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Animal Health and the Control of Diseases: Economic Issues with Particular Reference to a Developing Country

by

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by

Clem Tisdell[2]

September 1994

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The Commissioned Organization is the Queensland Department of Primary Industries. Collaborating institutions in Australia are CSIRO-ANHL, Geelong, Victoria and the University of Queensland (Department of Economics; Department of Geographical Sciences and Planning). In Thailand, the collaborating institutions are the Department of Livestock Development (National Institute of Animal Health; Disease Control Division), Chiang Mai University (Department of Agricultural Economics; Department of Animal Husbandry) and Thammasat University (Faculty of Economics). The collaborating institution in Laos is the Department of Livestock and Veterinary Services. Dr F.C. Baldock, Senior Principal Epidemiologist, Queensland Department of Primary Industries is the Project Leader in Australia and Dr P. Chamnanpood, Senior Epidemiologist, Thai Department of Livestock Development is the Project Leader in Thailand. Professor Clem Tisdell and Dr Steve Harrison, Department of Economics, University of Queensland are responsible mainly for the economic component of this project.

'The overall goal of this project is to develop and evaluate the .necessary tools to provide decision-makers with reliable animal health information which is placed in context and analysed appropriately in both Thailand and Australia. This goal will be achieved by improving laboratory diagnostic procedures; undertaking research to obtain cost-effective population referenced data; integrating data sets using modern information management technology, namely a Geographical Information System (GIS); and providing a framework for the economic evaluation of the impact of animal diseases and their control.

A number of important diseases will be targeted in the project to test the systems being developed. In Thailand, the focus will be on smallholder livestock systems. In Australia, research will be directed at the northern beef industry as animal health information for this sector of livestock production is presently scarce.'

For more information on *Research Papers and Reports Animal Health Economics* write to Professor Clem Tisdell (c.tisdell@economics.uq.edu.au) or Dr Steve Harrison,(s.harrison@uq.edu.au) Department of Economics, University of Queensland, Brisbane, Australia, 4072.

Animal Health and the Control of Diseases: Economic Issues with Particular Reference to a Developing Country

ABSTRACT

The economic importance of livestock production has been undervalued compared to crop production and agricultural economists have not given it the attention which it deserves. Animal health is a significant influence on the productivity of livestock and the economics of animal husbandry. The range of animal health issues which can be usefully considered by economists is outlined. Some of the economic issues and problems involved in extrapolating farm-level and village-level estimates of the economic benefits of livestock disease control to the national level are outlined and discussed. The main problem is the possibility that aggregation or extrapolation of micro-data will fail to account for externalities, market changes dependant on aggregate production, such as variations in market price and changes in access to markets, such as export markets. Traditionally, cost-benefit analysis has been the most widely used technique for assessing the economics of control of animal diseases. It has been criticised by Mcinerney who suggests an alternative approach and this is considered. In conclusion, a brief outline is given of the Thai-Australian Animal Health Project (ACIAR Project 92804) which contains an economic component.

Keywords: Animal Disease, Thailand, ACIAR.

JEL Codes: Q160

Animal Health and the Control of Diseases: Economic Issues with Particular Reference to a Developing Country

1. Introduction

Livestock are important to the agriculture economies of most parts of the world, not least so in less developing countries where they are an important source of animal protein, draught power, leather, fibres and other products. Furthermore, the demand for meat, especially beef is income elastic (at least at low- to medium-income levels) so there is likely to be increasing global demand for meat and rising livestock numbers globally. This rising demand for meat is for example evident in east Asian developing countries such as Thailand.

On the whole agricultural economists seem to have neglected the economic importance of livestock for most developing countries placing their major emphasis in agricultural research on the crop sector. While crops provide the bulk of human food requirements, a significant proportion of the world's fibre requirements, and so on and are therefore, worthy of considerable attention the present emphasis on crops (which to a large extent, may reflect the apparent success of Green Revolution technologies) seems to be unbalanced. The extent to which green revolution technologies can sustain their success in terms of maintaining production and the extent to which they can be further dispersed in their use, could well be limited (Alauddin and Tisdell, 1991). For example, extension of green revolution technologies depends on the availability of water (amongst other things) and this is becoming scarce in Asia during the dry season (Tisdell, et al., 1994). There may also be environmental and ecological limits to the extension of dryland cropping.

