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Parasite Control Options for Cattle in Hawaii

Glen K. Fukumoto[1], Burton J. Smith[2], and Michael W. DuPonte[1]
Departments of [1]Human Nutrition, Food and Animal Sciences and [2]Natural Resources and Environmental Management

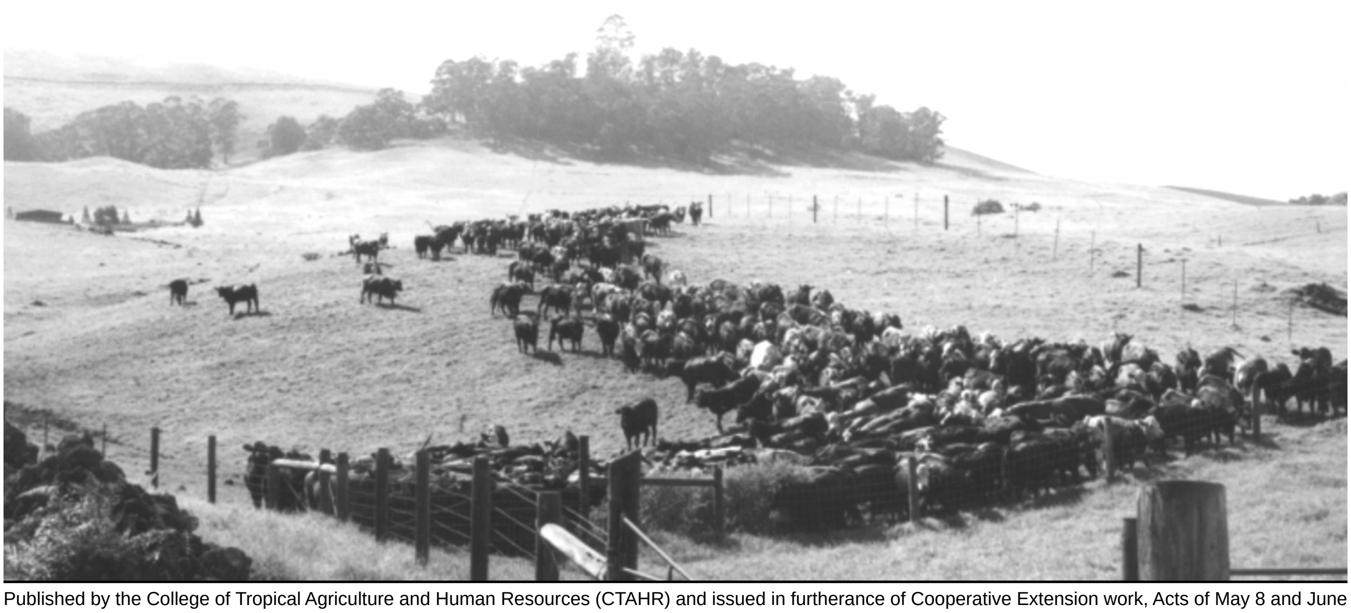
Most cattle harbor internal parasites. Parasitic infections cost the U.S. beef industry more than $3 billion in economic losses due to reduced weight gain and feed conversion and increased stress leading to increased susceptibility to diseases. Parasite populations and levels of infection are influenced by environmental factors and the production and management systems. In Hawaii, the subtropical/tropical environment creates a habitat suitable for the proliferation of these "profit-robbing" internal parasites.

We conducted trials to evaluate new parasite control products and formulations. The trials were carried out at a stocker-to-finish operation located in a humid, lowland ecological zone. The major forage in the intensive grazing management system is California grass (*Brachiaria mutica*).

Trial 1. Evaluation of dewormer application methods

Methods

A deworming trial evaluated three formulations of the avermectin class of parasite-control chemicals, including a sustained-release bolus, subcutaneous injection, and a pour-on application. The animals were weaned, weighed, randomly assigned to one of four groups (including an untreated control), and treated. The animals were weighed 42 and 90 days after the initial treatment. Average daily gain data were analyzed by the ANOVA procedure using the MINITAB, Inc. (1995) program. (Reference: unpublished data 1998, Mealani Research Station.)



