 112.09	423.2^{b}_{b}	± 96.22	47.6^{a}_{c}	± 96.22

^{a,b}Means within column with different superscripts are significantly different (P < .05).

^{a,b,c}Means within row with different subscripts are different (P < .05).

TABLE 9. ANALYSIS OF VARIANCE FOR AVERAGE EPG OF *HAEMONCHUS CONTORTUS* IN 1978

Source	Degrees of freedom	Mean squares, EPG
Date	6	26999015.82**
Treatment	2	20271142.58**
Date X treatment	12	5229591.71**
Error	249	

**P < .01.

TABLE 10. LEAST SQUARES MEANS AND STANDARD ERRORS FOR AVERAGE EPG OF *HAEMONCHUS CONTORTUS* BY MANAGEMENT SYSTEM AND SAMPLING DATE IN 1978

	TREATMENT					
	Pasture		Drylot		Expanded metal	
Date	LSM	SE	LSM	SE	LSM	SE
16 May	2082.9	± 125.32$^{a}_{a}$	2455.0	± 144.71$^{a}_{b}$	2462.5	± 129.43$^{a}_{b}$
30 May	0.1	± 125.32$^{b}_{a}$	0.0	± 133.98$^{b}_{a}$	0.0	± 133.98$^{b}_{a}$
13 June	961.0	± 125.32$^{c}_{d}$	63.2	± 139.03$^{b}_{b}$	12.8	± 129.43$^{b}_{c}$
27 June	3000.0	± 151.15$^{d}_{a}$	182.1	± 129.43$^{b}_{b}$	2.9	± 139.03$^{b}_{c}$
11 July	1363.2	± 151.15$^{e}_{a}$	96.4	± 133.98$^{b}_{b}$	2.2	± 151.15$^{b}_{c}$
25 July	1407.4	± 189.47$^{e}_{a}$	175.7	± 144.71$^{b}_{b}$	2.2	± 144.71$^{b}_{c}$
08 August	10.9	± 189.47$^{b}_{a}$	3.1	± 139.03$^{b}_{a}$	5.9	± 139.03$^{b}_{a}$

^{a,b,c,d,e}Means within column with different superscripts are significantly different (P < .05).

^{a,b,c}Means within row with different subscripts are different (P < .05).

TABLE 11. ANALYSIS OF VARIANCE FOR AVERAGE EPG OF *HAEMONCHUS CONTORTUS* IN 1979

Source	Degrees of freedom	Mean squares, EPG
Date	5	3313840.18**
Treatment	2	134059.41
Date X treatment	10	458981.42**
Error	220	

**P < .01.

TABLE 12. LEAST SQUARES MEANS AND STANDARD ERRORS FOR AVERAGE EPG OF *HAEMONCHUS CONTORTUS* BY MANAGEMENT SYSTEM AND SAMPLING DATE IN 1979

	TREATMENT					
	Pasture		Drylot		Expanded Metal	
Date	LSM	SE	LSM	SE	LSM	SE
22 May	415.2	117.86 $^{a}_{a}$	816.1	94.50 $^{a}_{b}$	1252.4	111.81 $^{a}_{c}$
05 June	0.4	91.29 $^{b}_{a}$	0.1	91.29 $^{b}_{a}$	0.0	91.29 $^{b}_{a}$
19 June	246.2	98.06 $^{a}_{a}$	0.5	102.07 $^{b}_{a}$	0.1	91.29 $^{b}_{a}$
03 July	243.1	91.29 $^{a}_{a}$	5.7	91.29 $^{b}_{a}$	0.3	106.61 $^{b}_{a}$
17 July	170.8	106.61 $^{a}_{a}$	8.7	102.07 $^{b}_{a}$	1.1	106.61 $^{b}_{a}$
31 July	192.6	88.39 $^{a}_{a}$	4.6	91.29 $^{b}_{a}$	1.8	94.50 $^{b}_{a}$

^{a,b}Means within column with different superscripts are significantly different (P < .05).

^{a,b,c}Means within row with different subscripts are different (P < .05).

Lambs fed in confinement had consistently lower fecal egg counts (figures 1, 2 and 3) and significantly fewer H. contortus present at slaughter (tables 13 and 14) than did the lambs that were constantly exposed to reinfection on pasture (7.25 vs 2.81 and .98 log worms at slaughter for lambs on pasture, in drylot and on expanded metal, respectively). This is in agreement with Colglazier et al. (1968) who found that lambs fed in drylot had lower ($P < .05$) H. contortus egg counts than lambs on pasture. The lambs fed in confinement had smaller worm burdens as indicated by fecal egg count than did pastured lambs. This was confirmed by the recovery of H. contortus from lambs at slaughter.

