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Cost of a Maedi Visna Flock Certification Program and the Changes in Productivity and Economic Return

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Summary

Maedi Visna (MV) has been identified as a common viral infection in Ontario sheep. The Maedi Visna Flock Status Pilot Project (MVFSP) sets a protocol for control and eradication of this disease. A static normative model was designed to measure the economic benefit of such a program. Of the 16 producers enrolled on the program in 2002, 15 cooperated and were surveyed.

Two benefits were identified from being MV free: 1) higher purebred sheep sale prices and 2) improved ewe productivity. The benefits to purebred sheep breeders warrant eradication within sheep flocks. With only a 10 percent improvement in purebred price, even on only 25 percent of lambs sold for breeding stock, a producer should expect to breakeven on the added costs associated with the MVFCP program just shortly after becoming 'A' Status. This outcome was robust for all combinations of flock size, ewe and purebred sheep sale values, and bleeding costs.

Commercial sheep producers did not find the same positive outcome. With low prevalence of the disease, few benefits accrued. Only with prevalence levels over 10 percent with low bleeding costs and large flocks would commercial producers show a reasonable payback period of about six years, and then only with the Monitored Program. Payback would never be reached on the Whole-Flock Program for commercial sheep producers.

Key Words: Sheep, Maedi Visna, Costs, Culling

Introduction

Maedi Visna (MV) is a common viral infection in Ontario sheep flocks and has been identified as causing significant production losses, including poorer reproductive performance, lower birth weights, reduced growth of lambs, and increased mortality and culling of ewes (Bruere and West, 1993). Eradication of MV also has significant costs associated with it, such as testing, depreciation on sheep that are removed, record keeping and facilities. The Maedi Visna Flock Status Program (MVFSP) identifies serologically positive sheep to MV viral infection, using a recombinant enzyme-linked immunosorbant assay (ELISA) and requires their subsequent removal from the flock to decrease the prevalence of MV to a level of insignificant risk.

The benefits of enrolling in an MV-status program can be divided into two areas: 1) reduction of productivity losses described above are critical to the commercial lamb producer; and 2) breeders of replacement animals (e.g. purebred producers) may derive an additional benefit of being able to claim that their stock is low risk of MV infection and thus may be able to increase price in the face of increased demand. When considering MV flock level status, residual disease cannot be tolerated as the infection will quickly spread within the flock again. The producer either buys into eradication with the goal to achieve low risk status, or attempts to control the disease through biosecurity.

Davies (1980) recognizes four significant elements that contribute to the costs of a disease-eradication program: the prevalence of disease present in the flock; the cost of culling a diseased animal and replacing it with a healthy animal, including the lost income associated with detecting and removing the diseased animal; the lost markets because the flock is diseased; and the ongoing cost of detection of the diseased animals within the flock, e.g. sampling, laboratory testing and time. It is important to continue to consider the costs associated with assurance that the flock maintains its low risk status. Repeated sampling of an apparently non-diseased flock must occur at some level in order to be sure that the disease status has not changed. This is particularly true when biosecurity and the sensitivity of the test are not perfect (Houwers et al, 1984). Although considerable work has been done with respect to MV-control programs, there is little research concerning their economic consequences. The costs and benefits of a disease-eradication program have a direct influence on whether the program will be implemented and followed by producers.

Copious amounts of literature document the effects of MV-serological status on flock performance. Sero-positive status has a negative effect on ewe fertility, fecundity, weaning rates and growth (Dohoo et al 1987, Keen et al, 1996, G.J. Gunn et al 1998). Keen summarizes the total effect of decreased lamb production due to serological MV status, as a loss of 4.95 kg per infected ewe exposed to the ram. This figure does not take into account losses from premature ewe death and culling for which there are no published estimates but is often reported in the lay literature as an important effect of the disease whether because of the effects of clinical disease or failure to raise lambs.

