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REVIEW ARTICLE

A REVIEW ON ANIMAL HEALTH ECONOMICS

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ABSTRACT

Animal Health Economics is a discipline that aims to provide a framework of concept, procedures and data to support the decision - making process in optimising animal health management. Research in Animal Health Economics deals with quantifying the financial effects of animal disease, developing methods for optimizing decisions when individual animals, herds or populations are affected and determining the costs and benefits of disease control. Key achievement of this discipline is the establishment of epidemiological and economic techniques as offering a distinctive and successful method of investigating and resolving animal health problems. Economic analysis compares the cost of tolerating a disease with the cost of controlling it and allowing animal health improvement strategies to be planned in such a way as to obtain maximum benefit from available resources. This article attempts to give an overview on this new emerging discipline.

Key words: Animal Health Economics, epidemiological and economic techniques, economic analysis of disease, Quantitative technique.

INTRODUCTION

Though significant progress has been made in the last four decades in reducing the prevalence of animal diseases of economic importance, there is still an increasing concern over the losses associated with diseases that cause reduction in production efficiency. In response to this, the disciplines of epidemiology and economics are now being applied to animal health problems to specifically evaluate the causal relationships, predict and measure the levels of association and prescribe the optimal preventive and /or control measures of such diseases that cause reduced production (Ngategize and Kaneene, 1985). In order to effectively measure the impact of a disease, one has to be able to identify the effects it has on the animal. This is not a simple task because disease effects (Ngategize and Kaneene, 1985): (a) are not always obvious and pronounced (b) are influenced by other factors such as management (e.g nutrition and housing) and environment (c) have a temporal dimension which adds to the complexity of evaluating their impacts at different stages in time and (d) often manifest themselves in a complex with other diseases. In an attempt to overcome the above problems, different types of statistical, epidemiological and economic models have been developed. Animal Health Economics is relatively a new subject that has been developed to provide quantitative insights into the economic impact of disease and disease control in livestock (Scharenaad and Dijkhuizen, 1990).

The Scientific foundation for the discipline of Animal Health Economics was laid around 20 to 25 years ago in Australia (Morris, 1969) and England (Ellis, 1972). The Netherlands is one among the countries that first adopted the new approach, initiated by the work of Renkema and Stetwagen (1979). Animal Health Economics is a discipline that aims to provide a framework of concept, procedures and data to support the decision - making process in optimising animal health management (Dijkhuizen *et al.*, 1994). Animal Health Economics is progressively developing a solid framework of concept procedures and data to support the decision making process in optimizing animal health management (Dijkhuizen *et al.*, 1995). Research in Animal Health Economics deals with quantifying the financial effects of animal disease, developing methods for optimizing decisions when individual animals, herds or populations are affected and determining the costs and benefits of disease control, (Dijkhuizen *et al.*, 1995).

Theme of Animal Health Economics

Key achievement of this discipline is the establishment of epidemiological and economic techniques as offering a distinctive and successful method of investigating and resolving animal health problems (Morris, 1995). Economic analysis compares the cost of tolerating a disease with the cost of controlling it and allowing animal health improvement strategies to be planned in such a way as to obtain maximum benefit from available resources (Ndiritu and McLeod, 1995). Disease loss estimation is not just a problem of measurement, it is a problem of decision making. Conversely, quantification