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Results and discussion

Table 1 summarizes the animals' weight gain response to the avermectin treatments. Animals receiving the bolus significantly outgained the others. Animals receiving injections had an average daily gain significantly higher than the control animals (no treatment) and those receiving the pour-on formulation. No statistically significant differences were noted between the control and pour-on groups. Figure 1 illustrates the total weight gains of the four treatment groups.

Table 2 summarizes the economic marginal analyses comparing the formulations. The analyses incorporate the differences in product cost and the potential revenue based on the differences in cattle performance. The differences in average daily gain among the treatments were determined (Column A), then multiplied by the duration of the testing period (Column B). The market price was then multiplied by the weight gain differential (Column C). For this example, $0.40/lb was used as the market price. The value of the gains was not adjusted for the sliding scale price. The per-head cost was based on the retail product cost to treat 100 550-lb calves. The cost differential between treatments was calculated (Column D). The comparative difference of total revenue minus the cost difference resulted in the marginal difference (Column E).

In this trial the bolus formulation was the most effective worming medication. It would net the producer $14.50, $11.17, and $6.66 per calf compared to no treatment, pour-on, and injection, respectively. The injectable formulation would net the producer $7.84 and $4.51 per calf compared to no treatment and pour-on, respectively. The pour-on formulation would net the rancher $3.33 more per calf compared to no treatment.

Summary, Trial 1

Deworming enhances performance of stocker calves. The 90-day weight gain data and economic marginal analyses show that the producer's revenue benefits outweighed the cost of the product; in other words, "worming pays." Compared to the average daily gain of untreated calves, growth of calves was about doubled with the pour-on formulation, increased 2½ times with the injected product, and was nearly 5 times greater with

Table 1. Cattle weight gains (lb) and average daily gains (ADG, lb/day) after various deworming treatments.

	No treatment	Bolus	Injection	Pour-on	All treatments
Number of animals	21	23	23	22	89
Initial weight	565.1	568.8	572.1	559.4	566.5
Period 1, 42 days	553.4	578.4	579.3	564.4	569.5
Avg. daily gain (or loss)	–0.28 [a]	0.23 [b]	0.17 [b]	0.14 [a,b]	0.07
Total weight gain	–11.7	9.6	7.2	5.0	3.0
Period 2, 48 days	583.1	653.9	617.6	593.6	612.9
Avg. daily gain	0.62 [a]	1.57 [b]	0.80 [a]	0.59 [a]	0.90
Total weight gain	29.7	75.5	38.3	29.2	43.4
Entire trial, 90 days					
Avg. daily gain	0.20 [a]	0.95 [b]	0.50 [c]	0.38 [a,c]	0.52
Total weight gain	18.0	85.1	45.5	34.2	46.4

Within a row, treatment values followed by different letters are statistically different from each other with a high level (P < 0.001) of significance (see p. 7).

the bolus. Extrapolating these gains to dollars for a lot of 100 calves, the difference in value of these treated calves would be $333.00, $784.00, and $1,450.00.

The producer's choice of formulation depends on the type of operation and the facilities. The bolus is best used for lightweight cattle—it is long lasting but requires a handling facility to administer it. The injectable form is the most economical on a per-head basis, but it also requires handling facilities and equipment. The pour-on formulation requires no restraining and is easy to use, but there is a slight cost to this convenience.

In forage-based beef production systems, timely treatment is a very important factor in reducing parasite populations. Treatment programs will vary in their effects due to seasonal changes, other environmental conditions, and the animals' stage of growth. Consult a veterinarian in developing the most appropriate program for your herd.

Figure 1. Total gains over a 90-day period with various deworming treatments.

