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COST SHARING IN ANIMAL DISEASE MANAGEMENT: A CASE STUDY OF FOOTROT IN SHEEP INDUSTRY

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Abstract:

This paper recommends a cost sharing approach for footrot management in Western Australia (WA). Appropriate public and private contributions are determined through an assessment of the benefits produced by the Department of Agriculture's footrot management program. With rising costs a decreasing departmental budget over time, moves towards a *beneficiary pays* approach to footrot management have been long anticipated. Although the principles underpinning the framework for national animal disease management (put forward by the Centre of International Economics in 1998) have been agreed to by WA industry stakeholders, this paper provides an alternative approach for cost sharing based on the principles of beneficiary analysis.

Summary

This paper recommends a cost sharing mechanism based on a comprehensive review of all the benefits that have accrued to sheep farmers in Western Australia due to the footrot management program undertaken by the Department of Agriculture. Ovine footrot is an infectious disease that causes lameness and results in lost meat and wool production. This is because affected sheep graze less and have difficulty keeping up with the flock at normal walking or grazing speeds.

Various measures for footrot control and prevention have been in place in Western Australia since 1949. An economic evaluation of the benefits and impact of footrot management was only undertaken long after the program was started. Mitchell *et al* (1990) estimated that over a 10 year period the net benefit accruing out of footrot management was approximately \$22 m, and this had already been enjoyed by the sheep industry in Western Australia. Later analyses, including those of Hanna and Thomson (1994) (with the adjustments by Thomson (1994)), also indicated that substantial benefits had accrued to sheep farmers.

Islam (1997) devised a Value Chain Model which facilitates the calculation of the positive externalities, or spill over effects, of treatments. Using this method Che (1999) estimated the benefits to the sheep industry over a 20 year period of eradicating footrot to be approximately \$116 m of which \$68.6 m (60%) would be received by sheep farmers. The rest of the benefits (40%) are spill over effects which benefit abattoirs, butchers and the like.

At the national level the Centre of International Economics (CIE), in 1998 provided a number of comprehensive principles of cost sharing for pest management in Australia. Industries agreed that these principles should be followed at the state level to avoid any inconsistent policies related to this matter.

Beneficiaries are defined as all of the individuals and economic sectors which directly, or indirectly, would be damaged by footrot and thus would be better off with the protection activity in place saving the potential costs caused by the disease. The main direct beneficiaries under the current footrot management project are those in the sheep industry in the high and medium rainfall zones (Zones 1 and 2 of the Agricultural Area, Mitchell *et al* 1990). Therefore, they should participate in the cost sharing of the management of footrot.

Funding arrangements are crucial to the speed with which authorities move to eradicate or contain a disease outbreak. As a part of the cost sharing arguments, CIE developed a table categorising different exotic and endemic diseases according to the private and/or public benefits that accrue from disease eradication. Footrot has been placed in category 4 as it is associated with minor public benefits. This disease is classified as causing mainly production losses.

Hassall and Associates (2001) support this categorisation in their report, i.e. they classify footrot as a category 4 disease. Under category 4, industry would contribute 80% of the costs of disease management. However, in the case of footrot management, as the share of

direct benefits to sheep farmers is 60% of overall benefits, industry should contribute their fair share. In other words, sheep farmers should contribute 60% of the cost of footrot management as they are enjoying the same percentage of overall benefits.

It is therefore recommended that a formal proposal regarding cost sharing of footrot prevention and management in Western Australia be put to the industry based on the following grounds:

- The disease falls under category 4 of the CIE norms.
- The CIE categorisation is supported by an independent consultant (Hassall and Associates).
- The level of benefits being enjoyed by the industry are significant, especially, if current sheep returns are used.

As 60% of all the benefits accrue to the sheep farmers in Zones 1 and 2, it is appropriate that they contribute 60% of the project cost. If the transaction costs of raising their contribution are too high, the wider sheep industry should consider a broader (statewide) fund raising mechanism to cover all animal health issues.

Introduction

Ovine footrot causes severe lameness in sheep flocks, resulting in substantial losses of production. Affected sheep graze less and have difficulty in keeping up with flocks at normal walking or grazing speeds.