The number of worms recovered from lambs at slaughter is shown in table 15. In 1979, all of the lambs sacrificed from the expanded metal group were free of Haemonchus; in 1978, only one lamb from that group had Haemonchus present at slaughter. In 1979, Haemonchus were recovered from only one lamb from the drylot group at slaughter; in 1978, Haemonchus were recovered from all four lambs slaughtered from that group. These results, and the egg count data presented in figures 1, 2 and 3, reflect a difference in handling the lambs at the times that samples and weights were taken. In 1978, all the lambs were walked up to the working area; they were released by group into separate pens after sampling, and were walked back to their respective locations. The confined lambs were thus exposed to reinfection by eating

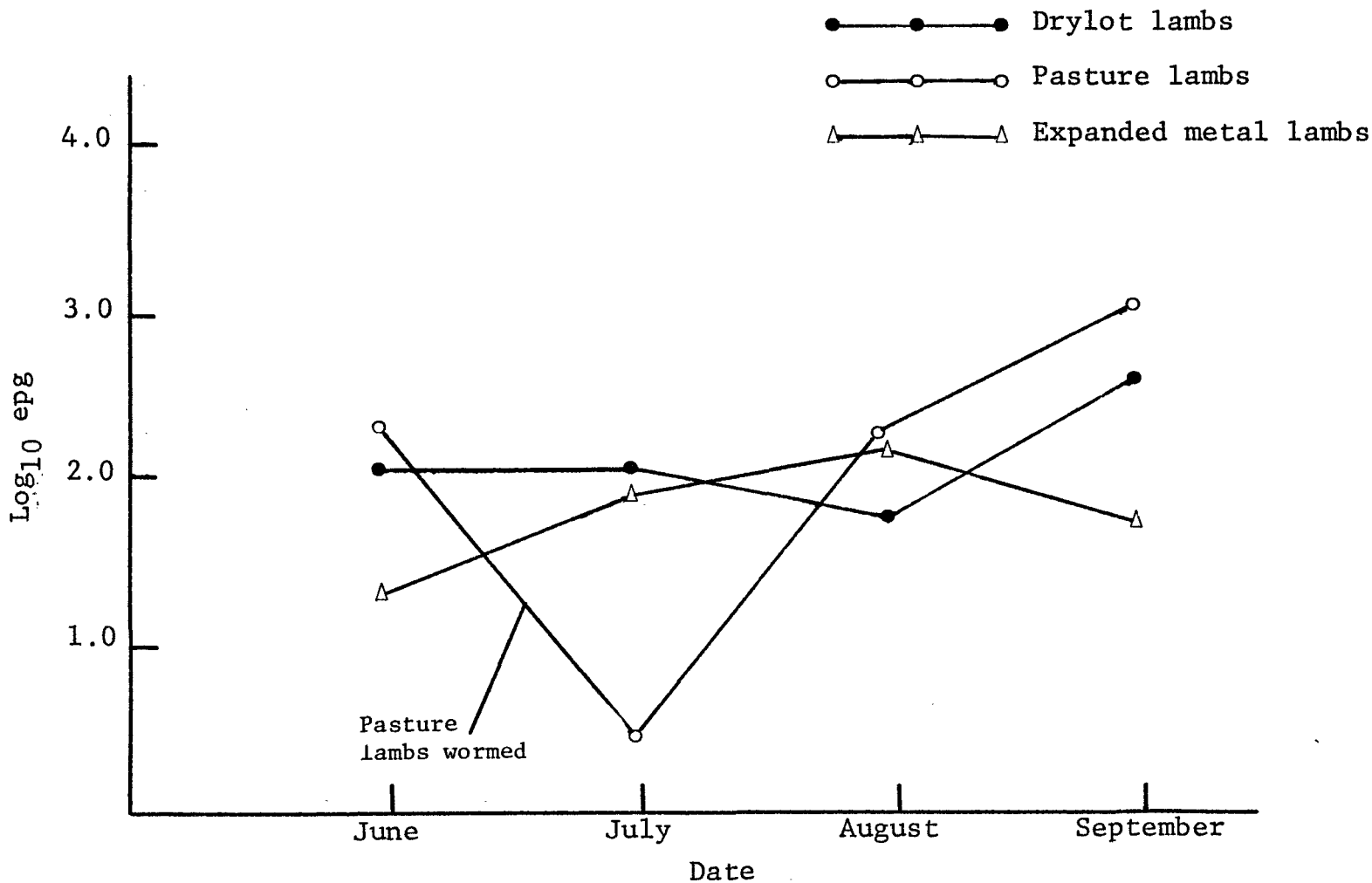

Figure 1. Least squares means, Haemonchus contortus epg, 1977

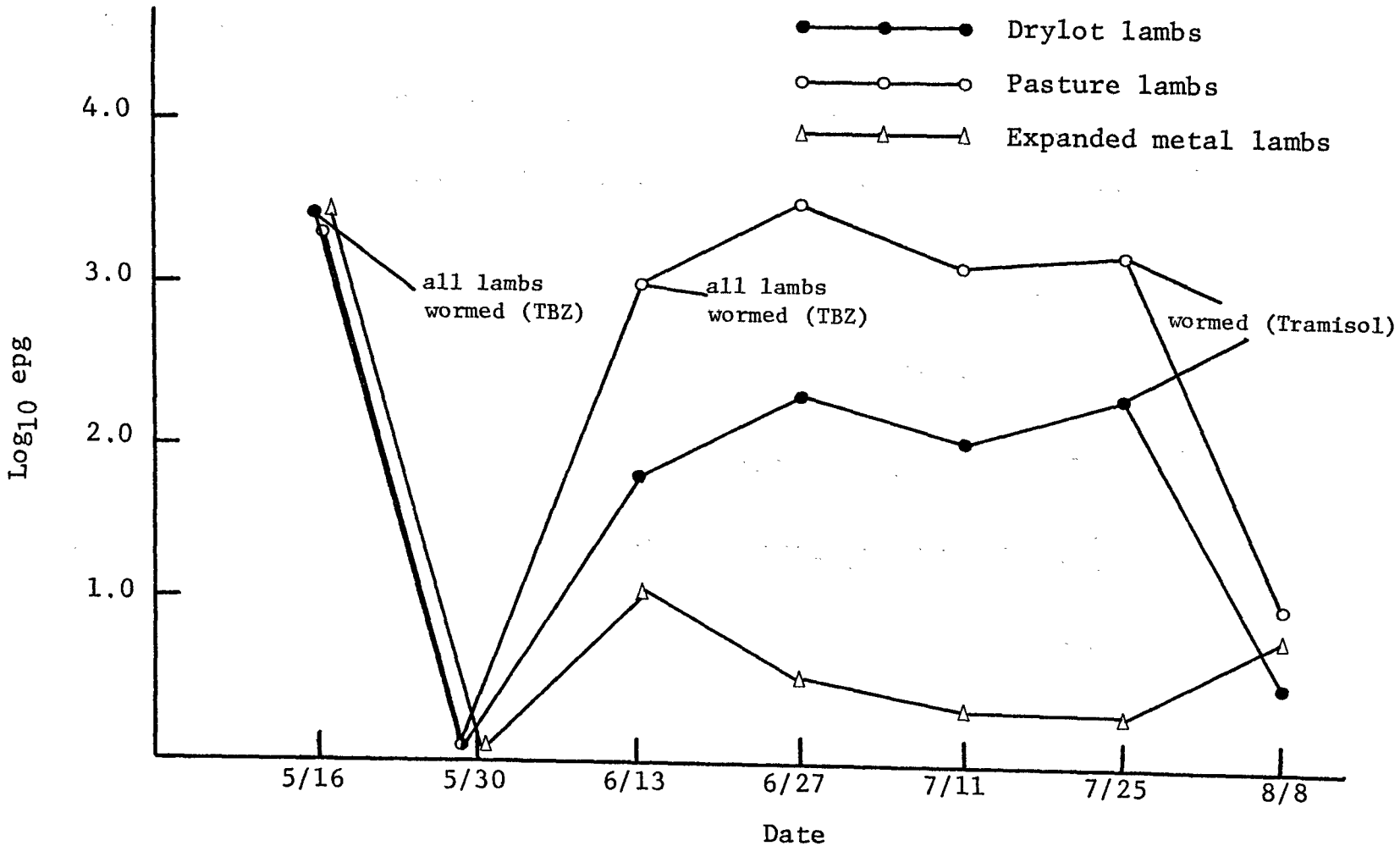

Figure 2. Least squares means, Haemonchus contortus epg, 1978

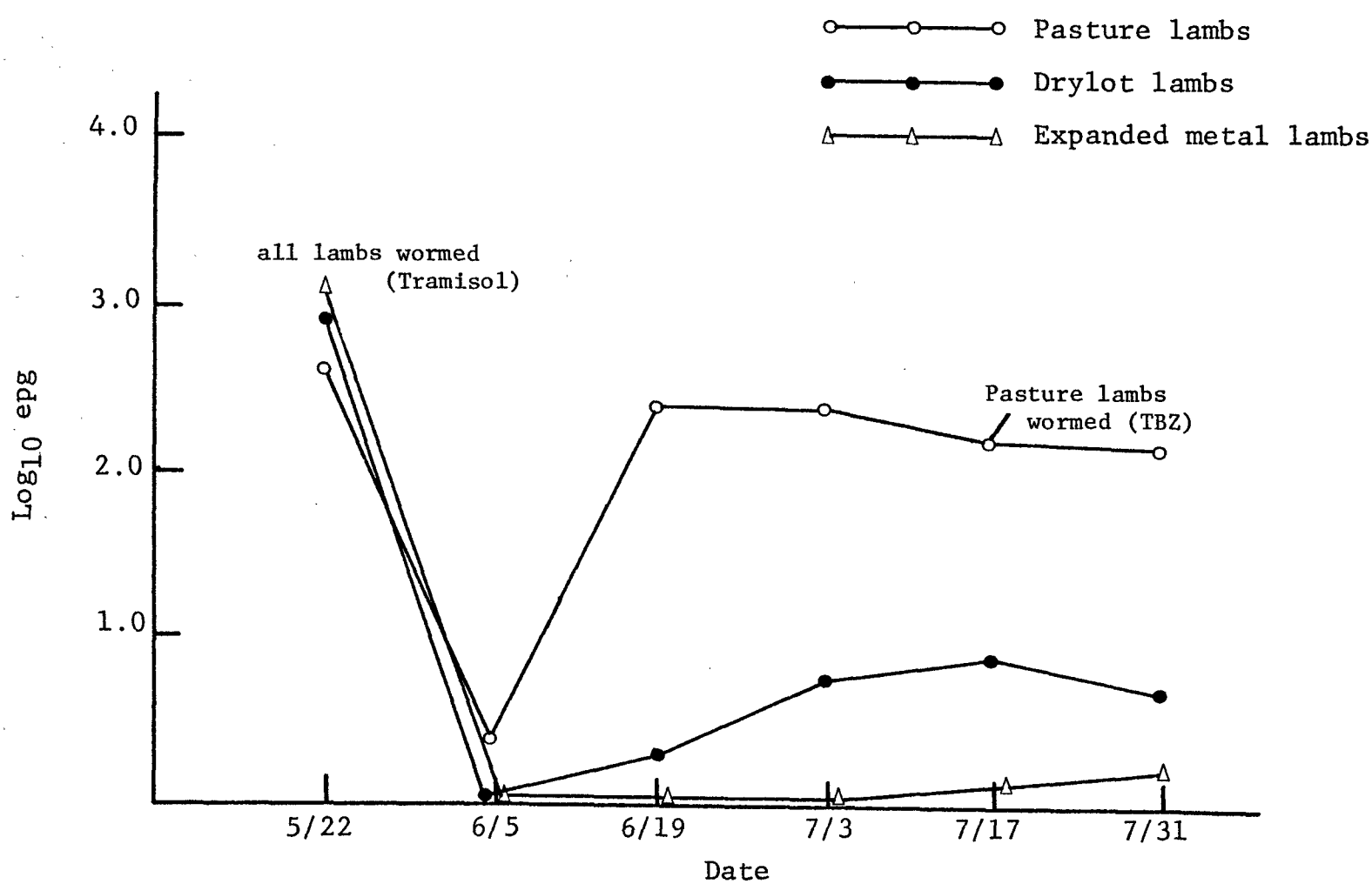

Figure 3. Least squares means, Haemonchus contortus epg, 1979

TABLE 13. ANALYSIS OF VARIANCE FOR LOG_{10} NUMBER OF HAEMONCHUS CONTORTUS PRESENT AT SLAUGHTER

Source	Degrees of freedom	Mean squares, Log_{10} Worms
Treatment	2	166.51**
Year	1	9.87
Treatment X year	2	11.70
Error	18	4.57

**$P < .01$

TABLE 14. EFFECT OF TREATMENT ON LOG_{10} NUMBER OF HAEMONCHUS CONTORTUS PRESENT AT SLAUGHTER

Treatment	N	Mean, worm numbers
Pasture	8	7.25^{a}
Drylot	8	2.81^{b}
Expanded Metal	8	0.98^{b}

^{a,b}Means bearing different superscripts are significantly different ($P < .05$).

