Journal of Animal and Veterinary Advances 6 (2): 146-151, 2007

Assessment of the Economic Impact of a Brucellosis Control Program in A Dairy Herd Using the Partial Budget Method

[1]R.M. Muñoz del, [1]M.F.Montaño, [1]T.B. Rentería, [1]E. Sánchez, [1]J.F. Moreno, [2]A. Pérez and [2]S. Saucedo
[1]Instituto de Ciencias Agrícolas, Universidad Autónoma de Baja California, Mexicali, México
[2]Instituto de Ciencias Agricolas Universidad Auronoma de Baja California, Mexicali, Mexico

Abstract: A study to estimate the economic impact of an eradication program for a brucellosis outbreak was performed in a dairy herd in the Mexicali Valley in Mexico. The study was done in a dairy herd with 175 Holstein Friesian cows. The presence of *Brucella abortus* was confirmed by bacteriological analysis done on milk samples obtained from positive animals. The impact was estimated by comparing economic costs and losses. The costs and income related with the control program were considered and used to determine the economic impact by means of a partial budget analysis. The result of the analysis indicated that the use of the government recommended program had excessively high costs which made the program economically unfeasible. Taking into account that the highest loss was as a result of the reduction of milk production because of the cows culled from the herd, it was considered that to make the program attractive to other milk producers, the government should establish a subsidy that paid for the cattle that was slaughter because in the case of the milk farm considered in this study with this payment, plus the income obtained from the sell of the positive cattle the amount of money obtained helped to reduce in 87.6% the total loss associated to the eradication program.

Key words: Bovine brucellosis, herd health, economic impact, partial budget

INTRODUCTION

World wide brucellosis has been considered one of the most important diseases in dairy cattle that are transmitted to humans. This disease produces abortions during the last stage of gestationand an important reduction in milk production (Bacigalupo *et al*., 1966) both of which have a negative impact on productivity in dairy herds. There are many negative effects on milk production as a result of a brucellosis infection, of which abortions (Kirkbride *et al*., 1973; Anderson, 1987), still births, (Crawford *et al*., 1978) and a 15 to 20% reduction in milk production are the most important. These problems are considered an important justification for establishing programs to prevent or eradicate the disease from herds. A program to eradicate the disease in positive herds has been established I n Mexico according to the federal guideline, (Mexican Brucellosis Official Rules: NOM-041-ZOO-1995 which states that all animals tested positive to the disease should be sacrificed, but the law does not include a government payment for every animal slaughtered (NOM, 1995). Animal health economics is a discipline that has been developed to help livestock owners make the best decision with the objective of achieving the optimum animal health management (Marsh, 1999).

Research in the animal health field considers three basic and related aspects: Quantifying the financial effect of animal disease, the development method that helps the decision making process when the disease affects a single animal, a herd or the whole population and finally the assessment of the costs and benefits that result from the use of the disease control method (Dijkhuizen, 1995). McInerney *et al*. (1992) proposed that in order to make an economic assessment of a disease it's necessary to clearly define the following concepts: Loss, expenditures and costs. In Mexico only a few studies have been done to measure the economic impact of a program to control or eradicate brucellosis in dairy herds and no information exists at this time regarding the economic effect that will result from using the federal program to eradicate the illness. The objectives of this work are to determine the costs that result from establishing a control program in a herd that tested positive to brucellosis and to determine the economic feasibility of establishing the Mexican government program in the same herd. The objective of

Corresponding Author: R.M. Muñoz del, Instituto de Investigaciones en Ciencias Veterinarias, Universidad Autónoma de Baja California, Mexicali, México

this work was the assessment of the economic impact of a brucellosis control program in a dairy herd using the Partial Budget (PB) method.

MATERIALS AND METHODS

Place of study: The study was done using data from the year 2001 obtained from a dairy herd of 175 cows located in Mexicali, Mexico. Between 1994 and 1999 the herd tested negative to brucellosis and in 2001 the test results were positive for one cow which due to human error was not culled, resulting in that the rest of the herd was infected with the disease. Laboratory tests were use to determine which animal was infected and also the following production information was obtained from cows that tested positive: Number of milking, open days, services needed for conception, gestation time at which positive pregnant cows were culled, abortions and the time when they happened and what was done to the cows that tested positive in order to control the disease. The government program was followed carefully so that the illness could be eradicated and the measures taken by the herd owner were: Detection, confirmation of the disease in cows that where suspected of having the disease, immediate culling of those confirmed positive, vaccinations, isolation of suspected and culling of heifers and calves exposed to the disease.