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of economic losses due to disease is not very important in itself, but it can help to provide a better overall view of the impact of diseases and can contribute to estimating the extent of the losses to be avoided. Quantification of disease losses is not only important for describing the actual situation but also to answer two inter-related set of questions : (a) How to limit the loss by veterinary intervention (b) what efforts are required to avoid the losses and at what cost? (Thirunavukkarasu, 1996). Animal Health Economics also helps in determining the profitability of specific disease control and health management programs and procedures (Dijkhnizen and Morris, 1997). Economic characterization of the actual situation would answer questions like to what extent does the problem in its various forms occur; what are the effects on production, mortality etc., expressed in physical terms' and 'how can these physical effects be expressed in financial terms' (Enting *et al.*, 1997). The provision of appropriate information to decision makers is vital for livestock health and disease - control decisions (Bennett, 1992). Information generally needed are the disease and production systems, the physical effects of disease and its subsequent effects on production systems, the incidence and /or prevalence of disease, technologies and options available to control disease and improve health and productivity, impact of disease and control options on other systems (eg - human health) and evaluations of the effects of disease and of strategies for control (Bennett, 1992). Controlling the cost of production is becoming critically important in modern livestock farming and improving animal health and fertility is expected to play a major role in achieving efficient and economically rewarding production (Dijkhnizen *et al.*, 1994). It leads to mean that economic considerations are increasingly forcing their way forward in decision making process of animal health management.

Epidemiology and Economics

The evaluation of veterinary epidemiology in the past 30 years has provided a strong base in infectious disease epidemiology. Quantitative methodologies have been developed and applied to numerous animal disease problems (Dorn, 1992). The reputation of veterinary epidemiology has been enhanced by the successful resolution in certain countries of animal disease problems such as Hog cholera, Brucellosis, Bovine Tuberculosis and outbreaks of foreign animal diseases. The interaction of veterinary epidemiology and agricultural economics had helped to focus epidemiologists and veterinarians , on economic importance of the disease (Dorn, 1992). Veterinary epidemiology is the study of disease within livestock population and economic analysis is a natural progression from epidemiology, since it attempts to put values to estimates of biological productivity effects and to relate the level of disease in a livestock population with its cost to a farmer or society (Ndiritu, 1994). Epidemiological modelling gives insight in to the population dynamics of the infectious agents that was obtained in the process of model building and model analysis and interprets experimental and observational data (de Jong, 1995). Disciplines usually emerge from drawing on techniques from number of existing fields and using them in new ways to create an identifiably separate set of tools and techniques, which form the basis of the new discipline. Animal Health Economics has drawn techniques from Veterinary Medicine, Agricultural Economics, Epidemiology, Biometrics and various other fields (Morris, 1995).

Durability of veterinary epidemiology and economics as a discipline will depend on its contribution to problem-solving and its evolution suggested that it can make a continuing contribution to offer a distinctive and successful method of investigating and resolving animal health problems, (Morris, 1995). Economic analysis and epidemiology are identified as natural allies since the combined disciplines allow animal health improvement strategies to be planned and evaluated, (Ndiritu and McLeod, 1995). Epidemiological models are used to identify the factors that contribute to the development of disease conditions, the magnitude and directions of the contributions and relationships between diseases and other animal conditions . After the causes of a disease have been identified, disaggregated and quantified, economic models will attach monetary value to the quantified impacts (Ngagegize and Kaneene, 1985). The disciplines combining veterinary epidemiology and economics is likely to answer the following questions (Nadiritu and McLeod, 1995)

- a. How much disease is there?
- b. What are the biological effects of ill health on productions systems?
- c. What are the economic effects?
- d. What are the cultural or institutional constraints to improve health?
- e. What are the priorities for actions in improving animal health?

Answers to these questions will help prudent decision making process of animal health management. The main contributions of veterinary epidemiology and economics is improved disease control through enhancing the decision making process on issues relating to the use of different control options (Perry and Young, 1995).

Animal Health Economics Research across the World

Quantitative techniques in Animal Health Economics: The models used in evaluation of economic impact of animal disease on production can be grouped under two headings namely statistical / epidemiological models and economic models (Ngagegize and Kaneene, 1985). Statistical / epidemiological models are used to identify the factors that contribute to the development of disease conditions, the magnitude and direction of the contribution, and relationships between diseases. Common models in this category include Regression analysis, Path analysis, Discriminant analysis and Analysis of variance. After the causes of a disease have been identified, disaggregated and quantified, the next step is to attach monetary value to the quantified impacts. Economic models used for this purpose are Equimarginal principle, Partial budgeting, Cost-benefit analysis, Decision analysis, Linear programming, Markov chains, Systems simulation and Dynamic programming (Ngagegize and Kaneene, 1985). Economic quantitative techniques like mathematical programming, network analysis, decision analysis, simulation and cost benefit analysis were helped the decision makers to choose appropriate livestock health and disease-control strategies and the value of information from these quantitative techniques would depend upon skill and judgment of analysts (Bennett, 1992). The relationship between repeat breeder syndrome and six common risk factors namely herd characteristics and environment, nutrition during dry period,