TABLE 15. NUMBER OF HAEMONCHUS CONTORTUS RECOVERED FROM LAMBS AT SLAUGHTER

PASTURE

1978		1979	
Lamb number	Worms recovered	Lamb number	Worms recovered
940	105	142	1155
949	1855	278	1715
951	1330	1039	8750
954	4025	1041	4305

DRYLOT

1978		1979	
Lamb number	Worms recovered	Lamb number	Worms recovered
941	182	275	0
948	21	1038	0
950	35	1047	455
957	1925	1056	0

EXPANDED METAL

1978		1979	
Lamb number	Worms recovered	Lamb number	Worms recovered
72	84	94	0
939	0	1046	0
947	0	1050	0
955	0	1052	0

grass in the holding pens and along the sides of the lane. In 1979, the confined lambs were trucked up to the working area and were replaced into the truck immediately after sampling. This operation greatly reduced accidental reinfection. This difference in degree of parasitism in the confined lambs confirms the findings of Kisel et al. (1963) that anthelminthics alone are not effective in preventing haemonchosis if management techniques are neglected.

Several of the lambs slaughtered were negative for Haemonchus eggs prior to slaughter, but worms were found in the abomasal contents. This indicates that fecal egg counts cannot be used as an accurate estimator of the actual worm burden in the living animal.

Coccidial oocysts were always present in the fecal samples, presumably at a subclinical level, since clinical signs of coccidiosis were not observed. This is in agreement with work by Lindahl et al. (1963), Mansfield et al. (1967) and Colglazier et al. (1968) who reported that coccidial oocysts were continuously present in lamb feces, but that coccidiosis was rarely a problem. The tapeworm Moniezia expansa and whipworm Trichuris ovis were sporadically present in some lambs at some times. These parasites usually have no deleterious effects on sheep (Soulsby, 1965) and the anthelminthics employed in this study had no effect on them.

The average blood values are shown in tables 16, 17 and 18. The average normal values reported by Frandson (1974)

TABLE 16. TREATMENT EFFECT ON AVERAGE PACKED CELL VOLUME OF LAMBS

	MANAGEMENT SYSTEM					
	Pasture		Drylot		Expanded metal	
Date	PCV, %	Range	PCV, %	Range	PCV, %	Range
1978						
May	28.1	(17-38)	24.1	(18-33)	24.1	(13-37)
June	28.3	(24-32)	30.8	(23-35)	33.6	(28-41)
July	26.0	(14-32)	29.9	(24-37)	32.1	(27-41)
August	32.2	(28-37)	29.6	(27-35)	31.5	(27-39)
1979						
May	32.5	(23-40)	26.3	(17-36)	24.5	(12-37)
June	32.1	(27-36)	32.9	(30-38)	32.9	(29-37)
July	33.7	(29-37)	34.7	(30-41)	35.1	(30-41)

TABLE 17. TREATMENT EFFECT ON AVERAGE PERCENT HEMOGLOBIN OF LAMBS

	MANAGEMENT SYSTEM					
	Pasture		Drylot		Expanded metal	
Date	Hb, %	Range	Hb, %	Range	Hb, %	Range
1978						
May	9.46	(5.4-11.9)	8.26	(5.8-11.5)	8.03	(4.0-11.7)
June	10.00	(8.6-11.6)	10.89	(7.8-12.6)	12.00	(9.9-14.5)
July	8.91	(4.7-10.9)	10.56	(8.6-12.1)	11.40	(9.8-14.3)
August	11.46	(10.4-12.9)	10.84	(9.9-12.5)	11.56	(9.5-15.0)
1979						
May	11.40	(8.2-14.1)	9.04	(5.3-12.7)	8.35	(4.4-12.7)
June	11.21	(9.6-12.3)	11.31	(10.1-13.3)	11.48	(9.5-13.1)
July	11.76	(10.3-13.2)	12.28	(10.9-14.5)	12.42	(10.5-14.8)