A number of types of livestock are capable of utilising land by grazing which is unsuitable for cropping and/or grazing as a land-use may result in greater sustainability of production than cropping. It can be the most efficient means of obtaining food for human use on some types of land. While it is true that in the food chain, man is utilising a secondary rather than a primary trophic level when relying on grazers for food, mankind is not always able to use the primary trophic levels efficiently because a large amount of the plant mass such as cellulose is indigestible to man whereas livestock often have special stomachs or microbes to assist

them in their digestion. Both from an environmental and from a food-supply point of view, grazing of livestock is preferable to cropping for a number of land-types. Thus, there are sound environmental reasons to be interested in livestock production.

There are also additional reasons for having an interest in the health of livestock in less developed countries (LDCs). First, they often provide an important vehicle for savings by villagers and their sale is an important means to supplement cash income. Stocks of cattle and buffalo can be drawn on by families to finance large cash outlays, e.g., a wedding, and sales of poultry (and probably also pigs) provide small cash supplements for many villagers on a regular basis. Secondly, the degree of economic dependence of villagers on livestock is often high in marginal low-income areas relatively unsuited to cropping. This for example is the case in Northeast Thailand which is a drought-prone area.

The occurrence of animal diseases has a significant economic impact on livestock production and on trade in livestock and livestock products. It is therefore appropriate that economists give consideration to the economics of controlling and treating animal diseases. A wide group in the community are affected by such diseases. These include naturally owners of livestock, consumers, exporters, importers, processors and traders in livestock and livestock products. Economists have an interest in estimating the economic value of control and treatment of animal diseases and in considering the extent to which governments should be involved in control and regulation affecting animal health. Let us consider the focus of economists a little further.

2. Focus of Economists on Animal Health and Diseases

There is scope for economists to focus on livestock health and diseases from many different points of view. Subjects of interest include:

1. The basis (and economics) of decisions by individual owners of livestock to protect, seek treatment or treat their livestock against diseases.

2. The social economic benefits of such decisions.

3. The evaluation of economic losses caused by particular animal diseases.

4. The economics of alternative methods of control of animal diseases.

5. Economic factors affecting the adoption of different methods of disease control, e.g., adoption of vaccination programmes.

6. Economic factors affecting the supply of inputs required for disease control, e.g., the supply of appropriate vaccines or medicines.

7. Spillovers or externalities arising from animal diseases and their control and treatment. These may be positive or negative. For example, uncontrolled use of antibiotics on animals may increase the resistance of bacteria, reduce their sustainable use and could reduce the value of the antibiotic for the treatment of humans (Tisdell, 1993, Ch. 12).

8. The extent to which market-failure occurs in disease control and provides a sufficient reason for government intervention.

9. The economics of research and development in relation to the control of animal diseases.

10. The economics of collection and dissemination of information in relation to animal diseases. This includes the economics of diagnosis of diseases.

11. There are also a number of public finance/public economics issues to consider. For example, who should pay for the costs of controlling animal diseases? Should livestock owners pay the total cost or are there other beneficiaries who should pay?

As in economics, it is not always possible to take a partial approach in dealing with the control of animal diseases. The occurrence of one disease for example can make an animal more susceptible to another and can limit effective control. For example, the occurrence of infectious bursal disease (IBD) in chickens adversely and irreversibly affects their immunosuppressive system (as does the virus causing AIDS in humans), and makes infected chickens susceptible to Newcastle disease. Furthermore, when such fowls are vaccinated against Newcastle disease they fail to gain immunity because the required antibodies are not produced.

The occurrence of animal diseases in villages in LDCs may also be related to the general nutritional level of livestock and the level of economic conditions in villages. For instance, the incidence of foot-and-mouth disease (FMD) in Thailand is said to be higher in villages

where economic conditions are poor compared to villages where economic conditions are better and livestock nutrition is better (Bartholomew and Culpitt, 1992).