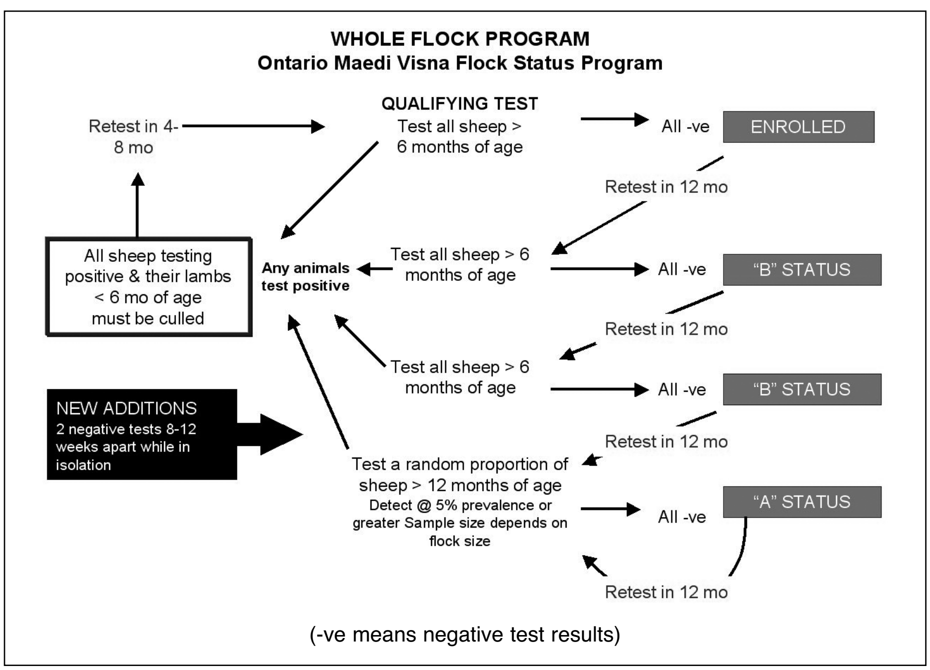
Dijkhuizen et al. (1991) and Renkema (1980) refer to positive and normative approaches to the costs of a disease-control program. A positive approach will evaluate the field data directly, using statistical/epidemiological models. The normative approach makes predictions based on existing knowledge and generates results using system modeling, enabling a simulation of the effects of various management decisions and control strategies, often using data derived from the field. Putt et al (1988) further break down types of models into dynamic versus static and deterministic versus stochastic. While static models often deal with the average of a set of values once a system has reached equilibrium, dynamic models take into account daily values over a certain period of time. In contrast, a deterministic model describes the situation that would arise if all the variables had average values, while a stochastic model allows the variables to take values from a range of values according to some probability distribution. In the case of MV, a normative/static/stochastic model is chosen as the best way to measure the costs of an eradication program.

The objective of this project was to quantify the costs associated with a Maedi Visna Flock Status Program and to determine the conditions under which this program would provide net economic benefits for the commercial and purebred sectors of the sheep industry.

Methodology

The MVFSP had been available to producers at the time of this study for less than three years. The program is administered by the Ontario Sheep Marketing Agency, with a partnership between the University of Guelph and

Figure 1. Schematic of the Maedi Visna Flock Status Program – Whole Flock.



the Canadian Food Inspection Agency (CFIA), which provides the MV ELISA testing. The program is comprised of two different schemes: the Whole-Flock program, which has three levels, "Enrolled" – after the initial negative whole flock test, "B" status – after two negative whole-flock tests and "A" status after three negative whole-flock tests and a negative test of a subset of the adult flock (Figure 1); and the Monitored Flock program designed for large, commercial flocks with two levels, Monitored and Monitored Low Risk (Figure 2). All sheep and goats greater than 180 days of age must be tested on the Whole-Flock Program. For the Monitored Program or when achieving or maintaining "A" status, a subset of the flock, greater than one year of age, is tested. This subset is a randomly selected portion of the flock, of sufficient size to detect MV at a flock prevalence of 5 percent or greater with a 95 percent probability. In addition to annual adult flock testing, producers are required to comply with specific biosecurity measures, which include isolation and testing of additions. Enrollment in the MVFSP is voluntary and costs are borne by the producer.

Numbers of flocks enrolled in the MVFSP at the time of this study were too low to statistically evaluate annual business reports. Instead a static normative model of the MVFCP was designed using field-derived data. Phone interviews were conducted with 15 producers enrolled in the program. Data included reported costs associated with the MVFCP. All dollar amounts shown are Canadian. [As of 12/05 Canadian dollar was .857 US dollars] Written feedback was provided to the participants after the interview was conducted, and consisted of a schematic of the MVFCP, copies of the programs pertaining to their individual situation, and a letter explaining the findings. This served as a beta test for the model.