TABLE 18. TREATMENT EFFECT ON AVERAGE ERYTHROCYTE COUNT OF LAMBS

Date	MANAGEMENT SYSTEM					
	Pasture		Drylot		Expanded metal	
	RBC X 10^6	Range	RBC X 10^6	Range	RBC X 10^6	Range
1978						
May	8.9	(6.0-12.1)	7.8	(4.8-10.2)	7.5	(3.8-10.5)
June	9.9	(7.7-12.3)	11.3	(9.8-13.4)	12.3	(10.3-13.7)
July	8.7	(4.4-11.5)	11.2	(8.6-13.1)	12.0	(10.1-13.1)
August	11.2	(10.4-12.8)	12.2	(10.2-17.8)	12.4	(9.9-14.5)
1979						
May	10.8	(7.5-14.8)	8.4	(5.4-11.3)	8.3	(4.2-12.3)
June	11.1	(9.0-12.5)	10.9	(9.1-13.9)	11.5	(9.6-13.3)
July	11.0	(9.0-14.1)	10.1	(8.0-12.6)	11.4	(9.4-13.9)

are 32% packed cell volume, 11% hemoglobin and 11 X 10^6 erythrocytes per milliliter. The three parameters measured exhibited approximately the same pattern and only PCV will be discussed.

None of the lambs developed a fatal anemia; although PCV dropped below 20% for some individual lambs in the pasture group in 1978, the drop was not prolonged. Lindahl et al. (1963) and Colglazier et al. (1968) have reported that the average PCV of lambs kept in drylot remained above 30% and that the PCV of lambs grazing on contaminated pastures fell to 19% (Lindahl et al., 1963). Packed cell volume sharply increased for confined lambs after worming (figures 4 and 5). The average PCV of the confined lambs continued to rise over the trial period in 1979. In 1978, the average PCV did not increase for these lambs as it had in 1979; it began to fall over the second half of the trial period in spite of the subsequent use of anthelminthics. These results were probably due to the difference in handling the lambs at the sampling times as discussed above.

The average PCV of the pastured lambs varied more than that of the confined lambs since the pastured lambs had heavier infections of Haemonchus and were wormed more frequently than the confined lambs.

There was a negative correlation ($P < .01$) between H. contortus fecal egg count and PCV ($r = -.60$). This was less pronounced ($P < .01$) in wether lambs ($r = -.57$)