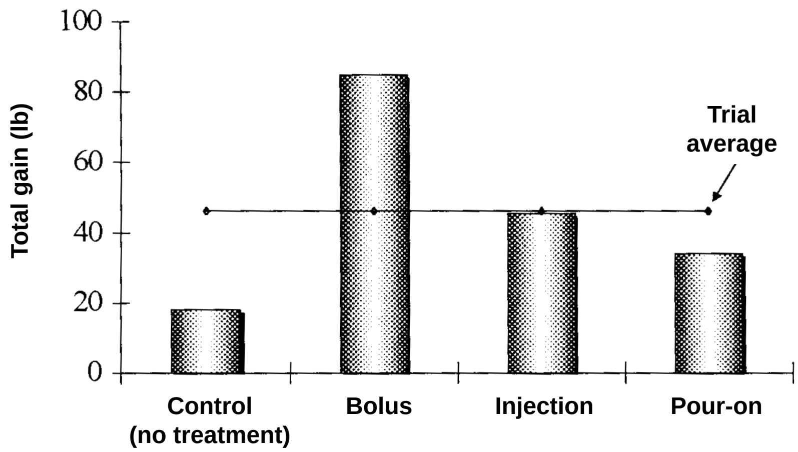


Table 2. Economic marginal analysis of dewormer application methods.

	A Avg. daily gain difference (lb)	B 90-day gain advantage (lb)	C Market price scenarios ($/lb) at various prices			D Cost difference ($/calf)	E Marginal difference[z] ($/calf)
			0.40[z]	0.45	0.50		
Control vs. bolus	0.75	67.5	27.00	30.38	33.75	12.50	14.50
Control vs. injection	0.30	27.0	10.80	12.15	13.50	2.96	7.84
Control vs. pour-on	0.18	16.2	6.48	7.29	8.10	3.15	3.33
Bolus vs. pour-on	0.57	51.3	20.52	23.08	25.65	9.35	11.17
Bolus vs. injection	0.45	40.5	16.20	18.22	20.25	9.54	6.66
Injection vs. pour-on	0.12	10.8	4.32	4.86	5.40	–0.19	4.51

[z]Marginal difference calculated using $0.40/lb price.

Trial 2. Evaluation of deworming products and application methods

Methods

We conducted a second deworming trial to evaluate different active ingredients in the avermectin/milbemycin class of parasite control chemicals. Animals were randomly assigned to one of four treatment groups, weighed, and treated. After 150 days they were weighed and, except for the bolus treatment, re-treated. The final weight was recorded on day 303. The treatment interval was based on the normal pasture rotation cycle and management scheme of the cooperator. Random fecal grab samples taken from approximately half of the animals in each treatment group were collected on day 1, 150, and 303 of the trial. Average daily gain data were analyzed by the ANOVA procedure using the MINITAB, Inc. (1995) program.

Results and discussion

Animal weight gains and counts of parasite eggs in their feces are shown in Table 3. During the first 150 days of the trial, calves receiving a bolus significantly ($P < 0.01$) outgained cattle that got the pour-on formulation; no differences were detected among the other treatments. Over the next 153 days, however, the animals receiving the pour-on treatment had significantly better gains ($P < 0.05$), likely because they received a follow-up treatment at day 150, whereas the animals receiving the bolus did not. The diminishing effectiveness of the bolus over time (135-day delivery period) obviously led to the lowered gains. Marked compensatory gains were noted during the second half of the trial in animals receiving injections and pour-on products, possibly as a result of response to the accumulating treatments. Over the entire 303-day trial, all treatment groups had statistically similar gains. Figure 2 (page 6) illustrates the total gains obtained during the two treatment periods.

Tables 4, 5, and 6 summarize the economic marginal analyses among the treatment groups for each period and the total trial period. The method used to calculate the values is similar to Trial 1. However, the per-head product cost was based on the retail product cost to treat 100 450-lb calves. The marginal analysis compares the economic factors of product cost and cattle performance based revenue between pairs of treatments.

During the first 150 days of the trial (Table 4), worming with the bolus product brought a greater return than the other treatments tested, with a marginal difference ranging from $6.09 to $15.85 per calf. The bolus for-

Table 3. Cattle weight gains, average daily gains (ADG), and parasite egg counts after various deworming treatments.

