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DETERMINATION OF THE ECONOMIC THRESHOLD

FOR CONTROL OF HORN FLIES ON BEEF CATTLE:

A WHOLE FARM APPROACH+

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ABSTRACT

Horn fly attacks on beef cattle result in reduced gains on pasture. A whole farm approach was used to determine the economic threshold of horn fly control under various prices of output and costs of control. Six control strategies were evaluated; complete control (4 spray applications) had highest returns but may not be optimal for all farms.

Horn Flies (Haematobia irritans (L)) inflict an enormous damage on beef production in North America. The U.S. Department of Agriculture has estimated that annual losses to the U.S. beef industry from horn fly infestation amount to at least $300 million (at mid 1970 price levels). Comparable estimates of losses to the Canadian beef industry have not been made; however, Skaptason estimated that total losses to the beef and dairy industries in late 1940's Canada were in the order of $60 million.

Production losses from horn fly attacks are manifested in at least 3 areas: (1) reduced weight gains among growing animals on pasture, (2) reduced milk production, and (3) reduction in reproductive efficiency. Khan and Haufe have estimated that yearling heifers on irrigated pasture in southern Alberta suffer reductions in their potential weight gains of 18-45 percent, depending on the level of horn fly infestation during the horn fly season. Unfortunately, no reliable estimates have been reported of the beef production losses resulting from diminished milk production and reduced reproductive performance.

The pest was christened a "horn fly" due to its characteristic habit of resting on the horns of cattle. It remains on or near the host animal during the night as well as the day. Both sexes of the horn fly suck blood from the host animal. Feeding takes place several times a day; an average meal consists of 1.71 mg. of blood (McLintock and Depner).

Horn fly abundance during the fly season (early June to late September) is affected by climatic conditions. Hot, dry weather favors the build-up of fly numbers in August and September; this is the very condition and time usually associated with pasture deterioration. A number of secondary factors such as area of pasture per animal, tolerance of the host to parasite attack, and social rank of the host animal in the herd, can affect the abundance of horn flies on a host animal (W. Haufe, animal parasitologist, Agriculture Canada Research Station, Lethbridge, Alberta, personal communications).

The objective of this study is to determine the economic threshold for horn fly control under various economic conditions. The economic threshold is defined as that level of infestation where the marginal cost of control just equals the marginal returns from control (Headley). The economic threshold for control is expected to shift in the direction of fewer flies with higher beef prices, lower costs of control, and higher rates of kill, cateris paribus.

This study was limited to losses inflicted on growing animals on pasture due to the lack of reliable data available on other types of losses.

The proportion of yearling cattle placed on pasture during any summer is dependent on prevailing and expected economic conditions as well as on the inventory and condition of the pasture resource. This proportion has ranged from 25-75 percent in Alberta in recent years (C. Sterling, statistician, Alberta Agriculture, Edmonton, Alberta, personal communication).

It was decided to use a whole farm approach (as opposed to simply equating marginal costs with marginal returns from control) for determining the economic threshold because:

1) other parts of the farm business can affect the price and availability of capital and labor required for control,
2) it keeps in perspective the magnitude of the problem and
3) continuous functions relating costs and returns of control are rather meaningless to cattle producers who must make decisions on a discrete basis, i.e., they must either kill all or most of the flies at a particular time or kill none.

A cattle producer has several options for control of horn flies, each having different labor and cost requirements, each having different efficacy. In this study, 6 methods were considered:

1) spray insecticide 4 times (assures complete control throughout the season),
2) spray insecticide twice, mid-June and mid-July,
3) spray insecticide twice, mid-June and beginning of August,

4) spray insecticide twice, beginning and mid-August,

5) spray insecticide once, mid-June, and

6) spray insecticide once, mid-July.

The recovery rate of horn flies after a spray treatment is assumed to be (M. Khan, animal parasitologist, Agriculture Canada Research Station, Lethbridge, Alberta, personal communication):

1) 100 percent control for first 2 weeks,

2) 80 percent control for next 2 weeks,

3) 40 percent control for next 2 weeks, and

4) no control after 6 weeks.