Often there are many alternative strategies for controlling animal diseases. In the control of FMD, for example, the following are some possible national strategies:

1. To reduce the incidence of FMD by increased vaccination coverage.

2. To try to eliminate it completely from a country if present.

3. To try to eliminate it from some regions of a country and reduce its incidence in other regions.

4. If elimination or eradication occurs, then a variety of policies may be available to try to prevent reintroduction. These may include restrictions on livestock movement, quarantine and limitations in trade in livestock products.

Thieme (1983) pointed out that there are two main policy considerations in relation to FMD. First in countries or regions where the disease is not present, policies to prevent the introduction of the disease 'by inspecting and controlling the imports of live animals, meat or other sources where live animal imports are permitted. This method is closely linked with a slaughter and eradication program if an outbreak occurs', (Thieme, 1983, p. 385). This is the current policy in place in Australia.

The second set of policy considerations are relevant where FMD is endemic or sporadic in a country, as in Thailand. The most common procedure is to adopt general vaccination schemes, but not necessarily vaccinating the entire susceptible livestock population. 'The objective is to vaccinate a high proportion of the population, to build herd immunity, which limits the number of primary outbreaks of FMD and breaks the transmission of the virus, thereby also limiting the number of secondary outbreaks', (Thieme, 1983, p. 385).

Although general vaccination of livestock herds may be engaged in, there may be concentration on (1) barrier vaccination and (2) ring vaccination. 'The former requires the vaccination of all susceptible animals in a buffer/zone to prevent the spread of FMD to adjacent areas. This strategy may be applied on a regional or sectional basis. By contrast, ring vaccination is limited to vaccinating around the outbreak and depends for its success on the rapidity by which the diagnosis, typing the virus and vaccination are conducted. In either of

these strategies, vaccinations may be carried out in conjunction with slaughter of the infected animals and those that have been in contact with them' (Thieme, 1983, pp. 385-386). From an economic viewpoint, it is useful to know which of the alternative strategies confers a positive economic benefit and of these which gives the greatest economic benefit. The method most commonly used for this purpose is cost-benefit analysis.

A procedure often used by economists studying the economic benefits of controlling contagious animal diseases is to estimate the benefit at the farm- or village-level by selecting a group of representative farms or villages. The results are then appropriately scaled up by the number of farms or villages nationally or in the region under consideration. This was, for example, the procedure adopted by Bartholomew and Culpitt (1992) in estimating the cost-benefit ratio for increased levels of vaccination against FMD in three provinces of northern Thailand. Using this method, they estimated a benefit-cost ratio in excess of 11, based basically on two types of representative villages.

Estimating the costs and benefits of FMD control is difficult (James and Ellis, 1978) and it has been claimed that much of this analysis has been faulty (Berentsen et al., 19 2). Certainly scaling up from farm-level or village-level economic benefits to national benefits can be misleading. Furthermore, doubts have been raised by Mcinerney (1991) about the value of cost-benefit analysis as used by a number of researchers interested in decisions about disease control. In particular, he is critical of the use of benefit-cost ratios. Let us consider each of these issues in turn.

3. Some Economic Problems in Extrapolating from Farm-Level or Village-Level Economic Benefits to National Economic Benefits of Disease Control

While farm-level or village-level estimates of CBA of animal disease control can be very useful, there are limits to the extent to which results from these can be extrapolated to give estimates of national benefits from such control. Apart from the question of whether the sample is representative, economic factors may limit this extrapolation. A useful way to consider this is by means of supply and demand analysis. Let us do this supposing first that trade is limited to the domestic market as far as the product from the animal is concerned and then let us introduce international markets.

Domestic Market Case

The effect of an improvement in animal health may be modelled by a shift in the market supply curve of the relevant product(s) produced from the animals. The control of FMD for example may cause the domestic supply curve of beef to shift to the right due to increased productivity. This is illustrated by Figure 1. The domestic demand curve for beef is assumed to be DD and the market supply curve of beef is represented by BS_1 given the existing control of the disease. Enhanced control leads to a shift in the supply curve from BS_1 to AS_2 and a change in market equilibrium from E_1 to E_2. Market supplies of beef expand from X_1 to X_2 and the market equilibrium price falls from *OH* to *OF*.