	Active ingredient and application method				
	Ivermectin Injected	Ivermectin Bolus	Eprinomectin Pour-on	Moxidectin Pour-on	All treatments
Number of animals	15	15	15	16	61
Heifers / Steers	6/9	7/8	6/9	7/9	26/35
Initial weight (lb)	433.7	423.8	417.9	420.4	423.9
Initial parasite count (eggs/g)	88	75	0	38	49
Period 1 weight (lb)	513.6	546.6	482.7	509.6	513.1
Parasite count (eggs/g)	47	8	14	5	18
ADG (lb), 150 days	0.52 [a,b]	0.82 [b]	0.43 [a]	0.59 [a,b]	0.59
Gain (lb)	79.9	122.8	64.8	89.2	89.2
Period 2 weight (lb)	715.1	715.5	700.3	719.8	712.8
Parasite count (eggs/g)	0	0	0	0	0
ADG (lb), 153 days	1.32 [a,b]	1.10 [b]	1.42 [a]	1.37 [a,b]	1.31
Gain (lb)	201.5	168.9	217.6	210.2	199.7
Test ADG (lb), 303 days	0.93	0.96	0.93	0.99	0.95
Total gain (lb)	281.4	291.7	282.4	299.4	288.9

Within a row, treatment values followed by different letters are statistically different from each other with signifance of ($P < 0.01$) for Period 1 and ($P < 0.05$ for Period 2 (see p. 7).

Table 4. Economic marginal analysis comparing deworming treatments[z] during the first half of the trial.

	A Avg. daily gain difference (lb)	B 90-day gain advantage (lb)	C Market price scenarios ($/lb) at various prices 0.30	 0.40[y]	 0.50	D Cost difference ($/calf)	E Marginal difference[y] ($/calf)
Bolus (I) vs. pour-on (E)	0.39	58.5	17.55	23.40	29.25	7.99	15.85
Bolus (I) vs. injection (I)	0.30	45.0	13.50	18.00	22.50	8.43	9.57
Bolus (I) vs. pour-on (M)	0.23	34.5	10.35	13.80	17.25	7.71	6.09
Pour-on (M) vs. pour-on (E)	0.16	24.0	7.20	9.60	12.00	0.28	9.32
Pour-on (M) vs. injection (I)	0.07	10.5	3.15	4.20	5.25	0.72	3.48
Injection (I) vs. pour-on (E)	0.09	13.5	4.05	5.40	6.75	–0.44	5.84

[z] I = Ivermectin, E = Eprinomectin, M = Moxidectin; [y] Marginal difference calculated using $0.40/lb price.

Table 5. Economic marginal analysis comparing deworming treatments[z] during the second half of the trial.

	A Avg. daily gain difference (lb)	B 90-day gain advantage (lb)	C Market price scenarios ($/lb) at various prices 0.30	 0.40[y]	 0.50	D Cost difference ($/calf)	E Marginal difference[y] ($/calf)
Pour-on (E) vs. bolus (I)	0.32	48.96	14.69	19.58	24.48	3.00	16.58
Pour-on (E) vs. injection (I)	0.10	15.30	4.59	6.12	7.65	0.05	6.07
Pour-on (E) vs. pour-on (M)	0.05	7.65	2.30	3.06	3.83	0.15	2.91
Pour-on (M) vs. bolus (I)	0.27	41.31	12.39	16.52	20.66	2.85	13.67
Pour-on (M) vs. injection (I)	0.05	7.65	2.30	3.06	3.83	–0.10	3.16
Injection (I) vs. bolus (I)	0.22	33.66	10.10	13.46	16.83	2.95	10.51

[z] I = Ivermectin, E = Eprinomectin, M = Moxidectin; [y] Marginal difference calculated using $0.40/lb price.

Table 6. Economic marginal analysis comparing deworming treatments[z] during the entire trial period.

	A Avg. daily gain difference (lb)	B 90-day gain advantage (lb)	C Market price scenarios ($/lb) at various prices 0.30	 0.40[y]	 0.50	D Cost difference ($/calf)	E Marginal difference[y] ($/calf)
Pour-on (M) vs. bolus (I)	0.03	9.1	2.73	3.64	4.55	–4.86	8.50
Pour-on (M) vs. pour-on (E)	0.06	18.2	5.46	7.28	9.10	–0.13	7.15
Pour-on (M) vs. injection (I)	0.06	18.2	5.46	7.28	9.10	0.62	6.66
Bolus (I) vs. pour-on (E)	0.03	9.1	2.73	3.64	4.55	4.99	–1.35
Bolus (I) vs. injection (I)	0.03	9.1	2.73	3.64	4.55	5.48	–1.84
Injection (I) vs. pour-on (E)	0.00	0.0	0.00	0.00	0.00	–0.49	0.49