disease which occurred within 72 hours of calving, disease which occurred after 72 hours after calving, reproductive management and milk production were examined by principle component analysis and the association among the significant risk factor were quantified through a path model (Lafi and Kaneene, 1992). Partial budgeting, cost-benefit analysis, decision analysis and systems. Simulation techniques could be used in making animal health economics decision (Dijkhnizen *et al.*, 1995). A stochastic dynamic programming mode based on the hierarchic Markov process technique was used to optimize economic decisions with respect to dairy cow health (Hoben, 1995). Partial budgeting technique was used to estimate the costs of outbreaks of clinical Listeriosis in sheep flocks with different risk factor profiles (Nash, *et al.*, 1995). Economic surplus analysis was used to measure the national economic benefits which would accrue by reducing livestock mortality taking into account of increased market supply due to lower death loss (Ott, *et al.*, 1995).

Research in Animal Health Economics: Mid-west Veterinary Association of Australia, implemented a farm preventive medicine scheme in 16 farms and the financial advantage to the livestock owner of the preventive medicine service was evaluated in terms of measurement of productivity (Grun sell *et al.*, 1969). The total annual economic losses to dairy man in the United States attributable to mastitis was estimated at \$400 to \$500 million and US \$23 per cow in 1970 and instituting and maintaining a program of prevention and elimination of infection could reduce losses from mastitis by 50% or more (Janzen, 1970). The costs associated with mastitis were found as decreased milk yield, discarded milk increased need for replacement of cows, decreased sale value of cows, drugs, veterinary services and increased labour (Blosser, 1979). Using a simple manual recording system Blowey (1986) estimated the cost of an average case of mastitis as £40 and the mastitis control scheme reduced the losses due to mastitis by £772 per 100 cows per year and a more than 12 fold return on investment in veterinary services in Gloucestershire was achieved. An investigation into economic losses due to paratuberculosis in dairy cattle found the losses were due to one or more of the following components (Benedictus *et al.*, 1987); first, losses before culling which includes production loss and examination and treatment costs, secondly, losses at culling which includes reduced slaughter value and ideal production factor, thirdly, losses due to premature culling which is unrealised future income due to paratuberculosis. Financial losses due to retained Placenta in Dutch dairy cattle from a data set of birth records and reproductive performance of cows with and without retained placenta were simulated in a computer farm simulations model, based on a Stochastic determination of events (Joosten *et al.*, 1988). Financial losses of retained placenta were due to increased calving interval, increased culling rate, loss of milk production, the costs of veterinary treatment and drugs. The sensitivity analysis showed that the greatest financial losses due to retained placenta were caused by loss of milk production, followed by the number of animals suffering from the complication. Relative magnitude of costs associated with mastitis in Ohio for a 12 months period during 1986 and 1987 using National Animal Health Monitoring System indicated that the milk loss accounted for 80% of the total cost of mastitis (Lightner *et al.*, 1988). The cost of fowl cholera in Turkey per kg of live production was estimated at

\$0.015 through case records, flock records and telephone and mail survey of Georgia commercial turkey flocks.(Morris and Fletcher,1988). The economic impact of Repeat Breeder Cow Syndrome and related risk factors and the economic effects of changing some nutritional risk factors during dry period that influenced Repeat Breeder Cow Syndrome was estimated through partial budgeting (Lafi *et al.*, 1992). The losses and the benefits of theileriosis control by the 'infection and treatment method of immunization 'in Africa was estimated by using a computer spread sheet model with the parameters such as national size and structure of cattle herds, estimated impact of disease in terms of incidence, case morbidity rate, case fatality rate and the effect of immunization on the disease. The calculated benefit cost ratio of immunization programme was in the range of 9-17 (Mukhebi *et al.*, 1992).