A representative farm from the dark brown soil zone of southern Alberta was chosen for the analysis (Sorboe). This farm consisted of 33 cows (and a standard complement of other ages of cattle), 455 acres of cropland, 329 acres of native pasture, and 70 acres of tame grass. It had a full complement of machines and buildings that would be required to operate the farm. Total beginning assets of the farm were $451,000; total beginning debts were $70,000 (as estimated by Agriculture Canada). The cattle enterprise was a cow-long yearling-feedlot type, i.e., placed in a stocker program for the winter, kept on pasture the next summer, then placed in the feedlot for finishing.

A farm level simulation model of beef, forage, and grain enterprises (Sonntag and Klein) was used to analyze the representative farm under the test conditions. Operating procedures of the farm (e.g., rotation, machine replacement policy, grazing strategies) were selected to be in line with standard procedures in the area. They were held constant for all tests in order to perform a comparative statics analysis.

It was decided to analyze the representative farm under conditions of low, moderate, and high horn fly infestation rates. The economic threshold for control could then be determined under various beef and feed grain prices.

Two key relationships had to be estimated to determine the impact of horn flies on the representative farm:

1) the impact of climatic factors on the abundance of horn fly numbers throughout the pasture season, and

2) the impact of horn fly numbers on weight gains by growing animals on pasture.

Horn fly abundance was estimated as a function of temperature in degrees Celsius (Temp), rainfall in millimeters (Rain), mixing ratio (Mixr -see Penman), and a binary irrigation variable (Irr) where 1=irrigation and 0=no irrigation. Data were obtained from the Lethbridge Alberta Research Station and from the Lethbridge weather station.

The regression results for each of 6 years of data are presented in Table 1. The equations provide, on the whole, satisfactory predictive capabilities. Many individual coefficients lacked statistical significance due to inter-correlation among the temperature, rainfall, and mixing ratio variables; however, exclusion of any one of these variables severely hampered the predictive powers of the equations. In any case, the model was meant to be predictive in nature, as opposed to explanatory.

The effect of horn flies on weight gains of heifers on pasture was estimated as a quadratic function of number of flies per animal (FLY), time (T), as measured by Julian days, where the onset of horn fly infestation is T=155, the cross-product and squared terms of these variables, and two binary variables to represent control of the pest (D1=1 for control, D1=0 for no control) and pasture quality (D2=1 for good or excellent quality, D2=0 for less than good quality). Unpublished data collected from 40 heifers per year for 6 years at the Lethbridge Research Station were used to estimate this relationship:

$$\text{Gain}_t = 51.62 - .212\ \text{FLY}_t^{**} - .316T_t^{**} + .00113\ \text{FLY}_t{*}T_t^{**} + .000516T_t^{2*}$$
$$+ .0000694\ \text{FLY}_t^{2**} + 3.29\ \text{D1}_t^{**} + 3.33\ \text{D2}_t^{**},\ R^2 = .05$$

(** is significant at .05 level; * is significant at .10 level)

To conform with the simulation model, each time period represented 14 days. The fly variable represented the average number of horn flies per animal over the 2-week period. The impact of the above variables on growth rates of steers was assumed to be the same as that for heifers except that they were adjusted upwards by 17 percent to conform with other unpublished research on comparative growth rates of males and females.

Data on fixed and variable costs, labor requirements, and efficacy of spraying insecticides were obtained from various government, industrial and on-farm sources. The spray machinery was estimated to have a fixed cost of $75 per year and variable costs of $.058 per head per use. Labor requirement for spraying was estimated at 0.1 hour per head per spray application.

Each of the horn fly control strategies was evaluated under conditions of low, moderate, and high levels of horn fly infestations, as derived from the equations in Table 1. The low level of infestation had a peak number of 173 horn flies per animal; the moderate level had a peak horn fly count of 231 per animal; the highest level of infestation had a peak count of 431 horn flies per animal.

The economic threshold for horn fly control was determined for the 9 combinations of low, medium, and high cattle prices, and low, medium, and high barley prices (see Table 2). Barley prices were used as a proxy for prices of all grain output. The price of barley was allowed to vary to test whether changes in grain enterprise would affect the optimal horn fly control strategy.

All analyses were done over a 5 year period (not including an initial start-up year for the model) to decrease the probability of an aberration due to the model or the farm that was evaluated.

Results

The expected losses in net farm income from no control are shown in Table 3. These losses would reduce 5 year average net farm incomes of \$-444 at low beef prices, \$4517 at medium beef prices, and \$16782 at high beef prices. As expected, the losses are higher for heavier rates of infestation. However, the differential losses between low and high levels of infestation are much greater at high beef prices (\$230) than at low beef prices (\$120).