Different strains of the bacteria that cause footrot vary from benign to virulent. Host resistance and environmental factors such as climate also influence the expression of the disease. Infections start with bacterial growth on the interdigital skin resulting in inflammation, necrosis and hair loss, described as benign footrot. Virulent footrot is a progression from benign lesion, where the infection may extend to the outer wall of the hoof, detaching the horn from the underlying epithelium (Dr Laurie Depiazzi: pers comm 2002)

Virulent footrot (VFR) has been eradicated from most individual properties in Western Australia. Adequate procedures are available to minimize the risk of reintroduction of footrot onto a clean property. Eradication is possible as the main bacteria, *Dichelobacter nodosus*, can not survive more than a few days in soil, and generally less than a week in a contaminated yard. Clean sheep can be introduced safely to an area two weeks after removal of all infected sheep from the property.

In addition to proactive footrot surveillance at abattoirs and on targeted properties, animal health authorities also rely on farmers to report lameness. Because the bacteria is highly infectious on direct contact, statewide eradication is very difficult without strict controls over the movement of infected sheep. Tracing of any prior movements and the need for skilful inspection of flocks to detect carrier sheep with partially healed footrot lesions are other major tasks in the eradication scheme.

Estimated Benefits to the sheep industry due to footrot management

In estimating the benefits of footrot management, Western Australia has been categorised in to three zones which are: (Zone 1, high rainfall districts in which VFR if present will be expressed as foot lesions during late spring and early summer and can be relatively easily diagnosed on a mob and property basis, Zone 2, the inner wheatbelt in which VFR may not be expressed in a dry year, but is easily diagnosable on a mob and property basis in most wet years, and Zone 3, the outer wheatbelt in which VFR is uncommon other than in recently introduced sheep and in which VFR is less likely to be established. Empirically, it has been established that most of the benefits of the footrot management flow through to the high rainfall and inner wheatbelt zones. The benefits flowing to the outer wheatbelt zone is negligible although it has been included in the estimation process.

The benefits of footrot control to the sheep industry are the savings of the potential production and output losses. The following factors are highest with severe VFR strains in Zone 1 and lowest with mild VFR strains in Zone 3:

- Reduced wool production (0 to 9%)
- Loss of body weight (0 to 15%)
- Increased susceptibility to fly strikes (incurring an average additional cost of 34 to 36 cents per sheep)

- Reduced fertility (0 to 8%)
- Increased mortality rate (0 to 4%)

The range of output losses arise due to the differences in the virulent and benign strains of footrot which are present. The above mentioned variables have been incorporated in a simulation process to calculate the stream of benefits over a 20 year period. It is important to note that the beneficiary and impact analysis provides both the farm and non-farm benefits. In other words, positive externalities emanating out of the footrot management program have been included in estimating the potential benefits and impacts on the sheep and the related industries. Details of the estimation process and related equations can be found in appendix 2.

Methodology

All economic estimations are carried out under the assumptions of uncertainty concerning the key economic variables. Past time series data have been used for estimating the main parameters, such as the numbers of flocks, numbers of sheep in flocks in Zones 1, 2 and 3, and the prices of sheep products etc. In total 16 variables have been used for the simulation process. The iteration limit for the analysis has been set at 500.

Results from the beneficiary and impact analysis

The results of the beneficiary and impact analysis are presented in Table 1 below. As stated earlier, both the farm and non-farm benefits have been incorporated for calculating the overall benefits. The Value Chain Model (Islam 1997) has been used for estimating these benefits, which provides a clear distinction between the direct farm benefits and the spill over effects. In other words, the benefits accruing out of positive externality are distinct from the benefits accruing directly to sheep farmers.

Table 1. Direct and indirect economic benefits for footrot management in Western Australia

	Value	Benefit share
Sheep Farms in Zone 1 and 2	\$68,656,000	58.8%
Abattoir	\$11,126,000	9.5%
Other meat processing	\$2,787,000	2.4%
Tannery	\$3,762,000	3.2%
Wholesale	\$267,000	0.2%
Retail	\$15,596,000	13.3%
Meat export	\$387,000	0.3%
Live Animal Export	\$5,880,000	5.0%
Wool Auction	\$1,177,000	1.0%
Wool Private Treaty	\$294,000	0.3%
Wool Processing	\$1,384,000	1.2%
Wool exports	\$2,066,000	1.8%
Additional consideration and Zone 3	\$3,451,000	3.0%
TOTAL	\$116,834,000	100%