Milk production loss due to mastitis was estimated by comparing performance of an infected quarter with the performance of the opposite uninfected one, or by comparing the present lactation with the previous lactation for the same cow or by comparing the identical twins or by comparing infected cows with uninfected cows (DeGrawes and Fetrow, 1993).

Benefit-cost analysis was used to evaluate the current African Swine Fever eradication programme in Spain with an alternative accelerated programme (Bech-Nielsen *et al.*, 1994). The macro economic implications of a non-cost reducing hypothetical technology, induced over a 5 year period, that reduced the swine mortality by 1% but did not alter the cost of production per unit, was studied with a dynamic simulation model of livestock industry and the macro economy to trace over a period of time (Year 1992-2000). The implications for an increase in the supply of live hogs by 1% diffused equally over the first 5 years and the economic impact was assessed (Crooks *et al.*, 1994). The costs and benefits of vaccinations against paratuberculosis in Netherlands were estimated at US\$ 15 and US\$ 143 per cow respectively, It was also found that the selective application of vaccination to cows that run an increased risk of clinical infections could further increase the profitability of vaccination programme (Dijkhnizen *et al.*, 1994). Cost minimization analysis by Defour and Mouton, (1994) found that the vaccination scheme against Foot and mouth disease in France in 1990 was costed FF 237,721,315 and the non vaccination scheme costed FF 18,846,094. Comparing the individual milk production curves of cows with mastitis, with that of healthy lactation cows, the milk production loss due to mastitis was estimated (Lescourret and Coulon, 1994). Majority of the benefits derived from the Psedo rabies Virus Eradication Programme implemented in the US in 1989 accrued to consumers of pork products rather than pork producers as estimated by benefit cost analysis. (Miller *et al.*, 1994). A whole farms simulation model termed as Technology Impact Evaluation Systems (TIES) was applied for assessing ex-ante financial and economic impacts of immunization of dairy cattle against East Coast Fever by the infection and treatment method or ITM (Nyangito *et al.*, 1994). Additional costs and returns of caesarian section in dairy cattle worked out through a partial budgeting model on a personal computer from the data recorded on 35 farms in Netherlands over 8 years period was estimated at a loss of Dfl 447 per caesarian section (Rougoor *et al.*, 1994). Benefits of Tsetse control using a deterministic herd model with and without Tsetse control were projected by Shaw, *et al.*, 1994.

Cost-benefit analysis of present vaccination policy against Foot and Mouth Disease and a situation if vaccination and quarantine measures were not implemented was estimated in Israel dairy herds (Van-Hans and Zur, 1994). Tick eradication programme in Kuroshima Island Okinawa, Japan was evaluated by Yamone *et al.*, 1994 through cost-benefit analysis of the retrospective data from 1981 to 1993 which took account of mean annual losses due to Babesiosis and ticks before the eradication programme. Informal livestock disease scoring technique was used to collect information on pastoralists perceptions of animal health problems in Somaliland (Catley, 1996). In Costa Rica, the milk production loss per affected quarter due to sub-clinical mastitis was found to be 17.6% on average in cows with sub-clinical mastitis compared to cows without signs of sub-clinical mastitis. (deGraft and Dwinger, 1996). Benefit-cost ratio of veterinary intervention programme of Dutch Committee in Afghanistan was calculated as between 1.8 and 4.8 (Schrender *et al.*, 1996). Partial budgeting model which included all physical effects of Clinical lameness in dairy cattle showed the average losses from clinical digital disease per foot-lame low were NIG 230 per year (Enting *et al.*, 1997).

