COST-EFFECTIVENESS OF PORCINE AUJESZKY'S DISEASE ERADICATION METHODS

Curk A.[1], Pogacnik M.[1], Tadic M.[2]

Cette analyse porte sur les dépenses et les pertes encourues dans un cheptel théorique de 100 truies en cas d'application d'une procédure d'éradication :

a. Testage et élimination des seuls séropositifs
b. Abattage total et repopulation

Les aspects économiques discutés sont les pertes dues aux réformes des truies, celles liées au blocage de l'exploitation ainsi que les dépenses nécessaires aux test sérologiques des truies après repeuplement et en cas de testage et d'abattage partiel, les dépenses liées à la vaccination des porcelets au sevrage. En comparant les coûts de chaque scénario d'éradication pour différents taux de prévalence, on arrive à déterminer le seuil de rentabilité. Le seuil de rentabilité très robuste est obtenu quand le taux de prévalence est de 0,8 % pour le scénario testage et abattage partiel. Le calcul des dépenses et des pertes pour un taux de prévalence de 0,2 % correspond à un coût de 67 052 $ pour le scénario « abattage total » et de 31 951 $ pour le scénario testage et abattage partiel. Les pertes dues au blocage de l'exploitation sont de loin l'élément déterminant puisqu'elles représentent 80 à 60 % des totaux respectifs. Le seuil de rentabilité est très sensible à la durée du blocage des exploitations. Si cette durée de blocage entre l'abattage et le repeuplement est réduite d'un mois, le seuil de rentabilité varie de 0,6 point. Le seuil de rentabilité est beaucoup moins sensible aux autres variables. Des variations minimes des prix de base n'influencent pas le seuil de rentabilité.

INTRODUCTION

Economic and epidemiologic studies of Aujeszky's disease eradication of the past ten years can be classified, according to the level of eradication, in two groups: i) the one that refers the Aujeszky's disease eradication at the national level (Miller, 1994), and ii) the group confined to the eradication at the farm level (Hoblet,1987). Within the latter group, notable methodical distinctions are seen with regard to whether the disease has a history at a farm or not. The values of epidemiologic variables in the 'ex post' type of analyses are given with the probability of 1. Which is of course not the case in the 'ex ante' type of analyses, where expected values as a result of forecasting methods of various types are used.

The expenditures and losses of the two disease eradication methods will be calculated from the taxpayers' perspective. That assumes an economic-type (as opposed to an accounting one) of analysis where the opportunity costs are taken into account. In our case, the opportunity costs equal the profit and non-covered fixed costs for pigs not marketed that normally would have been sold if the eradication was not implemented.

MATERIAL AND METHODS

A hypothetical herd of 100 sows with an Aujeszky's disease outbreak will be used in the analysis, but the results can easily be extrapolated to any herd size. The benefit achieved by the eradication equals the costs of disease not incurred as a result of eradication. Since both eradication methods to be analysed result in the same (constant) benefit, it can be ignored in the analysis. Therefore, the ultimate decision problem can be rephrased as which Aujeszky's disease eradication method is the most cost-effective. The term costs stands here for the expenditures necessary to eradicate the disease, and the disease losses. It follows from the goal set so far that only expenditures and the disease losses directly related to a particular eradication method will be taken into account.

Depopulation/repopulation

Depopulation/repopulation method assumes proper desinfection of the facilities after the depopulation and that replacement is done with Aujeszky's disease free pigs. Expenditures and losses will be examined separately, one by one.

- Loss from culling of sows.The number of sows culled out for eradication purpose equals the number of all sows in the herd minus the number of sows normally replaced. It is assumed that after depopulation the replacement sows are purchased at the beginning of pregnancy. Therefore, a four-month period of no farrowing (downtime) is assumed. The normal culling rate at Slovenian large pig farms was 56.8% in 1993 (Kovac, 1994), which in terms of uniform distribution means 21% in five months. Average body weight of a culled sow (175 kg) is calculated as a weighted average of sows, where the herd age structure serves as weights.
- Downtime loss. As already said, a four month-period of no farrowing (downtime) is assumed, if the depopulation/repopulation method is implemented. The downtime loss represents lost profit and non-covered fixed

[1] University of Ljubljana, Veterinary Faculty, Gerbiceva 60, 1000 Ljubljana, Slovenia.
[2] University of Zagreb, Veterinary Faculty, Heinzelova 55, 1000 Zagreb, Croatia.

costs for pigs not marketed in the four-month period. It is calculated as a four-month sale revenues minus variable costs of production during the downtime period. Basic data is 19.9 liveborn piglets per sow year (Kovac, 1994), 21.8% death losses up to market weight (Stuhec, 1995), and a market weight of pigs of 100kg.

- Serologic testing expenditures. After repopulation two rounds of serologic testing of a random sample of 36 sows in one year period are planned. The planned sample size is required to detect reactor animals by the given population size for 99% probability of detection and the prevalence rate at least 0,1.

Testing and removal of seropositives

This method anticipates serologic testing all the sows every 30 days and prompt removal of seropositives. Probability and pace of disease elimination by the method are supposed to be functionally dependant on the prevalence rate, test specificity and sensitivity, and spread of the virus in the period between two consecutive testings. Literature offers different estimates of ELISA test sensitivity and specificity, however the differences are not significant for our purposes. Test sensitivity is assumed to be 98%, specificity 100% (Blanks, 1983), which gives one to two expectedly false negative sows in a herd of 100 sows at the prevalence rate of at least 0.3. One can calculate the expected number of newly infected sows between two consecutive tests applying real life probabilities of virus transfer from a false negative sow. However, in order to improve the simulation of reality we made use of probability distribution of the virus transfer by means of stochastic simulation.

