POLICY BRIEF: A framework for estimating society's economic welfare following the outbreak of an animal disease: The case of Johne's disease

Authors: Alyson S. Barratt[1], Matthieu H. Arnoult[2], Bouda Vosough Ahmadi[1], Karl M. Rich[3], George J. Gunn[1], and Alistair W. Stott[1]

Contact details: [1] SRUC; [2] University of Reading; [3] International Livestock Research Institute.

Date: 19/12/2017

1. KEY MESSAGE

This study examined changes in economic welfare (i.e. the net benefit of an action) of the outbreak of Johne's disease in the Scottish dairy herd. The rationale was to understand the direct and indirect costs (effects on market price and quantity) of Johne's disease on producers and milk consumers. The results indicate the extent that producers of herds infected with Johne's, as well as milk consumers, lose out while producers of uninfected herds benefit from the outbreak of the disease. An economic welfare framework is a useful tool to evaluate the economy-wide trade-offs between stakeholders associated with the outbreak of an animal disease.

2. MAJOR FINDINGS

1. The economic welfare analysis suggests an overall indirect loss of £1.61M for Scotland as a consequence of the outbreak of Johne's disease in the national dairy herd.

2. On aggregate at the national-level in Scotland, milk consumers experience the largest economic loss (-£2.82M) associated with the outbreak of Johne's, as a result of a higher milk price (Figure 1). Producers of infected herds also incur economic losses (-£1.14M), suggesting that the higher market price of milk is not sufficient to offset losses incurred from reduced yield and higher production costs. Producers of uninfected herds are the only winners (£2.35M) benefitting from a higher market price because they do not incur additional production costs associated with Johne's (Figure 1).

5. Net economic welfare expressed per cow and per household is reported in Table 1. An infected producer loss (£37.01 per infected cow per year) was two times larger in magnitude than that of an uninfected producer's gain (£16.23 per uninfected cow per year) following the outbreak of Johne's disease (Table 1).

3. OBJECTIVES

This study evaluated changes in economic welfare to milk consumers and dairy producers in Scotland associated with the outbreak of Johne's disease. This provides a better understanding of the costs of prevalence at the national-level and the wider economic welfare implications which consumers and producers experience.

4. POLICY IMPLICATIONS

The evaluation of economic welfare is particularly important from a policy, public good, cost sharing, and human health perspective. The economic welfare framework presented in this study can be applied to other diseases to examine the relative economic burden of the outbreak, or eradication (Weldegebriel *et al.,* 2009), of a disease among stakeholders, besides producers. The results suggest that a Johne's eradication scheme would favour milk consumers and producers of infected herds who experience an economic welfare loss as a result of the disease. However, such benefits are partially offset as uninfected producers lose their comparative advantage. This is a smaller effect and may in turn be offset by reduced costs of maintaining freedom from Johne's disease. Therefore, this framework can be used as a decision-support tool for policy makers to prioritise spending on the prevention and control of alternative animal diseases.

5. METHODS

An economic welfare model estimated the changes in economic welfare associated with the outbreak of Johne's disease at the national-level in Scotland after a year, for dairy producers of

infected herds, producers of uninfected herds, and milk consumers.

Modelling framework

A Markov chain model (Stott *et al.*, 2005) simulated the spread of Johne's at the herd-level by estimating the cost of an infected cow as the difference between the unit variable cost of an infected and that of an uninfected cow.

An economic welfare model simulated the market-level impacts of Johne's disease after a year, estimating changes in the price and quantity of milk produced (Havrila and Arch 1991). Following changes in market price and quantity, net economic welfare of infected producers, uninfected producers, and milk consumers was quantified (Lichtenberg *et al.*, 1988).

Sensitivity analysis evaluated changes in economic welfare associated with a range of input parameter values obtained from the literature.

6. FIGURE AND TABLE

Figure 1: Aggregate net economic surplus in millions pounds for stakeholder groups (i.e. infected producers, uninfected producers, consumers) and Scotland in a year following an outbreak of Johne's.
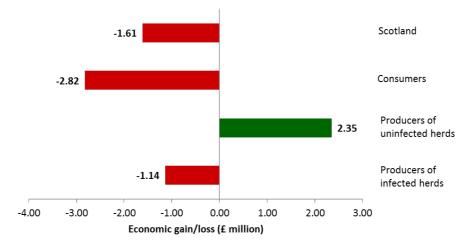

Table 1: Net economic surplus per cow and household in a year following the outbreak of Johne's under alternative Johne's disease prevalence scenarios (i.e. 7.5%, 17.5% and 27.5%) in pounds.

Prevalence (%)	Infected producers (£ per infected cow)	Uninfected producers (£ per uninfected cow)	Consumers (£ per household)
7.5	-19.59	7.75	-0.5
17.5	-37.01	16.23	-1.17
27.5	-44.33	22.55	-1.83

References:

Havrila A, Arch A. Pesticide regulations: Measuring welfare costs with marginal analysis. 35th Annual Conference Australian Agricultural Economics Society (AARES) 1991; February 11-14:2.

Lichtenberg E, Parker DD, Zilberman D. Marginal analysis of welfare costs of environmental policies: the case of pesticide regulation. *Am J Agric Econ* 1988; 70(4):867-874.

Stott AW, Jones GM, Humphry RW, Gunn GJ. Financial incentive to control *paratuberculosis* (Johne's disease) on dairy farms in the United Kingdom. Vet Rec 2005; 156(26):825-831.

Weldegebriel HT, Gunn GJ, Stott AW. Evaluation of producer and consumer benefits resulting from eradication of bovine viral diarrhoea (BVD) in Scotland, United Kingdom. *Prev Vet Med* 2009; 88(1):49-56.

Barratt A.S. , Arnoult M.H., Ahmadi B.V. , Rich K.M, Gunn G.J., Stott A.W.. A framework for estimating society's economic welfare following the introduction of an animal disease: The case of Johne's disease. PLOS ONE 2018 13(8): e0202253.

7. POLICY COMMENTS/RESPONSE