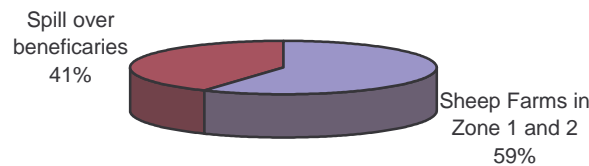
Note The total benefit over a 20 year period is \$116,834,000 out of which the direct farm benefit for sheep farms in Zones 1 and 2 is \$68,656,000 (in bold in Table 1), which is 58.8% of all benefits. The rest of the

benefits accrue due to various positive externalities of the Footrot Management Program and can be considered as spill over effects. The annual flows of direct benefits are presented in Appendix 1.

The results in Table 1 are based on the Hanna and Thomson (1994) model with extension of Islam's (1997) Value Chain Method. The estimated result is calculated as the present value of benefits over a 20 year period with a 7% discount rate. The major direct beneficiaries are sheep farms in Zones 1 and 2. The detailed breakdown of benefits of Zones 1, 2 and 3 are provided in appendix 1 with the additional benefits being those additional costs saved in the Hanna model.

The apportionment of direct and indirect beneficiaries are presented in Figure 1 below.

Figure 1: Share of Direct and Indirect Benefits of Footrot Management



Cost sharing arrangement

The above diagram can be considered as a basis for a cost sharing arrangement. The majority of the benefits, and almost all the direct benefits, accrue to the sheep farmers in Zones 1 and 2.

At the national level the CIE (1998) provided a number of comprehensive principles of cost sharing and disease management. Following those principles, disease management has broadly been categorised in four types. The underlying principle of the cost sharing basis is “beneficiaries pay” : in this case the beneficiary is the sheep industry. According to both the CIE (1998) and the Hassall and Associates (2001) reports, footrot falls under category 4 which indicates a cost sharing of 20:80 (Government/Industry) split in percentage terms. However, the proportion of benefits received by the sheep farmers and the rest of industry is 60:40 (Sheep farmer/Rest of the industry split in percentage terms)

Control of Category 4 diseases is associated with benefits and costs to producers but with low public benefits. These are diseases that could be classified as being mainly production losses. Whilst there may be some international and domestic trade ramifications, these would not be of the magnitude to disrupt the overall economy. The main beneficiaries of the eradication of these diseases are the livestock industries. Under these circumstances, the government does not directly benefit from the disease management.

Conclusion and recommendation

The result of this beneficiary and impact analysis establishes that the sheep industry in Western Australia, especially the sheep farmers in Zones 1 and 2, are the main

beneficiaries of the Footrot Management Program. Approximately 60% of all the benefits, and almost all of the direct benefits, flow through to the sheep farmers in these two zones. In addition, footrot is recognised as a category 4 disease which does not have any significant public benefits or impact on the overall economy. Therefore, under these circumstances the direct beneficiaries should contribute their fair share, aiming for 60% of the cost of the eradication program.

It would be prudent to continue the Footrot Management Program if the sheep industry agrees to contribute the said percentage of cost. If it is not possible for industry sources to make a significant contribution to project costs from 2003-04, the Department of Agriculture reassess its financial contribution to the project.

The mechanism for determining and raising contributions from producers in different zones should have regard for the transaction cost involved.

Appendix 1: Stream of benefits for footrot management in Zones 1, 2 and 3.

The period covered by this analysis is from 1996 to 2014.