- Loss from culling of sows. Seropositive sows are culled out promptly. By assumption it takes five months to resume the production after a sow is culled out, which corresponds to the interval from selection of gilts to first farrowing in Slovenian large farms (Kovac, 1994).
- Downtime loss. Calculation of this loss was described at the depopulation/repopulation method. The same principles applies here.
- Serologic testing expenditures. Expenditures for serologic testing of sows comprise testing of all sows up to the last seropositive sow plus two sample testings of sows after the last seropositive sow had been removed.
- Weaned pigs vaccination expenditures. It is assumed that vaccination at weaning will take place five months after the disease outbreak. The average litter size of multiparous sows in large Slovenian farms was 9.94 in 1993, while average litter size of first parity sows was 8.71 (Kovac, 1994); weighted average of both litter sizes was 9.64. At the same time 13.69% of liveborn piglets were lost (Stuhec, 1995). Attributable mortality of piglets owing to the Aujeszky's disease is hard to foresee, however it may be as high as 100% (Kluge, 1992). We will adopt literature data of attributable mortality related to a farm where the disease has been diagnosed for the first time (Hoblet, 1987). According to this data, the Aujeszky's disease caused 5% of piglets to be born dead, while piglet mortality rate increases by 21 percentage points.

RESULTS AND DISCUSSION

The calculated costs of the disease eradication at 0.2 prevalence rate equales $67.023 for the depopulation/repopulation alternative and $21.951 for the testing/removal alternative. The downtime losses are by far the most important element, accounting for 80% and 60% of the totals respectively (Table I).

Table I
Calculated costs per Aujeszky's disease eradication alternative (in US$)

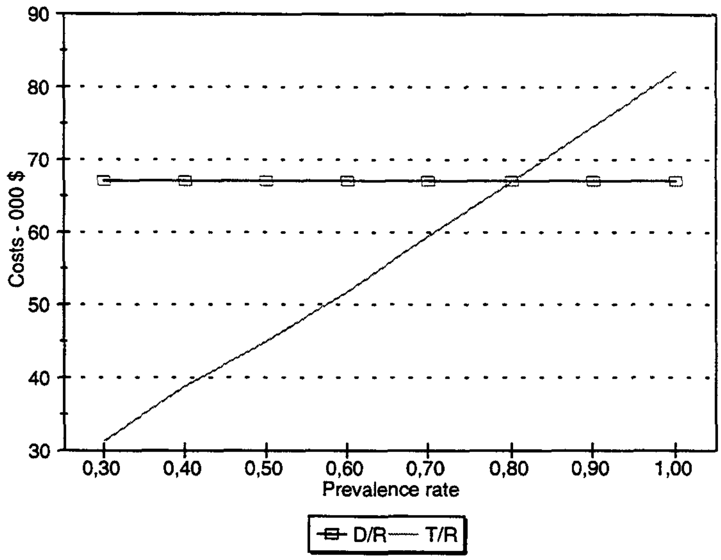
Element	R/D	T/R
Losses from culling	10304	2060
Downtime losses	55971	13993
Serologic testing expenditures	777	5309
Vaccination expenditures	0	589
Total	**67.052**	**21.951**

The crucial question of the analysis is which of the two eradication methods will result in lower costs. However, the costs of eradication are directly related to the future true prevalence rate. It would therefore pay to rephrase the question in the following way: what prevalence rate equates the total eradication costs of both methods. To state it another way, it would be helpful to have the break-even point calculated. Hence, the disease prevalence rates below the calculated break-even point will favour one eradication method, and the prevalence rates above the calculated break-even point will favour another method.

The costs of the test and removal method are nearly linearly related to the disease prevalence rate, while this is not the case with the depopulation/repopulation method. The graphically determined break-even point was established at the prevalence rate 0.8 (Fig. 1). If the prevalence rate at the time of decision-making is below the break-even point, then it is reasonable, taking into account the eradication costs only, to choose the test and removal method.

In face of uncertainty it is not enough to estimate the costs of each of the eradication methods. It is equally important to estimate the accompanying risks; in particular, how does the break-even point move when a particular independent variable is changed. Sensitivity analysis is supposed to disclose how and how much the calculated break-even point is sensitive to the variations in independent variables. The break-even point is very sensitiv to the downtime period. If the downtime period at the depopulation/repopulation method is reduced by a month, the break-even point moves to 0.6. On the contrary, if the downtime is shortened by a month at the test and removal method, the break-even point moves to 1.0. The break-even point is considerably less sensitive to the other variables' changes, and to some (e.g. vaccination costs) it is practically insensitive. Salvage value of a sow, for example, must rise 2.2 times to cause the break-even point to move to 0.7. The basic prices' changes within a real range do not influence the break-even point at all.

Figure 1
The break-even point presentation of the two disease eradication methods



The same calculated break-even point can be found elsewhere in the literature (Thawley, 1989). Authors normally observe depopulation/repopulation as a last resort at the prevalence rate above 0.8. They recommend the use of classical test and removal method whenever:

- the prevalence rate is below 0.3;
- the virus spread is not rapid;
- a farm consists of more than one building with separate ventilation systems.

If stated conditions do not comprise a combination of vaccination and test then the removal of sows is recommended. Of course, if the disease is detected in a country for the first time, this fact itself dictates prompt and radical action.

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