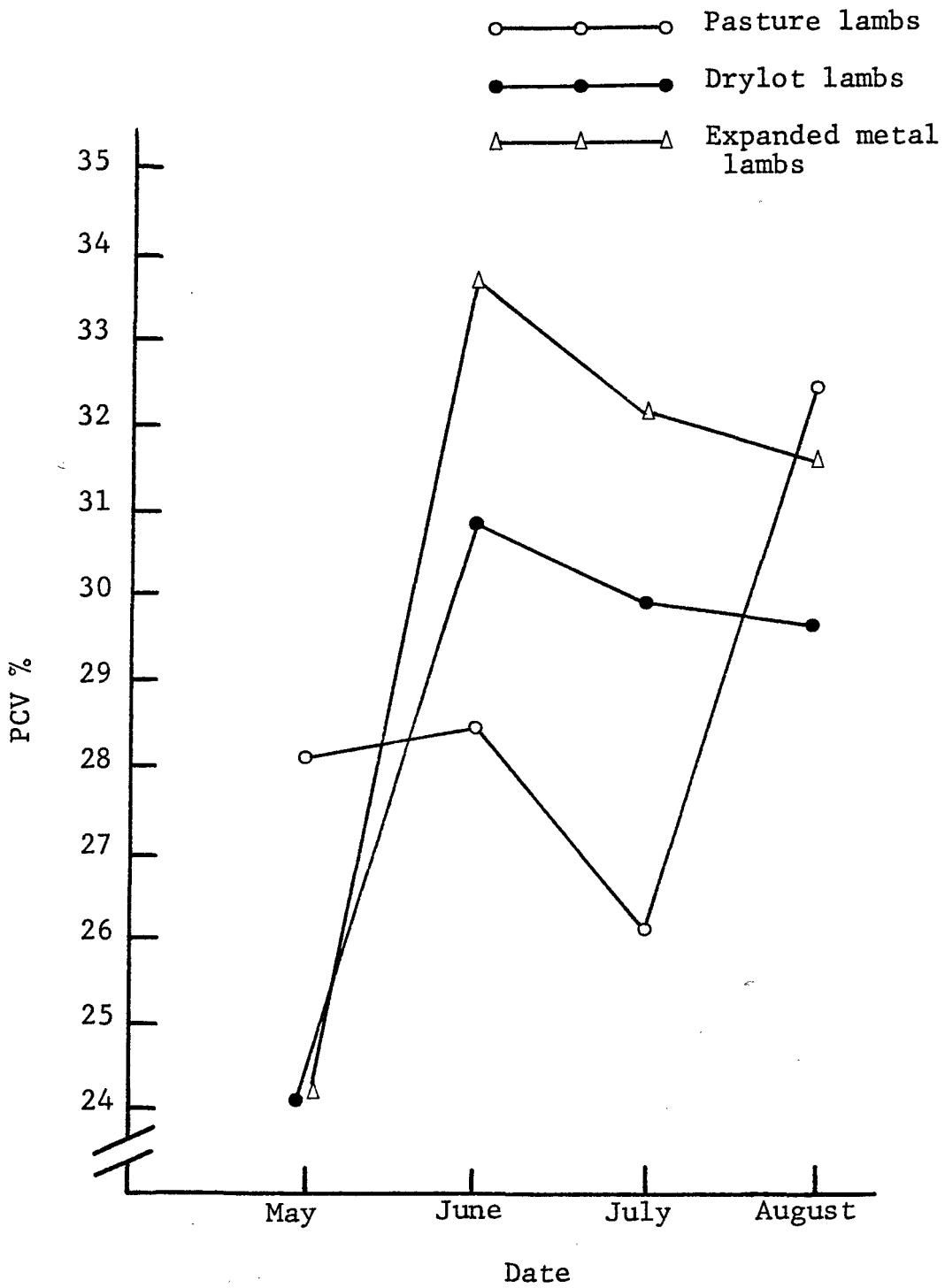

Figure 4. Average packed cell volume of lambs, 1978

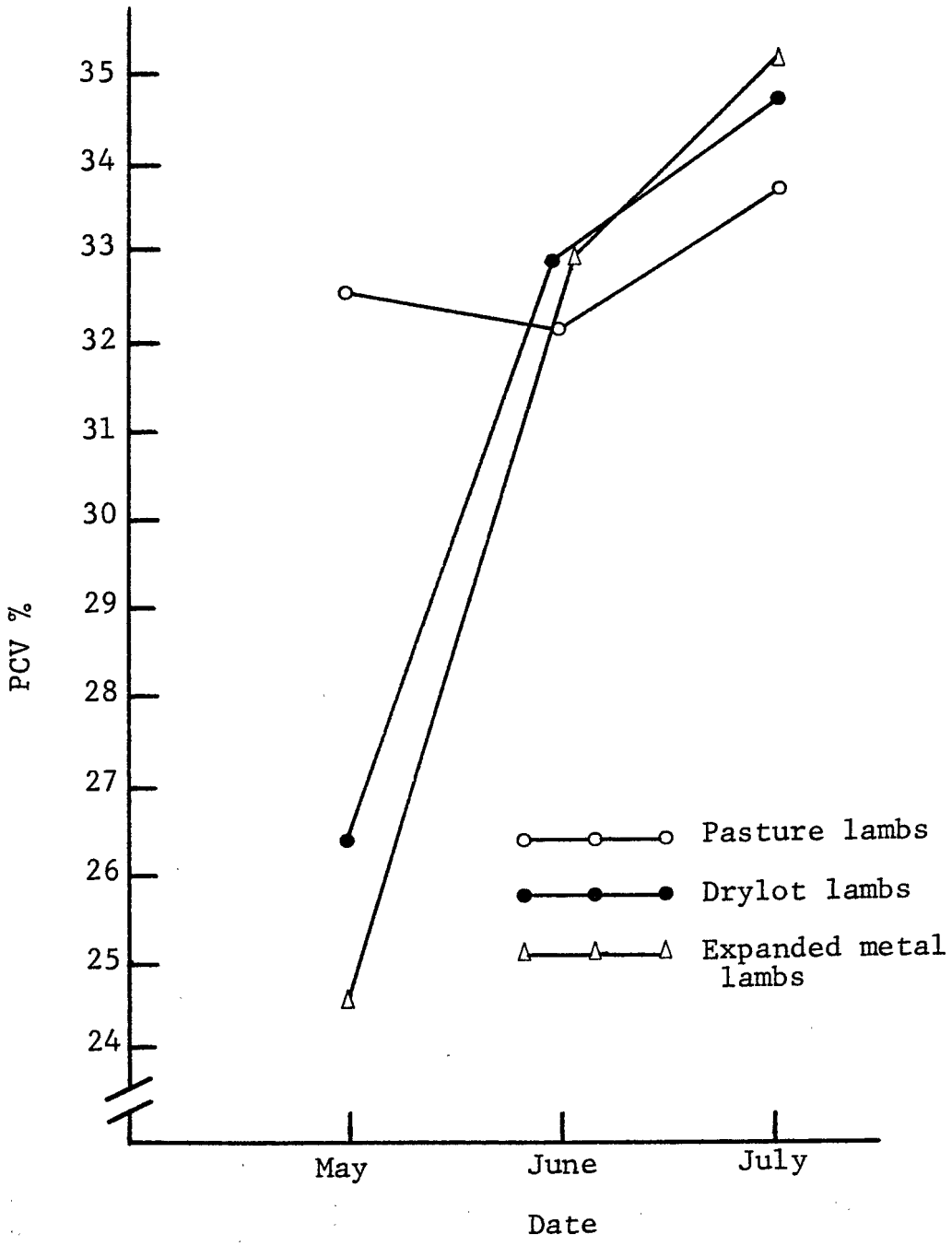

Figure 5. Average packed cell volume of lambs, 1979

than in ewe lambs ($r = -.63$). This is in contrast to Colglazier et al. (1968) who found that male lambs were more susceptible to haemonchosis than female lambs.

The correlation between fecal egg count and PCV was most pronounced in the lambs on the expanded metal floor ($r = -.73$, $P < .01$) and least pronounced in the pastured lambs ($r = -.50$, $P < .01$), for the lambs in drylot, $r = -.55$ ($P < .01$). It appears that the intake of infective Haemonchus larvae has a greater impact on lambs that are worm free or that have only a slight degree of infection than on lambs harboring an established infection. The lambs on pasture acquired and maintained heavier parasitic infections than the confined lambs and may either have developed some degree of immunity to further infection or have undergone a self-cure reaction (Stewart, 1950; Soulsby and Stewart, 1960; Malczewski, 1971). This self-cure reaction evidently occurs when an animal that is already carrying an infection of Haemonchus receives a dose of infective larvae. The major part of the existing infection may be eliminated or the egg production of the existing worms may be suppressed (Stewart, 1950). Soulsby and Stewart (1960) reported, "the self-cure reaction is initiated by a substance or substances antigenically related to exsheathing fluid, released during the first parasitic molt of larvae in the abomasum." The worm recovery data in conjunction with the fecal egg counts of the sacrificed lambs suggest that suppression of egg output

by the female worms was the more plausible effect.

It may be concluded from this study that confinement management systems result in better lamb performance and lower infection by Haemonchus contortus than do pasture management systems in the Gulf Coast area. Comparison of groups of lambs grazed on clean pasture with access to creep and of lambs grazed on clean pasture alone to the pastured lambs in this study would be helpful in determining the comparative value of the pasture management situation. These comparisons would be helpful in determining the actual value of the summer pasture since the pastured lambs in this study did not consume enough forage to maintain themselves or to gain weight.