Economic assessment of the disease control program: From the known methods of economic impact assessment of animal disease Partial Budgeting (PB) was selected, which according to Morris (1999) is consider to be the best to evaluate the economic impact of an endemic disease that affect a single herdand the reason for this is that PB is highly effective to determine the short term changes in production that are the result of the measures taken to control the disease (Rushton *et al*., 1999). Marsh (1999) considers that PB is the most recommended method to quickly and easily determine what the economic impact will be when new measures that affect the business are taken. For partial budgeting to become a reliable method of economic assessment it is necessary to clearly define which expenditures and revenues are affected by the illness, because if this is not done properly, the results will not be real due to the fact that relevant variables will not be included and variables that are not considered relevant may be included in the analysis. PB takes into account the changes in the dairy farm that result from the implementation of the new measures and does not consider the total budget of the farm, hence the name partial budget. PB is concerned with four basic items: New Revenue (R), costs Saved (S), revenue Forgone (F) and New costs (N). The R and S elements take into account all additional revenue and reductions of costs that are a consequence of the program and on the other hand element F considers the revenue that will no longer be received and N the costs that are related to the implementation of the control program. Therefore the sum of F+N is considered to be an estimation of the negative effect that the program will have. The difference between the positive and negative effects equals the net effect of the changes made to control the disease in the herd. For each of the four items, a group of elements were selected and every one of them received a monetary value so that the necessary calculations could be done. The description of each element from the four itms is as follows:

New Revenue (R): The program required the elimination of all infected animals and the result of this measure was obtained from the sales of infected cows, heifers and calves.

Costs Saved (S): As a result of sending the infected animals to be slaughtered, feeding and medical costs were reduced.

Revenue Forgone (F): The smaller size of the herd as a result of the control program decreases milk production and the number of calves that are born.

New costs (N): In order to control the outbreak, new expenditures were made and this additional costs result from a series of measures taken to prevent the spreading of the disease, creating the following additional costs. Table 1 shows a summary of all costs and revenues considered by the partial budget.

Estimated value for the elements classified as new revenue (r) cows sales: The market price for each cow sold was $286.36 usd. Considering that 87 cows were sold, the total revenue for this sale was

$$(87)\,(286.36) = \$24913.63$$

Heifers sales: In the case of the heifers the price paid to the owner per animal was $222.72. A total of 9 animals were sold obtaining the following revenue:

Table 1: Costs and revenues associated to the implementation of the control program used on the dairy herd

New Revenue (R)	Revenue Forgone (F)
Sales of culled cows.	Milk sales from culled cows
Sales of culled heifers.	Calves sales from culled cows
Sales of culled calves.	New costs (N):
Costs Saved (S):	Diagnostic tests
Feed from culled animals	Acquisition of new heifers
Vaccination and veterinary services	Additional electricity consumption
	Vaccination of new cattle

(9) (222.72) = $2004.48

Calves sales: A total of 49 calves were sold, 10 of them were lactating, 17 were weaned calves, 13 were between 6 to 8 months of age and 9 were between 10 and 12 months old. For a lactating calf the price paid was $40.90, so that the total revenue was $409.00. The price for a weaned calf was $40.90 obtaining a total payment of $695.30. For one calf between 6 to 8 months old the price paid was $63.63 obtaining a total of $827.27 and finally for each 10 to 12 months old calf the price paid was $163.63 so the total was $1472.72.
The revenue obtained for this element was $3404.54
For item (R) the total monetary value was $30322.72

Estimated value for the element classified as costs Saved (S)

Feeding costs from culled animals: In the case of cows the calculations were done by multiplying the daily cost of feeding by the number of days that the animal still needed to complete a 305 day milking period. For calves an estimation of feeding costs was done for each of the three stages (weaning, early growth and final growth). The calculations were done using the following formula:

$$CSC = (LMD)(DCC)$$

Where:

CSC : Cost of feeding cows saved
LMD : Number of Milking Days lost
DCC : Daily Cost for feeding a Cow

So that:

$$CSC = (846.81)(1.71) = 16004.86$$

To estimate the cost saved on feed for female calves that is needed for them to get to the final stage of growth, the total number of calves in each one of the three stages of development (weaning, early growth and final growth) was multiplied by the costs of feeding a calf during the stage or stages that it had to complete in order to become a heifer.