Year	Zone 1	Zone 2	Zone 3	Additional benefit
1996	\$115,722	\$37,102	\$0	\$0
1997	\$744,684	\$375,456	\$11,843	\$116,360
1998	\$1,265,148	\$671,978	\$22,137	\$217,496
1999	\$1,714,328	\$939,017	\$31,033	\$304,901
2000	\$2,099,321	\$1,168,240	\$38,670	\$379,939
2001	\$2,426,605	\$1,363,452	\$45,175	\$443,854
2002	\$2,702,081	\$1,528,123	\$50,664	\$497,781
2003	\$2,931,129	\$1,665,412	\$55,241	\$542,751
2004	\$3,118,643	\$1,778,199	\$59,002	\$579,708
2005	\$3,269,078	\$1,869,100	\$62,035	\$609,506
2006	\$3,251,023	\$1,862,878	\$61,842	\$607,607
2007	\$3,133,287	\$1,795,414	\$59,602	\$585,603
2008	\$2,957,885	\$1,694,906	\$56,266	\$552,820
2009	\$2,764,378	\$1,584,024	\$52,585	\$516,654
2010	\$2,583,531	\$1,480,396	\$49,145	\$482,855
2011	\$2,414,515	\$1,383,548	\$45,930	\$451,266
2012	\$2,256,556	\$1,293,036	\$42,925	\$421,744
2013	\$2,108,931	\$1,208,444	\$40,117	\$394,153
2014	\$1,970,963	\$1,129,387	\$37,492	\$368,368
Total	\$43,827,807	\$24,828,112	\$821,703	\$2,628,903

The main statistics are from Annan (1999) with the original source being the Australian Bureau of Statistics.

Appendix 2: Equations used in the model for calculating the benefits and impacts for footrot management in Western Australia

Potential benefit of disease management in the sheep industry

For our purposes, in this analysis the stream benefit generated from the disease management activity in farm sector (TB_F) is given as

$$TB_F = \sum_{i=1}^n \sum_{k=1}^m \frac{(c_k)(N_i^E - N_i^0)}{(1 + \rho)^i} \quad (1)$$

where n is the life-time of project; m is the number of cost items for production loss (c); c_1 is wool loss; c_2 is body weight loss; c_3 is loss from increased mortality; c_4 is loss from increased susceptibility to fly strike; c_5 is loss from the decreased ability to rear a lamb to weaning; superscription E and 0 indicates a scenario with and without footrot management activity; and N_i^E and N_i^0 are the number of infested sheep at year i with and without footrot management activity respectively.

Following the Hanna model N_i^E and N_i^0 is given as

$$N_i^E = (n^E(1 - f^E) + n^E(f^E)(1 - r^E))F \quad (2)$$

$$N_i^0 = (n^0(1 - f^0) + n^0(f^0)(1 - r^0))F \quad (3)$$

where n is footrot prevalence within a flock if the farmer does not treat during spread; r is reduction in infested sheep with treatment for footrot during spread; f is the proportion of farmers with infested flocks that treat during spread; and F is the number of infested flocks (Mitchell et al 1990, Che 1999).

Potential benefit of disease management in the non-farm sector

The analysis of the footrot impact by Mitchell *et.al* (1990) argues that there are only indirect spillover impacts on the non-farm sectors, those only connected directly to the sheep industry. There are several models for measuring the negative and indirect impact of Footrot in non-farm sectors. For simplification, it is assumed that (i) there is a linear relationship in the production gross line between farm and non-farm sectors and (ii) only one period (static) of impact is considered. In such a case, using either value added statistics or cash flow statistics in farm and non-farm sectors, we can measure approximately the impact of effects of footrot through the economic sectors that are in the “chain” from farm output to final product.