The confinement systems were both effective in maintaining the lambs free of Haemonchus; even though the lambs on pasture were routinely wormed, they acquired infections sufficient to adversely affect their performance.

SUMMARY

One hundred fifty-six lambs were studied over a three year period to determine the effects of internal parasitism by Haemonchus contortus and of three management systems on lamb performance in the Gulf Coast area. The lambs were weaned at an average age of 60 days and were randomly allotted in a manner to balance weight, sex and breeding to one of the three management systems. Group one was placed on a summer pasture of common bermudagrass and had access to a creep ration. Group two was self fed on a concrete slab drylot. Group three was self fed in an elevated expanded metal floored pen. The lambs were weighed every four weeks for 21 weeks. Fecal samples for worm egg counts were collected biweekly and blood samples were collected at the weighing dates.

Lambs fed in drylot gained faster ($P < .05$) than either of the other two groups, and the lambs on the expanded metal gained faster ($P < .05$) than those on pasture. Wethers gained faster ($P < .05$) than ewes. The confined lambs had lower fecal egg counts for H. contortus and fewer ($P < .05$) worms at slaughter. There was a negative correlation ($P < .01$) between average epg and average PCV in all treatment groups. The overall mortality rate was 9.0%

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VITA

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EXAMINATION AND THESIS REPORT

Candidate: Annabel Louise Kellam

Major Field: Animal Science

Title of Thesis: EFFECT OF MANAGEMENT SYSTEMS ON PERFORMANCE AND PARASITE INFECTIONS OF FINISHING LAMBS IN THE GULF COAST AREA

Approved:

F. Glen Hembry
Major Professor and Chairman

James D. Ingraham
Dean of the Graduate School

EXAMINING COMMITTEE:

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Date of Examination:

28 April 1980