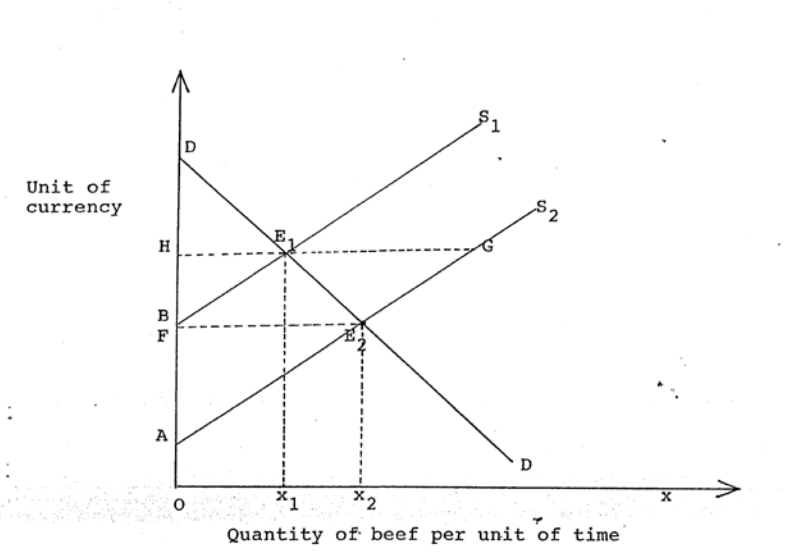

Figure 1 Case in which farm-level or village based CBA is liable to overestimate benefits from disease control when scaled-up to the national level (or in some cases the regional level).

In this case, farm-level or village-level estimates of benefits can be expected to overestimate the value of social economic benefits when scaled up to the national level and to also exaggerate the eventual gains to livestock owners. Assuming a short-run market situation, micro-based studies scaled up will estimate a net benefit to livestock owners equivalent to the area of triangle *AGH* less the area of triangle BE_1H and less any start-up costs involved in extra control. However, this overestimates social gains (increased consumers' surplus plus producers' surplus) by the area of triangle E_2GE_1 because it supposes that market demand for beef is perfectly elastic at the price prevailing prior to the increased control of disease.

The actual increase in social benefits (consumers' surplus plus producers' surplus) is equal to the area of quadrilateral AE_1B less any start-up costs of extra control. The increased benefits to livestock owners is actually much less than the area of quadrilateral AGE_1B (which would be estimated by the scale-up method) and less than the area of quadrilateral AE 1B because some of the benefits of increased disease control are captured by consumers by means of a lower price for beef. Consumers capture the equivalent of the area of quadrilateral FE_1H in benefits. Consequently the scale-up method overestimate benefits to livestock owners by the equivalent of the area of figure FE_2GE_1BF. This can be a substantial overstatement of benefits to livestock owners. The actual net benefit to livestock owners is equal to the difference between the area of triangle AE and the area of triangle BE_1H.

Import substitution case

Animal diseases frequently affect possibilities for international trade. This is for example the case when FMD occurs. The result is usually non-tariff barriers to international trade. Take a case where a country can for example import beef but cannot export it due to the occurrence of a disease like FMD. Suppose further that the supply of imports of beef are perfectly elastic. Then if imported and domestic beef are perfect substitutes, the domestic price will be equal to the price of imported beef if beef imports occur.

In this case, the scale-up method of estimating benefits from control of animal disease gives a relatively accurate result provided that increased domestic supplies as a result of better animal health do not completely substitute for all imports. This case is illustrated by Figure 2.