The following flock characteristics were incorporated into the model: flock size, i.e. 100 breeding ewes vs. 500 breeding ewes; type of sales, i.e. commercial in which only market lambs were sold vs. purebred in which replacement stock is also sold; and type of MVFSP enrolled in, i.e. whole flock vs. monitored vs. no program. Data derived from the participants on the following variables associated with being enrolled in the MVFSP were summarized and incorporated into the model. These variables were: observed increase in the quantity of purebred sales and value of those sales; value of ewes; costs of sampling the sheep, including laboratory costs; labour costs; prevalence of the disease; and the occurrence of a positive test (i.e. loss of low-risk status) later in the process. The dependant variables observed included cost to reach 'A' or 'B' Status and how long it would take to breakeven, given the costs and benefits of the MVFCP program. The computer model was programmed in *Lotus 123, Release 5.* The models were simple, accounting for cycles involved in the program protocols (Figures 1 and 3). The model assumes that the producers had similar levels of flock-health management, which is termed Level 1 Health Status[1]. All producers were enrolled in a provincial, flock-health scheme, the Ontario Sheep Health Program (OSHP) and so are representative of more progressive producers in terms of the general health of the flock, e.g. vaccination, parasite control, biosecurity. By doing this we have removed many complicating issues for comparing productivity gains due to this program versus the effects of better man-

Figure 2. Schematic of the Maedi Visna Flock Status Program – Monitored Flock.

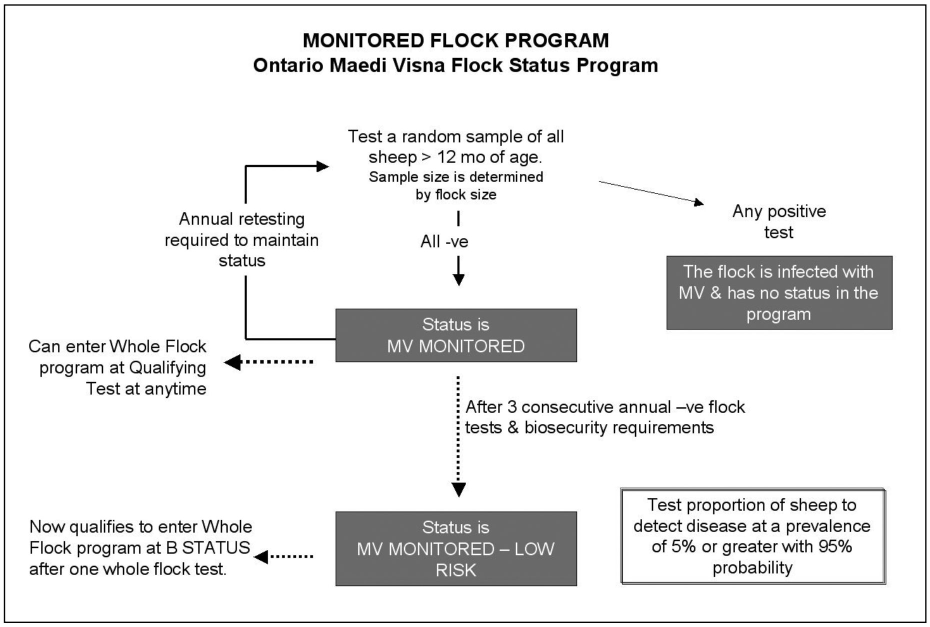
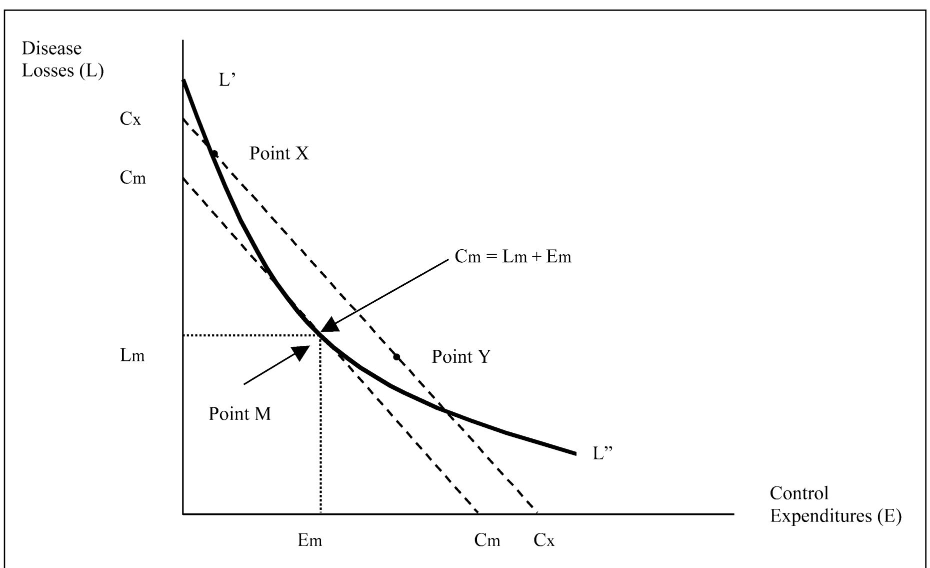


Figure 3: Disease Efficiency Frontier Including Isocost Lines - Conceptual.