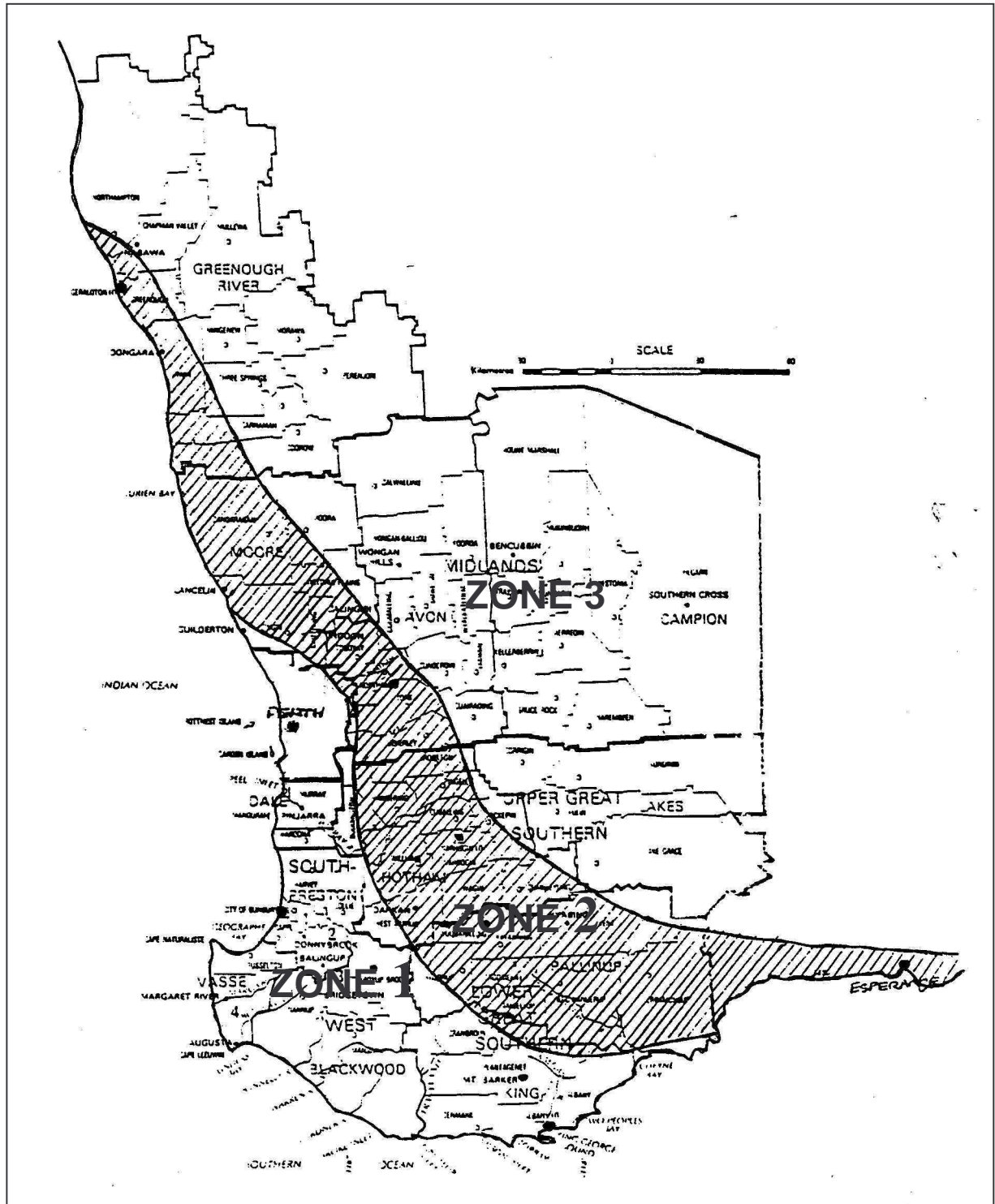
However, it is not enough simply to take the value added in the non-farm sector (corresponding to the potential cost in the farm sector) as a proxy for the potential loss or the potential benefit saved. More relevant models are still needed in which the main parameters for estimation are drawn from either value chain estimation or farm and non-farm budget cash flow. It can be argued that there is a rational expectation or self-adjustment in resource allocation so that the potential cost of Footrot is not simply the total value added (including both salary and benefit). In the simplest way, the Australian Animal Health Council indicates that the true cost is the difference between the current benefit rate made by non-farm sectors and the standard interest rate on bonds (5%).

The stream benefit generated from the disease management activity in the non-farm sector (TB_{NF}) is given as

$$TB_{NF} = \left(\sum_{i=1}^n \sum_{j=1}^k TB_F^{SH}(w_j)(\psi_j - \Pi^0) \right) + \left(\sum_{i=1}^n \sum_{j=1}^l TB_F^W(w_j)(\pi_j - \Pi^0) \right) \quad (4)$$

where TB_F^{SH} and TB_F^W is the total potential benefit of disease management for sheep and wool industry respectively; k and l is number of economic sectors connected directly to sheep and wool product in the “chain” from farm gate to consumers; j indicates the j th number of the economic sector; w_j is the weighted ratio of the economic sector j in the economy measured as the ratio of total output of that sector to the total output of sheep or wool industry; ψ_j and π_j are the benefit rates of economic sector j in the “value chain” for sheep product and wool respectively; and Π^0 is the standard interest rate of resource used.

Appendix 3: Footrot zones in Western Australia



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