The effects on net farm income of each of the horn fly control strategies under the 3 levels of infestation are shown in Table 4. The spray -4 times option is optimal under all conditions tested. However, the gains in net farm income from following this strategy are almost negligible under conditions of low beef prices and low or moderate levels of horn fly infestation.

Spraying 4 times during the pasture season may not be a feasible strategy for all cattle producers, especially those who would be fixed with a large job of "rounding-up" cattle. The one-spray (mid-June) or two-spray (mid-June and first of August) options would be profitable with high beef prices, but particularly so if combined with moderate or high levels of horn fly infestation.

It is not profitable to control horn flies when beef prices are at the low levels used in this study unless either horn fly infestation is at a high level or the spray -4 times strategy is followed.

About 7 hours of labor per spray application was required for the herd size that was studied. At low prices for this additional labor, the economic threshold moves in the direction of fewer flies, and the multiple spray treatments become comparatively more profitable than the single spray treatments. The opportunity cost of this additional labor may be much higher than the \$6/hr. used in Table 4. However, extremely high prices for the additional labor would be required to change the rank of the control strategies studied.

The economic thresholds for horn fly control for the most competitive spray applications under high and low cattle prices are portrayed in Figure 1.

The economic threshold for each control strategy is the point where the associated net farm income just equals the net farm income from the no control strategy, i.e., where they cross the "0" line. Thus, for high cattle prices, the economic thresholds for spraying 4,2, and 1 times are peak horn fly numbers of approximately 35,80, and 95, respectively. For low cattle prices, the economic thresholds are at 160, 250, and 300 flies per animal in the peak horn fly period. By varying the cattle prices, the economic threshold can be determined for any of the control strategies.

The whole farm approach to determining economic thresholds has the advantage that it is easily understandable by farmers. If farmers have some special conditions on their farm, relating to capital or labor availability, the economic threshold can be tailored to their needs. In addition, the whole farm approach provides a comprehensive analysis that obviates the need for decisions about how broadly to define the beef enterprise.

There are several untested conditions that could affect the results of this study: the most obvious is the effect of horn flies on weaning weights of calves. There seems to be general agreement among animal parasitologists (W. Haufe, personal communication) that weaning weights are affected; however, in the absence of controlled experiments they are reluctant to estimate the magnitude of the effects. The direction is clear, though: any impact on weaning weights would move the economic threshold in the direction of fewer flies.

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Table 1: Prediction Equations for Average Number of Horn Flies (Log_e) Per Animal Per Week

		Estimated Coefficients				
Year	Intercept	Temp	Rain	Mixr	Irr	R^2
1971	1.106	.1083	.0125	.1802	-.1867	.54
1972	2.238**	.0045	-.300**	.2929*	-.3340	.67
1973	-0.399	.1734**	-.0093	.2518	.1686	.61
1974	0.319	.0297	.0449	.3969	.4202	.32
1975	0.687	.2942**	-.6105	-.1659	-.2746	.74
1976	2.180**	.0937	.0026	.1223*	.4407	.64

(** means statistical significance at .05 level; * means statistical significance at .10 level)

Table 2: Price Scenarios for Cattle and Barley

Scenario	Slaughter Steers	Slaughter Heifers	Cull Cows	Barley
	($1 cwt)			($1bus)
Low	39.50	35.90	23.70	1.35
Medium	52.08	47.35	31.25	2.00
High	79.00	77.00	57.00	2.65

Table 3: Effects on Net Farm Income of Horn Flies at Three Levels of Infestation, High Barley Prices, No Control

	Changes in Net Farm Income		
Horn Fly Infestation Level	Low Beef Prices	Medium Beef Prices	High Beef Prices
Low	$-352	$-359	$-604
Moderate	-364	-417	-810
High	-439	-480	-834

Table 4: Effects on Net Farm Income of Various Methods of Horn Fly Control, 3 Levels of Pest Infestation, High Barley Prices, $6/Hr. Labor Charge

	Changes in Net Farm Income					
	Low Infestation		Moderate Infestation		High Infestation	
Control Method	Low Beef Prices	High Beef Prices	Low Beef Prices	High Beef Prices	Low Beef Prices	High Beef Prices
Spray 4 times	$ 29	$ 302	$ 41	$508	$116	$532
Spray twice-Jun 15,Jul 15	-105	-67	-93	142	-9	190
Spray twice-Jun 15,Aug 1	-30	97	-28	289	56	325
Spray twice-Aug 1,Aug 15	-63	28	-83	167	-8	191
Spray once-Jun 15	-47	2	-32	217	41	237
Spray once-Jul 15	-146	-189	-165	-43	-78	5