Source: McInerney, J. (1996).

agement. Therefore, just the costs of MV testing and the benefits from this testing need be modeled.

The variables of importance to the economic success of the MVFCP program appear to be flock size (as flock size increases, a smaller proportion of the flock is sampled, so the cost is spread over more animals), sampling costs, ewe value and purebred breeding sales value. To summarize the effects of these variables on the costs/benefit of the MVFCP, scenarios were presented for four groups of producers; purebred breeder and commercial producers in either the Whole-Flock Program or the Monitored Program. The standard scenario included isolation facilities at $125, ear tags at $0.36, OSHP at $75, education at $150, salvage at $69, isolation labour at $13.33 per animal, age at 3.8 years, 6.75 years of use for ewes, 5 years in added productivity, 10 percent improvement in breeding sales, two lambs per ewe per year, 25 percent of sales as breeding, and commercial sales at $100. Sampling costs varied between $4.50 and $15.00 per test, while ewe value varied between $200 and $600 per ewe. Direct-sampling costs consist of six items including: lab charges, vet supplies, and labour for record keeping, help, operator and veterinarian. To reflect the value of ewes as this affects the value of her lambs, the value of purebred breeding sales were set to be the same as the ewe value, so these two variables acted together. Breakeven (years) shows how long it would take for the producer to cover the direct expenditures with reduced loses.

Results and Discussion

Of the 15 producers surveyed, 12 purebred breeding flocks and two commercial flocks were enrolled on the Whole-Flock Program, and one purebred flock was enrolled on the Monitored Program. Table 1 displays the average and range of the 14 flocks enrolled on the Whole-Flock Program. The one flock enrolled on the Monitored Program was excluded. All of the producers sold some breeding stock. Average flock size was variable. Some expenses were invested in isolation facilities, although these were not elaborate. Double ear tags were required; so cost for one additional tag per animal was added. Participants were required to register in the OSHP that costs $75, and most partook in some sort of education program concerning flock health or MV specifically. Sampling charges include laboratory fees, as well as veterinary services and labour. Laboratory fees range from no charge[2] ; $2.50 per test for producers enrolled in the MVFHP; to $8.50, which is the cost recovery rate proposed by the CFIA. Veterinary services are based on the costs of sampling 30 sheep per hour. Sufficient labour is needed to assure this flow rate and included one operator and one record keeper per veterinarian. Veterinary services and labour at less than these rates were shown because the research team did some bleeding at no charge. Ewe depreciation is assumed to be a straight line. Benefits from MV eradication were two fold: a productivity increase or an improvement in purebred breeding sales from displaying a MV free status. The literature states a commercial benefit of 4.95 kg of lamb per infected ewe (Keen et al, 1996), which may underestimate the true impact of the disease. Purebred breeders, who advertise various flock health credentials, found it easier to sell stock to shepherds when able to state the flock was low risk for infection with MV. Those surveyed reported a significant improvement in

Table 1. Input data from Participants of MVFCP Whole Flock Program.

(n=14)	Mean	Range
Number of ewes ...	149	60-600
Separate flock health equipment & Isolation facilities	$125	0-$500
Ear Tags (per ewe)	$0.36	0-$0.60
OSHP Registration and Binder	$75	$75
Education & Expert Advice on Maedi Visna	$150	0-$200
Laboratory Charges (per test)	$2.50	0-$8.50
Veterinary Supplies for Sampling (per test)	$0.25	$0.16-$0.25
Labour for Record Keeping (per ewe)	$0.75	$0.75
Labour for Vet to Sample Sheep (per test)	$1.46	0-$4.00
Labour for Help to Sample Sheep (per test)	$0.17	0-$0.50
Labour for Operator to Sample Sheep (per test)	$1.05	$0.50-$2.00
Labour for Isolation Unit (per positive ewe)	$13.33	0-$20.00
Value of Average Animal (per ewe)	$374	$180-$1,000
Salvage Value of Average Cull Animal	$69	$50-$100
Age of Average Cull Animal	3.8	3-6
How many years are ewes usually kept	6.75	5-10
Number of sheep in a random sample	48	38-56
Added Productivity per ewe per year without MV - 11 lbs (4.95 kg) is assumed (Keen et al, 1996)	11	11
Average Improvement in Breeding Sales	11%	2%-50%
Average Lambs per Ewe Per Year (assumes 100 lb lambs)	2.04	1.6-2.8
Percent of lambs sold as breeding stock per year	26%	2%-50%
Value of breeding lambs per each	$373	$200-$1,000
Value of commercial lambs per each	$130	$100-$250

[1] Level I Health Status can be described as 'best management practices for producing sheep, including nutrition, facilities, records, medicines and health procedures'. For a complete description reference Menzies P.I., Fisher J.W., *Economics of Flock Health Management*. 2001. *www.kemptvillec.uoguelph.ca/*

[2] Up until recently, the CFIA would test individual sheep for MV as part of their export mandate and would on occasion test the entire flock if time allowed. This has since been discontinued.