[z] I = Ivermectin, E = Eprinomectin, M = Moxidectin; [y] Marginal difference calculated using $0.40/lb price.

mulation, although the most expensive single-dose treatment, improved the weight gain of these lightweight calves enough to pay for itself. The economic marginal analysis shows the advantages of the other treatments were Moxidectin pour-on > Invermectin injection > Eprinomectin pour-on

During the second half of the trial (Table 5), the diminishing effectiveness of the bolus was evident, and this treatment had both the poorest weight gain and economic value. The pour-on treatment with Eprinomectrin resulted in the best economic return, possibly due to compensatory gains resulting from adjustment following the initial period. The marginal difference advantage ranged from \$2.91 to \$16.58 per calf. Moxidectin poured on provided consistently better return than Ivermectin injected during this period. By the end of the trial, no parasite eggs were observed among the treatment groups.

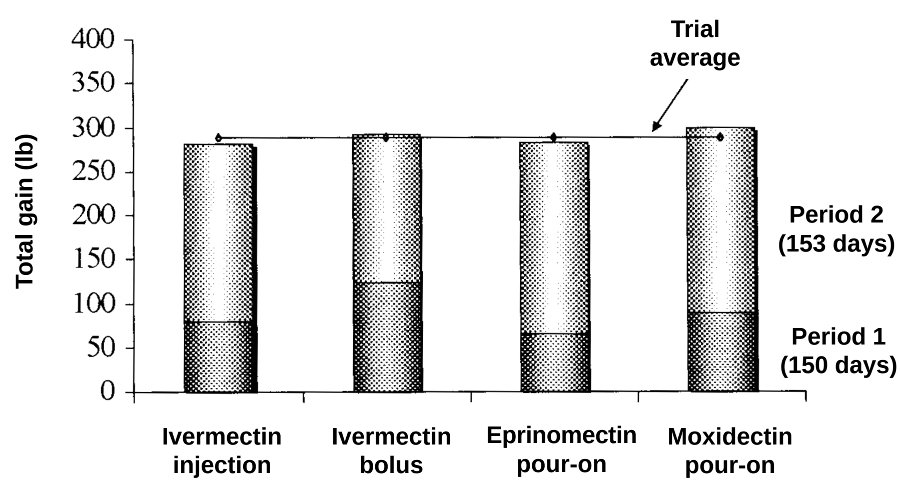
Table 6 summarizes the economic marginal analyses of both periods of the trial. For the 303-day trial period there were no statistically significant differences among the four treatments; animals receiving all treatments grew similarly. Although there were no significant differences in average daily gain, we suggest that based on consideration of product cost and cattle growth results, and when applied as was done in our trial, pour-on treatment with Moxidectin would result in the best economic outcome, followed by injection of Ivermectin, pour-on of Eprinomectin, and bolus application of Ivermectin.

Summary, Trial 2

The products tested in Trial 2 performed equally. The bottom line is the effective per-head cost of the product; lower cost results in higher marginal return to the producer.

Under low to moderate parasite loads, greater than 30 to less than 100 egg counts per gram, treatment for the suppression and control of parasitic infection in cattle is an important production and management consideration. Timing the treatment intervals correctly is critical in optimizing the efficacy of the worming medication. Follow the manufacturer's label recommendations for treatment intervals. Many veterinarians recommend rotating among worming medications with different active ingredients to reduce the chance of building resistance in the parasite populations. Talk to your veterinarian about these decisions.

Figure 2. Total gains over a 303-day period with various deworming treatments.



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Interpreting statistics

The data presented in Tables 1 and 3 are means or averages of the treatment groups. For the average daily gain treatment comparisons, the data were analyzed statistically with a procedure called analysis of variance (ANOVA), and those data are accompanied by statements of probability that the treatment means differ. Such statements look like ($P < 0.05$), ($P < 0.01$), or ($P < 0.001$) and mean that the probability (P) that any two treatment means differ entirely due to chance is less than 5, 1, or 0.1 percent, respectively. Using the example of $P < 0.05$, there is less than a 5% chance that the differences between the two treatment averages are really the same. Statistical differences among means are indicated in the tables by means of superscript letters. Treatments with the same letter are not statistically different, while treatments with no common letters are.