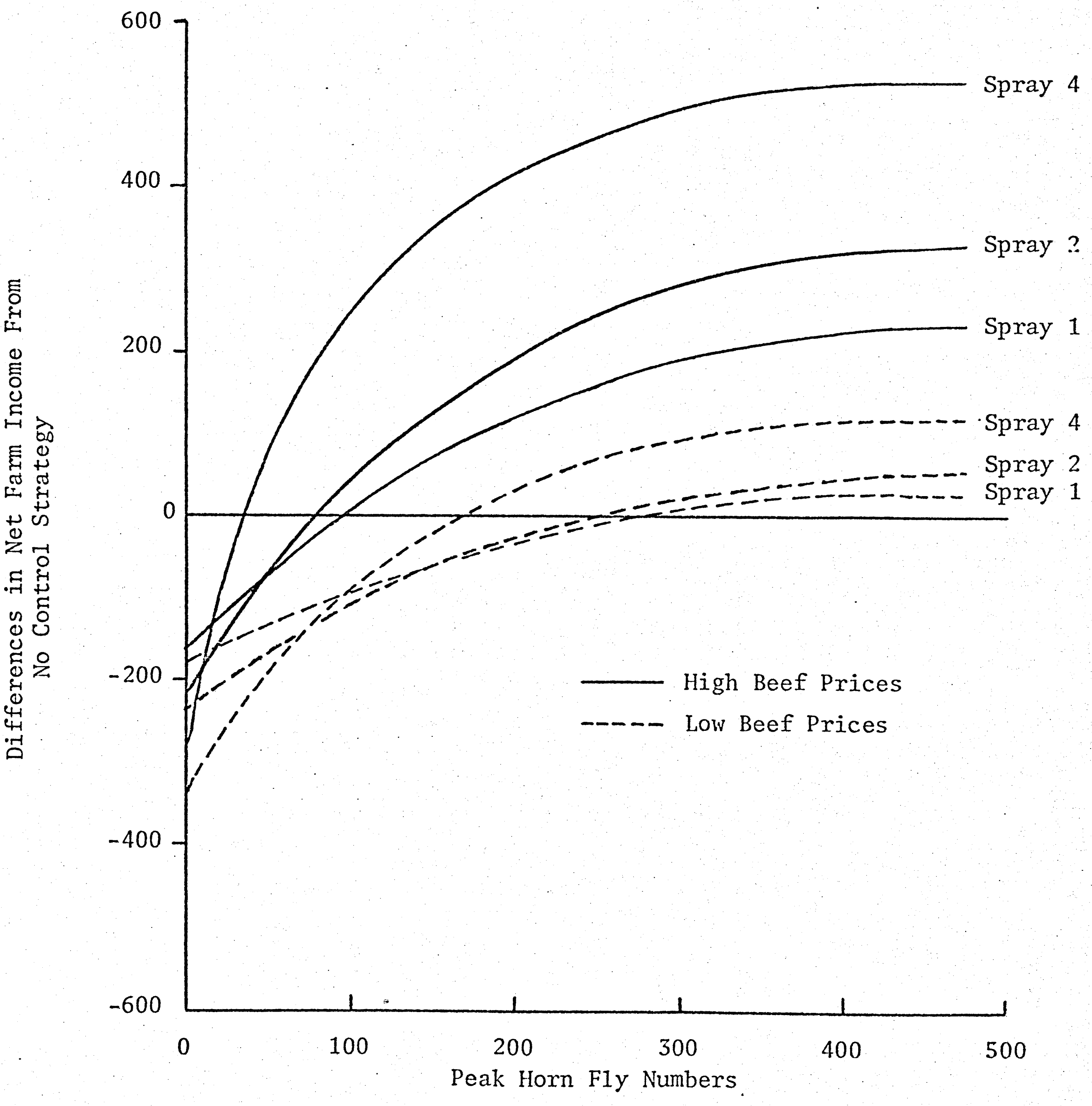

Figure 1: Economic Thresholds For 3 Horn Fly Control Strategies, High and Low Beef Prices