Table 2. Breeding Flock/Whole Flock Enrollment showing Breakeven[3] in Years (no sero-positive then one sero-positive).

	Sampling Costs			
100 Ewes	**$4.50**		**$15.00**	
Ewe Value — $200	-1.4	-1.2	+0.8	+1.9
$600	-2.0	-1.9	-1.5	-1.2
500 Ewes	**$4.50**		**$15.00**	
Ewe Value — $200	*-1.5*	*-1.3*	*+0.1*	*+0.9*
$600	-2.0	-1.9	-1.5	-1.2

[3] Using breakeven as the dependant variable, showed that to become 'A' Status with no sero-positive tests (will take four years), the number of years either before (a negative number) or after (a positive number) becoming 'A' Status the scenario would breakeven. To become 'A' Status with one sero-positive test would usually take 5 years. To become 'B' Status under the Monitored Program usually takes three years with no sero-positive tests, and four years with one sero-positive test. For example in Table 2, the first scenario broke even 1.4 years before becoming 'A' Status.

the value of breeding sales, in either price per animal or quantity sold.

The mean number of positive results of purebred producers enrolled on the Whole Flock Program on the first test was 7.25 resulting in 5.83 culls, and the cost to achieve "A" status was $5,207. Reported accrued benefits were $14,851. Based on these data, this group would break even 1.5 years before the earliest opportunity of achieving 'A' Status, i.e. after five years if the first test resulted in some animals testing positive. Most of the benefits come from improved purebred breeding sales. In fact only a 3.7 percent improvement in breeding sales (on 26 percent of lambs being sold for breeding stock) is required to breakeven by the time 'A' Status is achieved. This assumes a farmer can achieve a price premium soon after enrolling in the MVFCP.

All scenarios for purebred producers on the Whole-Flock Program had very early payback periods of either just before becoming 'A' Status or just shortly after, regardless of flock size, cost of sampling, ewe value or prevalence of sero-positive ewes (Table 2). Although the payback period is slightly longer for the smaller flock size, this difference is slight and does not significantly impede the financial success of a program for breeding flocks. This is important, as most breeding flocks in Ontario are less than 100 ewes.

Breeding flocks' enrolled in the Monitored Program (Table 3) again showed very encouraging payback periods. Certainly the Monitored Program was cheaper because it used random samples; however it took one additional test to achieve "Monitored-Low Risk" status. The status is not as high a level as "A" status. If the flock is small, the sample size is relatively large compared to the flock size. So cost savings for purebred breeders with small flocks between the Whole Flock and the Monitored Programs are minimal.

Commercial flocks in contrast, don't have the opportunity to breakeven given the standard scenario presented with either the Whole-Flock or Monitored Programs. The annual cost of testing is always greater than disease losses (Table 4). This is because without sufficient level of infection, there is no benefit to eradication. However, commercial operations will breakeven after 308 years, when disease prevalence is greater than 3.6 percent with large flocks (500 ewes) and low bleeding costs. At a 10 percent prevalence the payback would be 5.9 years after becoming 'B' Status. The recommendation would be to commercial flock owners who do not know the sero-prevalence of disease in their flock, would be to enroll in the Monitored-Flock Program to determine prevalence. If greater than 10 percent, then there may be an economic justification to enrolling in the Monitored Program to eradicate MV and derive the benefits from increased productivity. If the prevalence is less than 10 percent, then the producers should not enroll in either program.