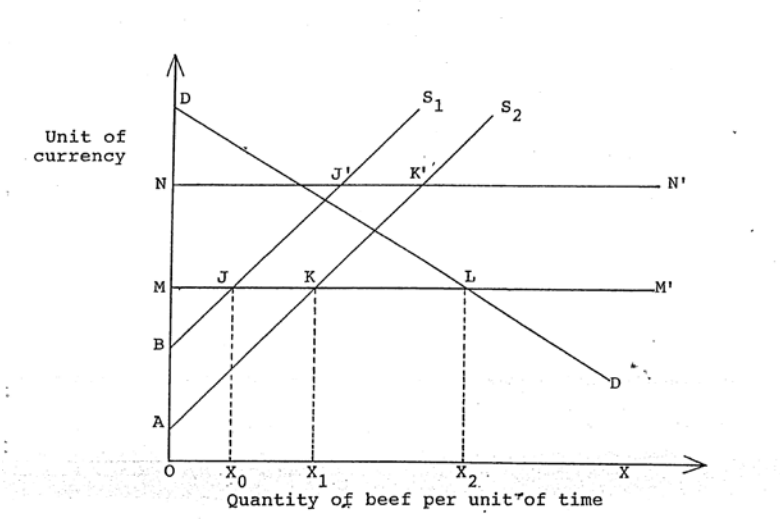

Figure 2 Illustration of import substitution and an export enhancement case

Figure 2 has the same interpretation as Figure 1, except now provision is made for beef imports. The landed price of imported beef is assumed to be OM per unit. The producers' surplus of livestock owners is the equivalent of the area of triangle *BJM* prior to increased disease control and equivalent to the area of triangle *AKM* after increased control. Beef imports fall from (X_2 - X_0) to (X_2 - X_0).

Export Enhancement Cases

If the export of the relevant livestock product is already permitted and taking place and export demand is perfectly elastic, it is once again true that the scale-up procedure can yield relatively accurate estimates of economic benefits. This can also be illustrated in Figure 2 by assuming that *ON* is the price per unit received by domestic producers for beef exports. In this case, the domestic price of beef is *ON* per unit. Increased disease control leads to greater exports and all benefits are captured by beef exporters. They gain by the equivalent of the area of quadrilateral *AK'J'B*.

Opening Up of an Export Market

Sometimes the control or eradication of an animal disease can open up an export market previously denied. When this occurs, the scaling up of farm-level or village-level cost-benefit data is liable to underestimate benefits to livestock owners of control of livestock disease and will also underestimate national economic benefits from this control. This can be illustrated by Figure 3.

In Figure 3, *ON* represents the price which can be obtained for exports if exports are allowed. Suppose, however, that because of 'inadequate' control of a disease that exports are not allowed and the supply curve of beef is BS_1 In this case only the domestic market is supplied and the market equilibrium is at E_1. Now suppose that disease control is instituted which shifts the domestic supply curve to AS_2 and opens up the export market. As a result, the domestic price of beef rises from *OH* to *ON*. A quantity *NR* of beef is taken by the domestic market and *RK'* is exported.

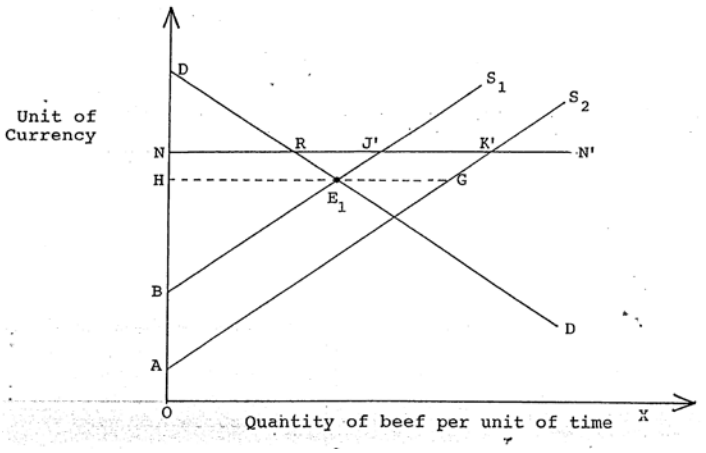

Figure 3 A case in which the scaling-up method underestimates the benefit to livestock owners and to the nation of control of animal disease.

As a result of the changed situation, producers' surplus rises from the equivalent of the area of triangle BE_1H to that of triangle $AK'N$. On the other hand, the surplus of domestic consumers is reduced by the equivalent of the area of quadrilateral HE_1RN. Despite the fact that domestic consumers of beef are worse off, domestic suppliers of beef are much better off. According to the Kaldor-Hicks principle, the economy is better off by an amount equivalent to the area of quadrilateral $AK'J'B$ plus the area of triangle $E_1J'R$.