The three formulas used to make the calculations are:

$$CSF_1 = CW (CFW+CFE+CFF)$$

Where:

CSF_1 : Saved costs of feeding female calves in the first stage of development
CW : Total number of weaned calves
CFW : Costs of feeding a calf during the weaning stage.
CFE : Costs of feeding a calf during the early growth stage
CFF : Costs of feeding a calf during the final growth stage

$$CSF_2 = CE (CFE+CFF)$$

Where:

CSF_2 : Saved Costs of Feeding female calves in the second stage of development
CE : Total number of Calves in the Early growth stage

$$CSF_3 = CF (CFF)$$

Where:

CSF_3 : Saved Costs of Feeding female calves in the final stage of development
CF : Total number of Calves in the Final growth stage

Substituting we get:

$$CSF1 = 17(48.19+84.56+141.05) = 4654.60$$
$$CSF2 = 13(84.56+141.05) = 2932.93$$
$$CSF3 = 9(141.05) = 1269.49$$

So that the total cost saved on feed for female calves is: 8857.53
Adding this result to the one obtained for the cows, the total amount to:

$$16004.86+8857.53 = 24862.39$$

In the case of costs saved on vaccination and veterinary services the calculations were done using the following formulas:

$$VC = PV (CW+CE+CF)$$

Where:

VC = Vaccination Costs for culled calves
PV = Price of a brucellosis Vaccine
CW : Total number of weaned calves
CE : Total number of Calves in the Early growth stage
CF : Total number of Calves in the Final growth stage

And:

$$VS = (PS)(LMD)$$

Where:

VS = Veterinary services costs
PS = Price of one day of veterinary services
LMD = Lost milking day

Substituting both formulas we get:

$$VC = 1.36(17+13+9) = \$53.04$$

And

$$VS = 0.058(9315) = \$541.96$$

Adding the two results we obtain:

$$53.04+541.96 = \$595.00$$

And if we add this number to the total costs saved on feed we get:

$$24862.39 + 595.00 = \$25457.39$$

And this result is the value of element S.

Estimated value for the element classified as revenue Forgone (F)

Milk sales from culled cows: To estimate this loss the number of milking days that each cow had at the time that it was culled from the herd was subtracted from the total days that a normal milking period has (305) and this result multiplied by the daily production average, this number was then multiplied by the price of a liter of milk, the formula used is as follows:

$$MPL = [(LMD)(AQ)](PM)$$

Where:

MPL = Milk production lost per cow
LMD = Number of milking days lost
AQ = Daily average production
PM = Price of one liter of milk

Based on the number of cows that were culled during their milking period, the total revenue forgone attributed to lost milk production was:

$$MPL = [(9315)(20.14)](0.31) = \$58157.27$$

Calves sales from culled cows: Based on the work of Weaver (1986) and Goodger and Skitrow (1986) the estimation of this loss assumed that 95% of pregnant cows that were culled would have given birth, this assumption is based in a 5% abortion rate. The calculations were made using the following formula:

$$SCNM = [(CPC)(AR)](CP)$$

Where:

SCNM = Sales of calves not made
CPC = Culled pregnant cows
AR = 1-probability of an abortion
CP = Calf market Price

The calculation were done separately for female and male calves, because the price is different for each one and it was considered that half of them would have been males and the other half females. In the case of male calves the lost revenue (SCNMM) was:

$$SCNMM = [(14.5)(1-.05)](45.45) = \$626.07$$

The lost revenue for female calves (SCNMF) was:

$$SCNMF = [(14.5)(1-.05)](90.91) = \$1252.29$$

So that the total loss from forgone sales of calves is:

$$626.07+1252.29 = \$1878.36$$

If we add this result to the amount of revenue foregone from milk sales we obtain the total value for F.

$$58157.27 + 1878.36 = \$ 60035.63$$

Estimated value for the element classified as New costs (N)