McInerney (1996) defined the responsibility of economists in the question of disease control as those who will help set the boundary to controls. Some systemic diseases, for example mastitis, may optimally exist at some level if we consider the balance between control

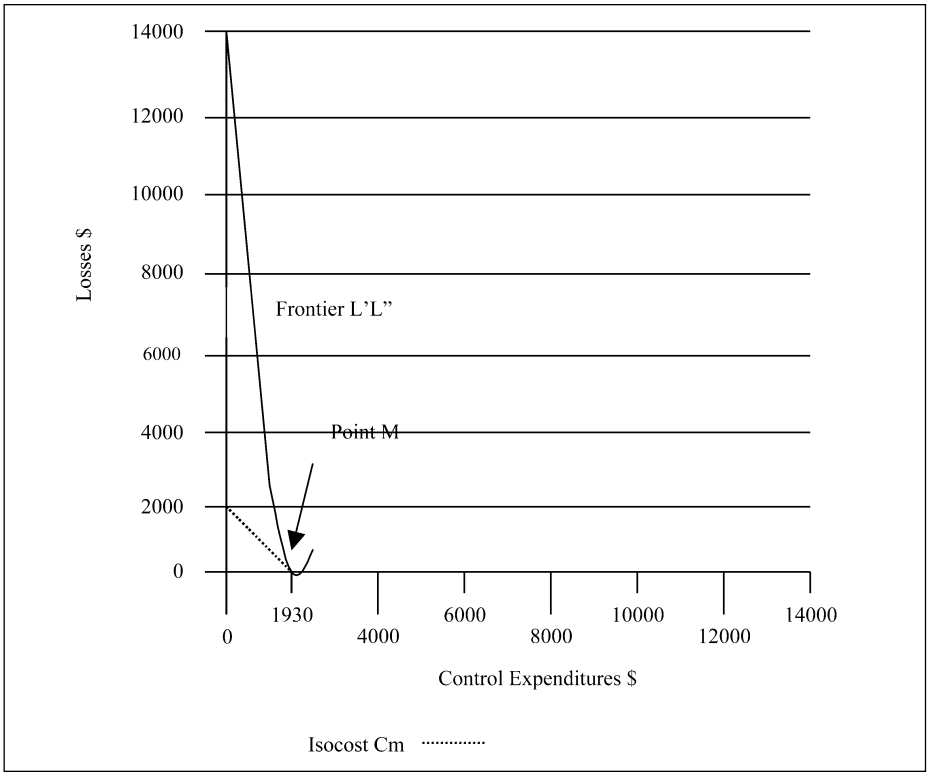
Table 3. Breeding Flock/Monitored Enrollment showing Breakeven in Years (no sero-positive then one sero-positive).

	Sampling Costs			
100 Ewes	**$4.50**		**$15.00**	
Ewe Value — $200	-1.4	-1.4	+0.6	+0.6
$600	-1.8	-1.8	-1.6	-1.5
500 Ewes	**$4.50**		**$15.00**	
Ewe Value — $200	*-1.9*	*-1.9*	*-1.8*	*-1.7*
$600	-2.0	-1.9	-1.9	-1.9

Table 4. Commercial Flock/showing Breakeven in Years. (no sero-positive then one sero-positive).

	Sampling Costs			
Whole Flock Enrolment	***$4.50***		***$15.00***	
Number of Ewes — 100	never	never	never	**never**
500	never	never	never	never
Monitored Enrolment	**$4.50**		**$15.00**	
Number of Ewes — 100	*never*	*never*	*never*	never
500	never	never	never	never

Figure 4: Disease Efficiency Frontier – Purebred Sheep with Maedi Visna (Ontario, 2002).



costs and controllable losses due to the disease. Where a disease is not systemic and can be controlled only by eradication, such as with MV, then the optimal level will exist (if the losses are great enough) or it will not exist at all for that particular economic environment.

Taken directly from McInerney (1996), Figure 3 shows a hypothetical efficiency frontier for a disease, below which is impossible to achieve. The y-axis represents production losses due to the disease, which includes loss of productivity, death loss, loss of markets, etc. The x-axis represents expenses to control and fight the disease, such as veterinary services and medicines. When eradication is necessary, the efficiency frontier L'L" will intersect the x-axis. MV is such a disease. Isocost lines are, by definition, a 45° angle to the x-axis and represent combinations of equal cost to the disease if we accept the basic premise that the cost of the disease is equal to the losses plus the control expenditures. McInerney argues that the optimal disease level is seldom at zero. The isocost line that is tangent to the efficiency frontier defines the optimal level of disease loss and control expenditure, at point M.

This study has identified the production losses (y-axis) and the expenditures (x-axis) for disease efficiency frontiers given specific farms (and scenarios) in Ontario. Specifically:

1. Purebred Breeding operations on the Whole-Flock Program show potential losses of $13,500 (Canadian $) and expenditures of $1,930 to become 'A' Status (100 ewes with value on ewes/sales at $600), (Figure 4). This has an average slope of -7, which is less than an isocost's slope of -1 (45° angle). As long as the curve of the efficiency frontier L'L" touches the isocost Cm at the x-axis intercept, then the point of the x-axis intercept is the optimal control point for this farm. And as such this demonstrates that eradication is the most economical option in this case, point M in Figure 4.

