The Bio-economic Feasibility of Selection for Health & Production in the UK Sheep Industry

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MLC

INTRODUCTION

THE ECONOMICS OF DISEASE CONTROL & GENETIC SELECTION

The total cost (TC) of a disease can be divided into its fundamental components of production losses (L) and control expenditure (CE), incurred as a result of the disease. The scale of investment made in controlling the disease will decide the overall detriment faced. The *economic optimum* of investment occurs at a particular combination of (L) and (CE) where the (TC) is minimised.

The "Loss-Expenditure Frontier" (LEF) model is a method of locating the economic optimum of disease control. It can constructed for any given disease by evaluating both likely (L) and (CE) required for each of the available methods of control. The frontier is then developed as a line of best fit from the two extremes of investment (Max L tolerated) & (Technical Optimum). The line is a curve because of the law of diminishing returns (whereby it becomes progressively more difficult to reduce (L) for an increase in (CE)).

If elimination of a disease is possible the frontier will intercept the x-axis (whereby (L) are completely minimised). It is not possible for a current means of control to exist below the frontier due to the technical limitations in reducing (L). Any method above the frontier is regarded as inefficient because for the same investment in (CE); (L) could be reduced by other means. The economic optimum is located by means of marginal criterion analysis (the point at which a -£1(L) is obtained via +£1(CE) offers little incentive to change investment).

Livestock with a degree of natural resistance to disease have the potential to vastly reduce both (CE) whilst simultaneously minimising (L). Animal welfare and food safety will also be likely to be enriched. As a new technology genetic selection may lie below the current frontier in the (LEF) model. Thus, genetic selection for disease resistance is in essence a highly attractive proposition

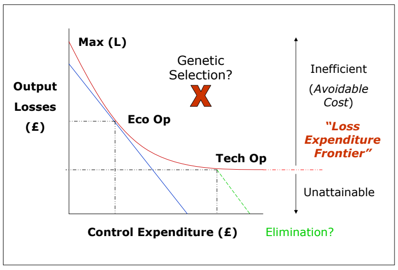

Figure1: The Loss Expenditure Frontier Model

Genomic based commercial breeding programmes could be established as a viable means of disease prevention on the basis of DNA sampling (most likely involving MHC II haplotype). Conversely, a more rudimentary approach to resistance breeding could involve on farm selection using resistant or resilient phenotypes noted in farming records to assign parentage. The most appropriate method will likely be disease specific.

At what true alteration in (CE) (and other practicalities) such a breeding programme for resistance could be implemented and disease specific efficacy in reducing (L); have yet to be comprehensively determined in the UK.

The overall objective of this PhD is to place genetic selection as a means of disease prevention in relation to the economic optimum for the existing methods of control for a variety of diseases.

DISEASE ANALYSIS

The question then arises of how to select the most appropriate diseases in sheep for this analysis. A literature review was performed of the most prevalent UK diseases; discriminating on the basis of four factors, with bias given to the most relevant:

Incidence (/k/yr) **Welfare Risk** (Subjective)

Economic Impact (£m/yr) (Double Score)

Genetic Selection Potential (Subjective) (Double Score)

Scores were then allocated to each disease depending on their assessment for each category. The breakdown of the individual results is show in (*Figure2*)

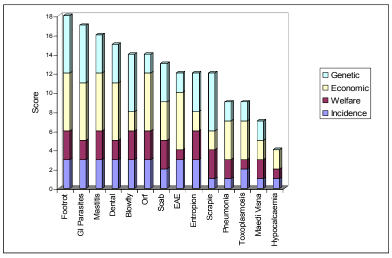

Figure2: Analysis of Appropriate Diseases

Footrot was the highest scoring disease in this analysis, obtaining maximum points in each category. Footrot is an extremely painful condition reported to be problematic on 90% of UK flocks (along with scald) and affecting 8-10% of UK sheep. Its causative agent is the anaerobic soil bacterium *Dichelobacter nodosus.* It is estimated to cost the UK sheep industry approx. **£25m/yr** (£1.32/ewe and £0.15/lamb). Thus, it is an excellent berth for this project.