Diagnostic tests: The control and eradication program required 651 diagnostic tests and considering that the price of one test was $1.18 the total cost for this element was:

$$(651)(1.18) = \$768.18$$

Acquisition of new heifers: To substitute the infected cows 20 new heifers were bought by the herd owner, the price paid for each one was $1438.00 so that the total cost of this measure was:

$$(20)(1438) = \$28760.00$$

Table 2: Partial budget results

Program benefits		Program costs	
New Revenue (R)		Revenue Forgone (F)	
Sales of culled cows	$ 24913.63	Milk sales from culled cows	$ 58157.27
Sales of culled heifers	$ 2004.48	Calves sales from culled cows	$ 1878.36
Sales of culled calves	$ 3404.54	Total (F)	$ 60035.63
Total (R)	$ 30322.72	New costs (N):	
Costs Saved (S)			
Feed from culled animals	$ 24862.39	Diagnostic tests	$ 768.18
Vaccination and veterinary		Acquisition of new heifers	$ 28760.00
Services	$ 595.14	Additional electricity	
Total (S)	$ 25457.54	Consumption	$ 408.41
		Vaccination of new cattle	$ 68.00
		Total (N)	$ 30005.00
Results:			
R +S = $55780.26			
F + N =$90040.63			

Additional electricity consumption: To prevent the new heifers from infection they were isolated from the rest of the herd and once they started producing milk it was necessary to milk them on a different time as a result of this preventive measure electricity consumption increased, this additional energy cost was estimated using the following formula:

$$AEC = (EM)\ (CK)\ (PK)\ (DI)$$

Where:

AEC = Additional Electricity Costs
EM = Additional minutes of milking
CK = Kilowatt/min. consumed by the milking equipment
PK = Price of a Kilowatt
DI = Total Days in Isolation

Substituting the numbers in the formula the total cost for this element was:

$$AEC = (70)\ (0.12)\ (0.11)\ (442) = \$408.41$$

Vaccination of new cattle: The vaccination cost of new cattle was calculated using the following formula:

$$VC = (VA)\ (PV)$$

Where:

VC = Vaccination Costs
VA = Number of animals vaccinated
PV = Price of a Vaccine

So the cost for this item was:

$$VC = (50)\ (1.36) = \$68.00$$

Adding all the items in element N, we get:

$$768.18+28760+408.41+68 = \$30005.00$$

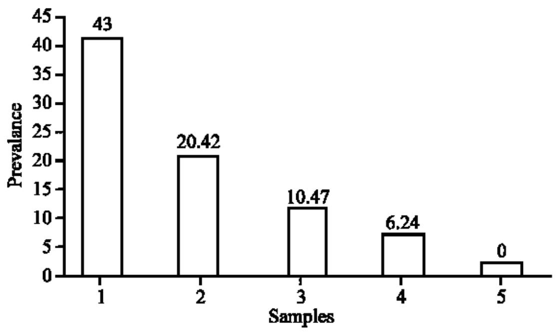
RESULTS AND DISCUSSION

To determine the outcome of establishing the eradication program using the PB method the results of adding the values of F+N are subtracted to the summation of R+S so that the total cost of the program is known. Table 2 shows the numbers obtained for the four items and the difference between costs and benefits.

$$(R + S) - (F + N) = -\$34260.37$$

The most important result given by the partial budget method is that the cost to eradicate the disease was $37914.69, however another relevant result is that PB helps to determine which are the most important costs and benefits of using a particular disease control method so that owner of an infected herd can make the best economic decision regarding which course of action to take to control of disease. In this study PB helped to determine that the most important cost was the lost revenue from milk sales which amounted to 64.6% of the total loss, this cost was so big that the sum of all the items considered as benefits was not enough to cover this cost. Another important application of PB analysis is that it can be used for the government to determine the best way to help a milk producer that follows the official guidelines to eradicate a disease, in this case the government after looking at the PB results could decide to cover the costs of buying new heifers, so that the total cost to the owner could be reduce to only $5500.37 ($34260.37-$28760.00) the use of this subsidy would promote the use of the government program to eradicate the disease.