2. A commercial operator on a Monitored Program with 500 ewes, low bleeding costs and 10 percent prevalence would save production losses of $1,100 and incur control expenditure costs of $3,209 to achieve a 'B' Status, (Figure 5). This is the scenario where breakeven will occur in 5.9 years after becoming a 'B' Status (which would take four years). Over these 5.9 years the efficiency frontier #1 for this producer will shift, frontiers #2 and #3, until its slope becomes equal to -1. The frontier shifts because the annual costs of testing are less than the annual benefits after the first year or so during which all sero-positive animals

Figure 5: Disease Efficiency Frontiers, Commercial Sheep - Conceptual.

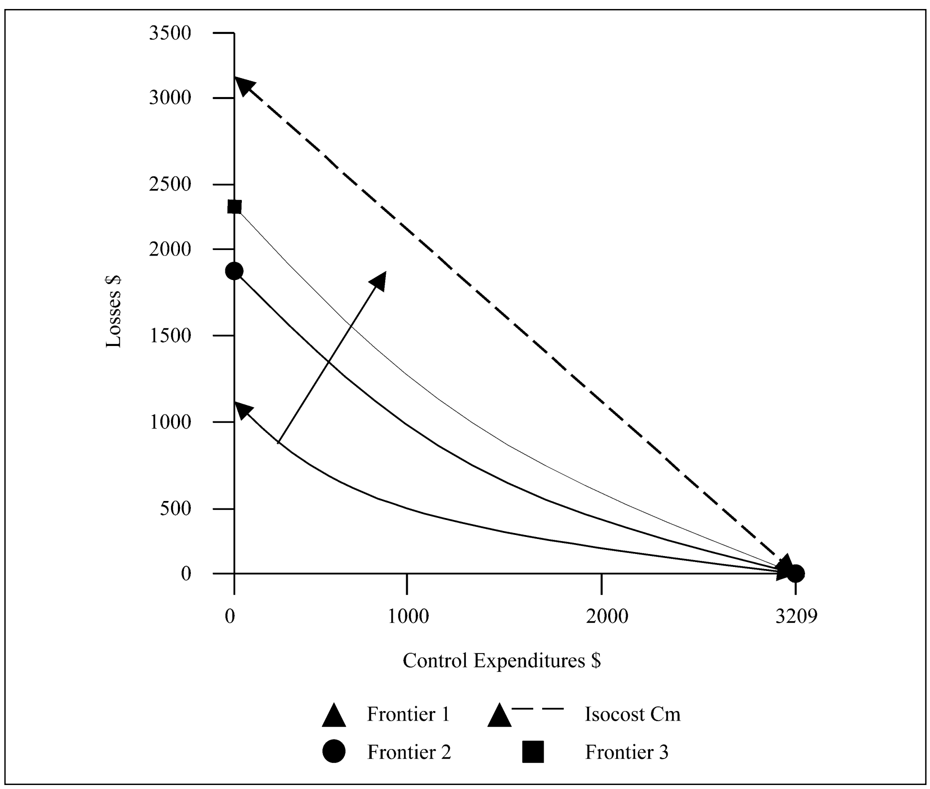
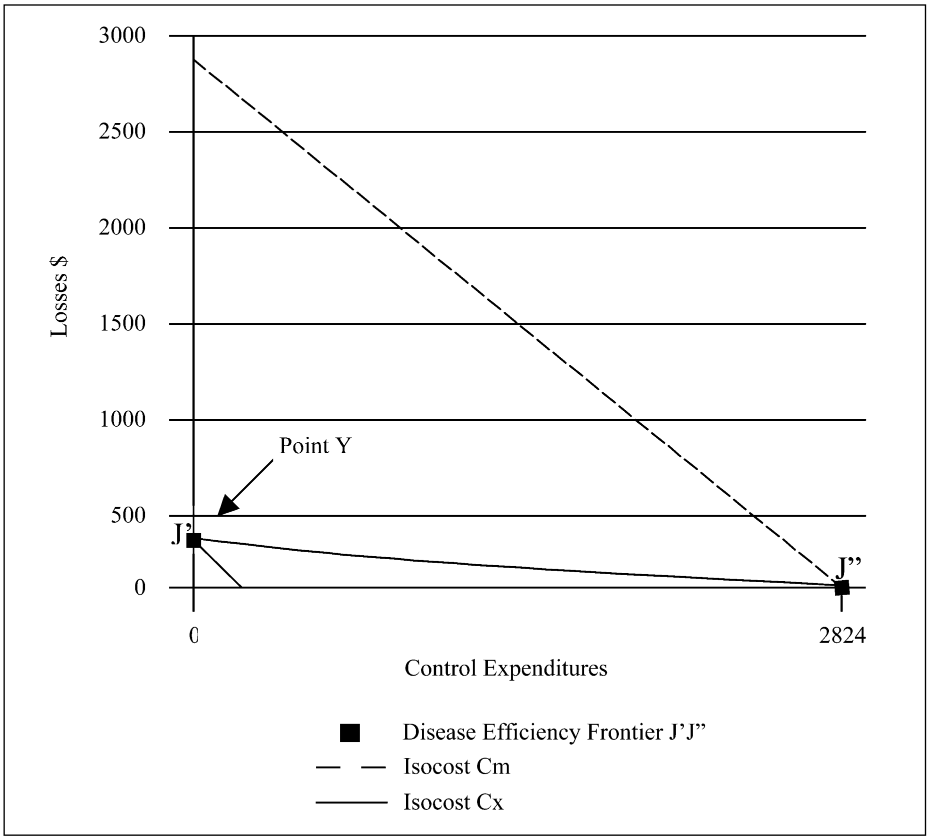