METHODOLOGY

The objectives of this economic assessment of footrot control are to:

- *Construct a (LEF) for existing methods of footrot control in the UK*
- *Place genetic selection as a means of footrot control in relation to other existing methods within this framework*
- *Evaluate the overall reception and likely success of the implementation of genetic selection at some level in the UK sheep industry*

In order to construct the (LEF) it is first necessary to consider elimination as a means of controlling footrot in the UK (**1**). Since this is not a viable option given the prevailing UK climate; current control methods must then be considered in terms of their efficacy in reducing incidence of footrot, (L) attributable to each case and (CE) investment.

In order to assess the (L) attributable to footrot data from 750 ewes from a lowland farm in Oxford, their lambs and their lameness records from the period 2005 – 2007, have been analysed along with data regarding their associated (L). The initial analysis from this is shown below under the heading "(L)".

In order to construct a detailed picture of the current lameness management effort from which to estimate (CE), a postal questionnaire was sent to 265 farmers in Nov 2006 (63% response rate). Current farmer opinion regarding their management of lameness was also gauged. Examples of results from this questionnaire are illustrated below under the headings "(CE)" and "Social Aspects of Change".

RESULTS

PRODUCTION LOSSES (L)

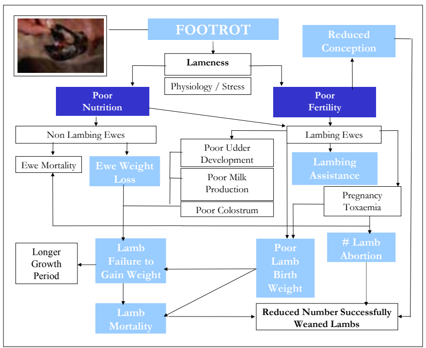

***Figure3**: Estimated Production Losses Associated with Footrot*

The expected key areas of (L) associated with footrot (blue) are based upon poor nutrition and fertility; including reduced lambing % and poor lamb growth (*Fig3*). In order to quantify (L) to a typical case of footrot; multiple regression analysis was used to directly correlate a developed scoring algorithm (based upon the severity of the lesion on each foot of the sufferer) and the associated (L).

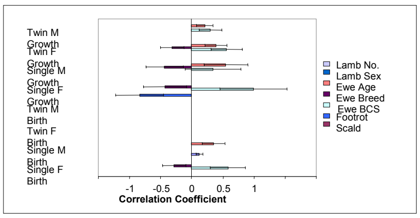

***Figure4**: Lambing 2005: Lamb Birth / Growth & Footrot Score*

This initial direct assessment has proven difficult. In (*Fig4*) the only significantly associated (L) with footrot is reduced single female lamb growth. This apparent failure can be attributed to the temporal limitations in the restricted periods of recording footrot lesions. An indirect assessment which associates lameness score throughout the year and (L) is ongoing. While not temporally restricted it is not a direct assessment. Attempts to establish a bridge between lesion score and lameness score were made in a longitudinal study in Oct 2006.

CONTROL EXPENDITURE (CE)

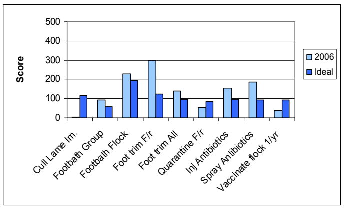

***Figure5**: Ranked Preference: Footrot Prevention*

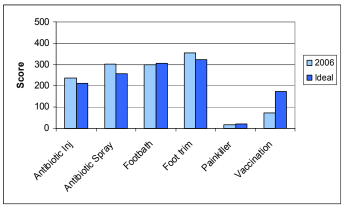

***Figure6**: Ranked Preference: Footrot Treatment*

In order to assess the popularity of current footrot control and place these in relation to genetic selection in the future, farmers were asked to rank their top 5 methods for footrot prevention (*Fig5*) and treatment (*Fig6*) in 2006 and also in an "Ideal" context. The % of farmers who ranked each method was multiplied by that rank, giving a total score /500.