The scaling-up method estimates the benefit to beef suppliers to be equal to the area of triangle AGH. Thus it underestimates their benefits by equivalent of the area of quadrilateral $HGK'N$. Furthermore, it underestimates total welfare gains for the domestic economy by the equivalent of this area also.

Overall Assessment

While the use of the scaling-up method overestimates benefits of disease control to a livestock industry in many cases, it does not always do so and indeed in at least one case indicated above can underestimate such benefits. The same is true in relation to total national benefits, that is those obtained by consumers and producers.

4. A Note on McInerney's Critique of CBA as Applied to Evaluation of Programmes for Control of Animal Diseases

McInerney (1991) outlines a rather different economic CBA framework for evaluating the control of animal diseases to the one given above. He uses it to warn against the dangers of relying on benefit-cost ratios for choosing between programmes for control of animal diseases. In addition, McInerney et al (1992) further elaborate on that theme and apply their framework to the control of mastitis in the UK. They state (1992, p. 137) 'Economic studies on disease in farm livestock have focused largely on cost/benefit analyses of control programs or gross estimates of costs due to particular diseases. Neither offers an adequate basis to guide economic decisions'. They claim to have developed a more rigorous framework for evaluation. One can certainly agree with their observation that gross costs due to a particular disease do not provide a guide to economic decisions about its control. This is because no account is taken of the costs of control or of the effectiveness of available controls. Nevertheless, large estimates of gross costs of a disease do indicate that the potential economic benefits from control of the disease could be larger.

As for the criticism of Mcinerney (1991) and Mcinerney et al., (1992) of cost-benefit analyses, they appear to be on less firm ground. One of their arguments is that the use of benefit-cost ratios to make decisions about levels of control of diseases can give misleading results and it seems from Mcinerney (1991) that some writers have completed these analyses in a misleading way using these ratios. The probleni, however, appears not to be with cost-benefit analysis but with people who use inappropriate rules for optimal decision-making using this analysis. Furthermore, the so called alternative framework proposed by Mcinerney et al., (1992) while a very useful conceptualisation is in fact firmly grounded in cost-benefit analysis.

The framework involved was first proposed by Mcinerney (1991) and illustrated by a figure similar to that shown in Figure 4. On the vertical axis he shows 'the loss in net value of output resulting from the presence of a livestock disease. L^* is the loss when is no attempt is made to control the disease. By incurring expenditure for control, it may be possible to reduce the incidence or severity of the disease. The level of expenditure on control is shown on the horizontal axis. Increased control expenditure is likely to reduce the incidence or severity of the disease thereby reducing economic losses on the production side. The relationship might

be for example like that indicated by the curve marked L^*XY.

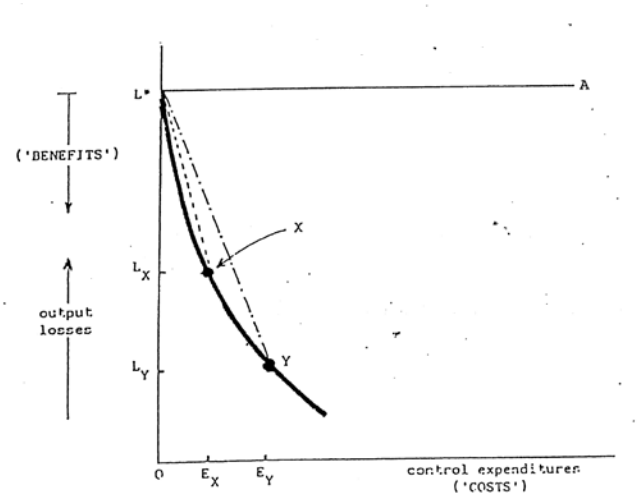

Figure 4 Comparative CBA of alternative control schemes

Mcinerney (1991) points out that the optimal amount of expenditure on disease control can be determined from this diagran1. It occurs at point Y where a 45° line is tangential to the loss-avoidance curve L^*XY. In terms of this analysis, there can be no objection to this. He then goes on to suggest that the use of B/C ratios will not lead to this result.