Figure 6: Disease Efficiency Frontier, Commercial Sheep.



are disposed. Eventually the frontier will be above the isocost Cm where again, the optimal point will be at the x-axis intercept (as is the case in Figure 4).

3. Also for a commercial operator (Figure 6) on the Whole-Flock Program (100 ewes, low bleeding costs and 10 percent prevalence) the savings from production losses would be $275 and control expenditures would be $2,824 with no potential to breakeven. This is because the annual costs exceed the annual returns, even as time goes on. The efficiency frontier J'J" has a slope that is more than -1 and will never shift lower than a slope of -1. Therefore the isocost Cx will intersect the efficiency frontier J'J" at an optimal point Y, which does not represent eradication. Actually, point Y is very close to the y-axis intercept, suggesting that very little control expenditure is economically warranted in MV control, for this scenario. The implication is that commercial producers with low prevalence should practice selective culling and good biosecurity and not enroll in the Whole-Flock Program of the MVFCP.

This analysis varies slightly from that of McInerney (1996) and that of Chi et al (2001), in that the costs of this disease (production losses plus control expenditures) will not have a particular time frame. A minimum of four years is needed to gain 'A' Status, three years for a Monitored 'B' Status and breakeven can happen over any number of years thereafter. And so the efficiency frontiers presented here are not time specific. This should not affect their use to explain the concept of optimal disease control.

MV testing involves a few other issues that need special attention. Depending on the organization of the farm, pre-bleeding assembly of animals may be easy or arduous. Meticulous record keeping needs to be done, and strict biosecurity measures must be followed to prevent reintroduction of the disease. Once 'A' Status is attained, if at some point the disease is reintroduced at greater than 5 percent prevalence, the status is lost and the program starts at the beginning. The dollar cost of this positive test would be that a whole-flock test would be required the next time and the culprits culled. Because the 'A' Status would be lost for a time, the designation for promotion would need to be removed, which in turn would reduce sales for purebred breeders. The implication of the reintroduction of disease is financially large.

Conclusions

The MVFCP program assumes that producers will enroll in the Ontario Sheep Health Program, educate themselves about controlling disease, test their sheep on a regular basis, cull all sero-positive animals, and practice good flock-health management, including biosecurity. Without this type of protocol, the eradication program would not work. Eradication is currently the only way to prevent losses from the disease (i.e. 4.95 kg less lamb weaned per ewe) and achieving low-risk status is the best way to derive benefits from being low risk of infection (i.e. improved sales of breeding stock).

Within these parameters, there seemed to be a solid economic return for purebred breeders in Ontario. These farms need not be large, the costs of sampling can reach $15.00 per test, and only a portion of lambs need to be sold as breeding stock. Breakeven occurred just before or shortly after becoming 'A' Status for all combinations of flock size, ewe and breeding sale values, and bleeding costs. Commercial producers, however derive no benefit from the program if their flocks do not have disease. At levels above 10 percent prevalence level, with low bleeding costs, commercial producers on the Monitored Program began to show a reasonable payback of about six years. While useful for purebred producers, some MVFSP protocols need to be adjusted if more participation from commercial producers is expected.

More research is needed in the assessment of production losses due to this disease. The commercial loss of 4.95 kg per ewe per year is not sufficient to warrant eradication without high prevalence levels. In many countries MV is a reportable disease, some national eradication programs have occurred over the years, all of which suggest this disease to be more destructive than described in the literature.

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