For prevention it can be seen that foot trimming diseased feet (*299*) was the most popular measure for 2006, followed by flock footbathing (*230*) and spray antibiotics (*184*). In an ideal context the most popular was flock footbathing (*195*), then foot trimming diseased feet (*125*) and culling lame sheep immediately (*117*). The largest difference between the contexts was for culling lame sheep (*+113*) and trimming feet (*-174*). For treatment, foot trimming (*324*) was the most popular option for 2006, followed by footbathing (*305*) and spray antibiotics (*258*). Unlike prevention there was no real significant divergence between the contexts, except for vaccination (*+100*).

It may be hypothesised from these results that due to the significant difference between the contexts for the prevention of footrot; there may be a niche for a new preventive technology such as genetic selection.

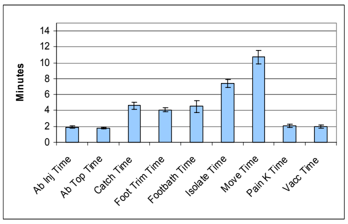

***Figure7**: Lameness Management Time*

Farmers were asked to estimate the duration of each lameness management in minutes (*Fig7*). Combining this information along with the % of farmers who indicated that they use these methods will allow for the creation of an idea of the total labour effort which currently goes into the management of lameness in the UK. From this comparisons can be made regarding any likely alleviations made by the introduction of genetic selection as a means of footrot prevention.

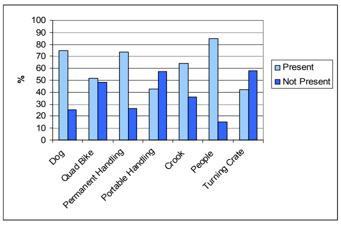

***Figure8**: Resources for Lameness Management*

Farmers were asked to indicate their ownership and use of resources utilised for lameness management (along with reasons for not doing so, if appropriate) (*Fig8*). By compiling this information it will be possible to estimate the investment saved by the use of genetic selection which may make some resources redundant (e.g. use of costly mobile handling systems as 40% farmers indicated, may not be feasible if genetic selection as a preventive measure only requires the treatment of a small %/yr)

SOCIAL ASPECTS OF CHANGE

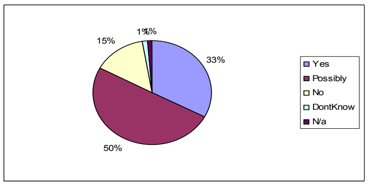

***Figure9**: Farmer Incentive to Alter Lameness Management*

83% of interviewed farmers suggested they would either consider (50%) or definitely (33%) change their current management practices (*Fig9*) – an encouraging sign for the widespread implementation of selection against footrot.

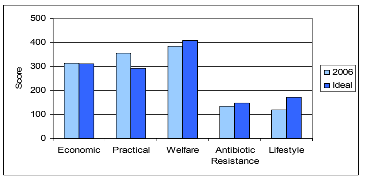

***Figure10**: Ranked Lameness Management Priorities*

Animal welfare, practical and economic interests were clearly shown to be key priorities in lameness management in both 2006 and an "Ideal" context (*Fig10*). If genetic selection can be demonstrated to appeal to these areas of management; its introduction is likely to be met with success.

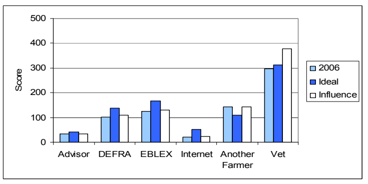

***Figure11**: Ranked Sources of Information*

The high faith placed in vets by farmers in contexts of 2006, "Ideal" and "Most Influential" as sources of information is underlined above (*Fig11*). Influences on technology transfer are an important consideration when attempting to introduce new practices such as genetic selection

CONCLUSION

INITIAL INFERENCES & FUTURE AIMS

Initial analysis has demonstrated the potential for a new technology in the prevention of footrot and that further continuation of this will likely prove of value. Future investigation into the (L) associated with footrot and the relevant (CE) will lead to the construction of a (LEF) from which inferences regarding likely success of genetic selection can be drawn. If this is proven successful, this process may then be repeated for other diseases.

REFERENCES

1.Assessment of current knowledge of footrot in sheep with reference to *D.nodosus* and implications for elimination or control strategies for sheep in GB, L.E.Green & T.R.N.George (Accepted), Veterinary Journal, 2007

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