The effectiveness of the recommended eradication program is clear if it's taken into consideration that after



Graph 1: Brucelosis prevalence in the herd

five samplings for brucellosis diagnosis, cero prevalence was achieved (see graph number 1) however this result will not be considered attractive by the dairy owners if the cost for total eradication of the disease is too high.

The results shown by Graph 1 are consistent with was reported by Xolalpa (1993) when he based cost analysis of different programs to eradicate brucellosis concluded that the ones that culled all infected animals presented the smallest incidence.

CONCLUSION

According to Dohoo and Dijkhuizen (1993) and Morris (1999) the dairy herd owner should decide on the use of a program to eradicate brucellosis considering the effect that this disease has on productivity, however, considering the fact that this is a zoonotic disease all efforts to reduce its presence will result in benefits for the milk consumer and this is a very important reason why the government should use all its available resources to help milk producers in their eradication programs. As demonstrated by this research partial budget is a simple but effective way to evaluate the economic impact of a brucellosis eradication program when used on a infected herd, so it can be considered as the recommended evaluation technique to find out in advance if the cost of the program is to high or to determine the total economic cost of a program and the value of the particular benefits and costs that result from its use. It is also important to comment that partial budget however very useful to asses the economic impact of a program to eradicate or control a disease it only compares enterprises in a steady stage and ignores the time needed to reach this state and thus the time value of money is cero (Rushton *et al*., 1999) however these shortcomings are not considered to diminish its usefulness as the best tool to be use for assessment of endemic disease in a herd. To make a good economic assessment of a disease the problem should be approach as a system if relevant epidemiological, medical and economic variables are not taken into consideration to evaluate the impact, the result will not be reliable and the benefits for producers and consumer of animal products will not be as good as expected.

REFERENCES

Anderson, B., 1987. Brucella abortus (Biotype 2) Abortion in a Cow. Compend Contin. Edu. Pract Vet., 9: 294-295.

Bacigalupo, N., J.M. De Benedetti, J.J. Guichandut, E.J. Gimeno and C. Mayer, 1966. Evaluación de pérdidas económicas producidas por Brucelosis. Bull. Off. Int. Epiz., 66: 277-285.

Crawford, R.P., F.C. Heck and J.D. Williams, 1978. Experiences with Brucella abortus strain 19 vaccine in adult Texas cattle. J. Am. Vet. Med. Assoc., 173: 1445-1461.

Dijkhuizen, A.A., R.B. Huirne and A.W. Jalvingh, 1995. Economic analysis of animal diseases and their control. Prev. Vet. Med., 25: 135-149.

Dohoo, I.R. and A.A. Dijkhuizen, 1993. Techniques involved in making dairy cow culling decisions. Compend Contin. Edu. Pract. Vet., 15: 515-520.

Goodger, W.J. and S.Z. Skirrow, 1986. Epidemiological and economic analysis of an unusual long epizootic of trichonomiasis in a large California dairy herd. J. Am. Vet. Med. Asoc., 189: 772-776.

Kirkbride, C.A., E.J. Bicknell, D.E. Reed, W.V. Knudtson and K. Wohlgemuth, 1973. A diagnostic survey of bovine abortion and stillbirth in the northern plain states. J. Am. Vet. Med. Assoc., 162: 556-560.

Marsh, W., 1999. The economics of animal health in farmed livestock at the herd level. Rev. Sci. Tech. Off. Int. Epiz., 18 : 357-356

McInerney, J.P., K.S. Howe and J.A. Shepers, 1992: A framework for the economic analysis of disease in farm livestock. Prevent. Vet. Med., 13: 137-154.

Morris, R.S., 1999. The application of economics in animal health programmes: A practical guide. Rev. Sci. Tech. Off. Int. Epiz., 18: 305-314.

Norma Oficial Mexicana: NOM-041-ZOO-1995. Campaña contra la Brucelosis de los Animales. Diario Oficial de la Federación, México, DF.

Rushton, J.P., K. Thomton and M.J. Otte, 1999. Methods of economic impact assessment. Rev. Sci. Tech. Off. Int. Epiz., 18: 315-342.

Xolalpa, V.M., C.J. Jaramillo and F.A. Pesado, 1993. Evaluación financiera de un programa de control de la brucelosis bovina en la Comarca Lagunera (1987-1990). Vet. Méx., 2: 127-134.