Economic consequences of introduction of contagious animal diseases in to the Netherland was estimated through a virus introduction model and an economic model focused on quantification of losses due to epidemics (Horst, 1997). About 91% of the total disease cost in dairy cattle in Hungary was incurred for the disease incidence cost while the rest was for prophylactic measures (Safiullah *et al.*, 1997). A simulation model was used to evaluate different scenarios of epidemiological and economic effects of infections and control strategies of Infectious Bovine Rhinotracheitis in the Netherlands to assist policy makers (Noordegraaf *et al.*, 1988). A standardized methodology was used to estimate the direct costs to livestock production of some 30 endemic disease / conditions of farm animals in Great Britain and also identified the livestock population at risk, annual incidence of each disease on production, valued the physical effects of each disease and estimated financial values out output losses, resource wastage due to disease the costs of specific treatment and prevention measures (Bennett *et al.*, 1999). Break-even analysis of different East-Coast fever Control strategies in the Central Province of Zambia over a period 2.5 years showed the importance of immunisation with seasonal tick-control measures (Mukhebi *et al.*, 1999). Infection - dynamics model of Heart Water disease was used to estimate the incidence and impact under various scenarios over a period of 10 years and Z\$ 61.3 million was estimated as total annual national losses due that disease (Mukhebi *et al.*, 1999). Herd productivity due to Johnne's disease was affected in US , resulting in economic losses occurred through premature culling, reduced milk production and body weight losses in slaughter cattle (Ott *et al.*, 1999).

Research in India

Cost-benefit analysis of foot and mouth disease control programmes in India showed that the benefits of the programme occurred through likely reduction in the incidence of the disease and losses that a farmer suffers when the disease strikes his cattle. The benefit-cost ratio of the four different control strategy of disease was used to select the most

economically profitable control strategies (I I C M S R, 1987). A total financial loss of Rs.1607.20 crores was estimated as due to bovine mastitis in India and this was claimed as first scientifically calculated mastitis loss in India as on 1992 (Singh and Singh, 1992). Economic analysis of health disorders in Holstein x Sahiwal cross breeds showed that the higher crosses (3/4 and 7/8 grades) were more susceptible to health disorders and had higher severity of diseases and higher treatment cost. (Jadhan *et al.*, 1995). Various preventive and control measures in the context of economic losses of mastitis estimated were recommended by Thirunavukkarasu,(1996) ,by studying the incidence of mastitis in dairy farms, it's predisposing factors and quantification of economic loss due to mastitis .This study assumes significance from the fact that this study is the first of it's kind in it's kind and in it's scientific approach and output.

Future Outlook

Globalisation of economy, shift in extensive system to more intensive livestock production, less tolerance to animal diseases problems by producers, humane movement that may change animal production and animal health programmes and the expectation of a rapid veterinary response to new animal health threats establish the need for modern trends in veterinary epidemiology and economics encompassing necessary tools and knowledge that are needed in responding to the these changes (Dorn, 1992). The challenge for this discipline is to establish priorities and to successfully control or eradicate the diseases in future (Dorn, 1992). The durability of veterinary epidemiology and economics as a discipline will be depended in the future on it's contribution to problem solving in animal health economics research (Morris, 1995). The epidemiological basis of any country's 'disease free status declaration' will have to be far better than now, if non-tariff trade barriers based on animal health are to be removed as promised by WTO (Morris, 1995). Epidemiological approach to animal welfare is gradually becoming more established and involvement of epidemiological and economic techniques in diseases investigation, epidemiology is likely to expand in future. Increasing emphasis will be given for overall assessment of the adequacy of production system and assessment of environmental effects of animal production (Morris, 1995). Predicting target population for vaccines through the use of serological tests, determining the appropriate sampling strategy to quantify infection prevalence, modelling distribution and dynamics of infections and predicting the economic impact of disease and their control are the areas identified as emerging disciplines of epidemiology and economics (Perry and Young, 1995).

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