He suggest for example if two levels of control expenditure are compared, namely E_x and E_y, the use of B/C ratios will lead to the choice of E_x and this is not optimal. The B/C ratio for control expenditure E_x is higher than for control expenditure E_y. The ratio L^*L_x/L_xX exceeds L^*L_y/L_yY. Or since benefits are the losses avoided and these can be measured downward from the horizontal line L^*A, it can be seen that the slope (or angle) of line L^*X relative to line L^*A is greater than that for line L^*y. However, B/C ratios are usually only used for choices between projects when they are discrete and independent, or based on an optimum scale. Where a project allows variation in scale, the general rule, if there is not capital rationing, is that scale should be expanded until benefits less costs (discounted) are at maximum. No project should be undertaken for which the B/C ratio is less than unity. To make decisions just on the basis of B/C ratios would be to base these on averages and this would violate marginal rules for an optimum. Marginal conditions for the optimum will apply in cost-benefit analysis wherever the basic continuity and differentiability conditions for marginalism apply to the situation being modelled. The analysis is not faulty (even though it may have philosophical weaknesses). The problem is that it is sometimes used carelessly or with only a

limited understanding of optimisation problems.

Having said all this, let me hasten to add that the Mcinerney's (1991) framework and its further refinement by Mcinerney et al., (1992) is useful and in my view is capable of further development, e.g., for the purposes of comparing the economics of controlling different diseases, that is, for application to the comparative economics of disease control.

5. Some Notes on the Thai-Australian Animal Health and Disease Control Project (ACIAR Project 9204)

I am currently involved in a research project funded by the Australian Centre for International Research (ACIAR) entitled 'Animal Health in Thailand and Australia- Improved methods in diagnosis, epidemiology, economics and information management', in which the principal parties are the Queensland Department of Primary Industries (QDPI) and the Thai Department of Livestock Development (TDLD). Dr Steve Harrison and myself at the University of Queensland are contributing to the economic component with contributions also expected from Chiang Mai University and Thammasat University. The Project leader in Australia is Dr F.C. Baldock, Senior Principal Epidemiologist, Animal Research Institute, QDPI and in Thailand Dr P. Chamnanpood, Senior Epidemiologist, Northern Veterinary Research and Diagnostic Centre, TDLD.

The main focus of the study has primarily been determined by the veterinary interests of the main parties. The project aims specifically to consider a total of six diseases in three types of livestock. In bovines (cattle and buffalo) foot-and-mouth disease and gastrointestinal parasitism is to be considered and in pigs, hog cholera and Aujeszky's disease. In poultry, Newcastle disease and infectious bursal disease are the main focus.

The main emphasis of the project will be on the economics of controlling these diseases in villages because ACIAR's prime concern is with low-income farmers in villages rather than with commercial farmers operating on a large scale. The empirical portion of the study will be initially based in northern Thailand. It is planned amongst other things to carry out village surveys there to obtain data. The design of the survey is currently well advanced but it is a co-operative effort and some interaction is taking place to come up with an agreed final design. The village surveys are to provide a basis for detailed cost-benefit analysis of the control of FMD and should be of value in providing information about the comparative

benefits and costs of control of several diseases of livestock. As the study progresses, its focus will expand from the village and regional level to national policy questions and the economic importance for Thailand of control of animal diseases for purposes of international trade. If time and opportunity, permits some possible implications of the study for Laos may be considered.

It is planned that a literature review and examination of economic techniques for evaluating the control of animal health be undertaken. This will involve an evaluation of techniques such as cost-benefit analysis for optimal decision-making about control of animal diseases. In this respect, this paper constitutes a small start. In addition consideration will be given to the economics of diagnosis of animal diseases (a form of information provision) and the economics of possible government intervention in the control of animal diseases. Furthermore, it is necessary to take account of the social structures, types of motivation present amongst villagers and conditions involved in husbanding livestock in Thailand. These do not mirror those in Western commercial farming exactly. For example, Thai village poultry may be described as 'semi-feral' and they utilise open-access village resources (Johnston, 1990; Roberts, 1992; Cumming, 1992). This affects the likelihood of treatment of poultry diseases such as Newcastle disease (for instance, using oral vaccine) and involves an interesting study in the use of open-access resources. So far we have only taken a few small steps with this project.

6. Acknowledgments

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