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Working Paper No. 19

Cost-Benefit Analysis with Applications to Animal Health Programmes: Complexities of CBA

by

S.R. Harrison

September, 1996

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S.R. Harrison[2]

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[1] See Page 1.

[2] School of Economics, The University of Queensland, St. Lucia Campus, Brisbane QLD 4072, Australia
Email: c.tisdell@economics.uq.edu.au

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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.

This is number two of a set of six papers by Dr S. Harrison on ‘Cost-Benefit Analysis with Applications to Animal Heath Programmes’ to be published in this series Research Papers and Reports in Animal Health Economics.

Papers in this Set

1. Cost-Benefit with applications to Animal Health Programmes: Basics of CBA, Research Paper or Report No. 18.

2. Cost-Benefit Analysis with Applications to Animal Health Programmes: Complexities of CBA, Research Paper or Report No. 19.

3. Cost-Benefit Analysis with Applications to Animal Health Programmes: Spreadsheet Implementation of Discounted Cash Flow and Risk Analysis, Research Paper or Report No. 20.

4. Cost-Benefit Analysis with Applications to Animal Health Programmes: Allowing for Project Risk in CBA, Research Paper or Report No. 21.

5. Cost-Benefit analysis with applications to Animal Health Programmes: Valuation of Non-Market Costs and Benefits, Research Paper or Report No.22.

6. Cost-Benefit Analysis with Applications to Animal Health Programmes: Animal Health Programmes and Information Systems, Research Paper or Report No. 23.

Cost Benefit Analysis with Applications to Animal Health Programmes: Complexities of CBA

ABSTRACT

Cost-benefits analysis is a powerful method of evaluating the economic merits of public sector investments. Demands by treasury departments for justification of budgets of government agencies, and new developments in measurement of non-market costs and benefits, ensure wide use. The availability of powerful computer spreadsheets with built-in financial functions has greatly facilitated the application of CBA. At the same time, the computational ease with the technique can be applied has frequently led to a rather mechanistic approach being adopted.

No two projects will have exactly the same characteristics, and it is unlikely that a standardised approach to CBA can ever be relied upon. Blind use of the technique can lead to results which do not truly represent the investment situation, and to misinformation rather than good information. CBA is often inadvertently and sometimes deliberately misused. The practitioner needs to be aware of a number of complexities which often arise and to comprehend the best ways of dealing with them. To some extent, successful application of CBA is an art rather than a science, and there is no substitute for experience in carrying out real-world applications. However, there are a number of technical issues and complexities of which potential users should be aware. This discussion paper examines some of the major decisions which must be faced when carrying out CBA, then some further complexities which often arise. As well, common misuses of the technique will be considered.

Keywords: Cost-benefit analysis,

JEL Classification: Q16, Animal health programs,

Cost Benefit Analysis with Applications to Animal Health Programmes: Complexities of CBA

1. INTRODUCTION

Cost-benefits analysis is a powerful method of evaluating the economic merits of public sector investments. Demands by treasury departments for justification of budgets of government agencies, and new developments in measurement of non-market costs and benefits, ensure wide use. The availability of powerful computer spreadsheets with built-in financial functions has greatly facilitated the application of CBA. At the same time, the computational ease with the technique can be applied has frequently led to a rather mechanistic approach being adopted.

No two projects will have exactly the same characteristics, and it is unlikely that a standardised approach to CBA can ever be relied upon. Blind use of the technique can lead to results which do not truly represent the investment situation, and to misinformation rather than good information. CBA is often inadvertently and sometimes deliberately misused. The practitioner needs to be aware of a number of complexities which often arise and to comprehend the best ways of dealing with them. To some extent, successful application of CBA is an art rather than a science, and there is no substitute for experience in carrying out real-world applications. However, there are a number of technical issues and complexities of which potential users should be aware. This discussion paper examines some of the major decisions which must be faced when carrying out CBA, then some further complexities which often arise. As well, common misuses of the technique will be considered.

2. MAJOR ISSUES TO BE FACED IN CBA APPLICATIONS

Box 1 lists a number of the most common technical questions which have to be addressed when carrying out CBA. These will be discussed in turn.

2.1 Identifying the project and its variables and bounds

Experienced CBA practitioners sometimes comment that one of the most difficult tasks in carrying out any project evaluation is to determine the bounds to the project. Any change to a component of an economic system is likely to have an impact on various other components of the system. The further removed from the project these components are, the weaker the impact is likely to be.

Box 1: Some major issues when carrying out CBA

DEFINING THE PROJECT AND IDENTIFYING BOUNDS
IDENTIFYING ALTERNATIVE PROJECT OPTIONS
INDENTIFYING CASH-FLOW VARIABLES
DETERMINING THE 'WITH' AND 'WITHOUT' CASES
DETERMINING THE PLANNING HORIZON
REAL VERSUS NOMINAL DISCOUNT RATES
ACCOMMODATING PRICE AND COST CHANGES OVER TIME
DETERMINING THE DISCOUNT RATE
CHOICE OF PERFORMANCE CRITERION
USE OF STANDARD SOCIAL AND ENVIRONIVIENTAL VALUES

In defining an animal health program, it is necessary to identify which livestock species will be affected, what diseases will be involved, and in what areas will the program operate. Also, it is necessary to decide the level of detail at which modelling is to take place. Should this be at the village level or individual livestock owner level? If the latter, should attention be confined to livestock enterprises. Rising meat prices due to opening of export markets could lead to an increase in supply, but this would depend on the extend of land and stockfeed resources available, and the economics of switching from say crops to livestock.

Improved animal health could have impacts not only for producers but also for consumers, for community nutrition and health, for regional economic development and so on. Obviously, we cannot analyse the impacts of a particular expenditure program on the 'whole world'. The task is to determine reasonable limits to the impacts. In essence, this means defining the technical scope of the project, and listing all of the variables which are likely to be affected, in terms of benefits received and costs imposed. This listing of affected variables should be carried out prior to attempting valuation of impacts. As well, an attempt needs to be made to determine the nature of the relationships between relevant variables. At some point,

it will be necessary to make the explicit assumption that some impacts which could be included are not being considered in the analysis, because they are relatively minor or because of estimation difficulties.

2.2 Identifying project options

For any animal health program (AHP), a range of alternative design options is usually possible, so decisions have to be made about which options to consider to evaluate. (These options may be determined to a large extent by the government agency or client.) Also, various future 'environmental' scenarios - weather, prices and costs, technical change- are possible, and assumptions have to be made about which of these to consider. The economic implications of disease control options can be compared in terms of relative benefit-to-cost ratios or relative cost-effectiveness.

In general terms, national management strategies for a livestock disease such as FMD could involve several approaches (Ozawa, 1993):

- do nothing. Some south-east Asian countries have only rudimentary veterinary services and minimal livestock disease control strategies. For other countries- including Thailand - the 'do nothing' policy would mean a reduction in the control methods presently in place.

- maintain the current strategy. This may mean that a country has to live with particular diseases permanently, which can be a sub-optimal strategy in that there is the continuing economic losses due to the disease and the continuing control costs.

- increase the disease control effort, i.e. use more resources with a view to having lower disease costs.

- eradicate the disease. This may take a decade or more, with very high initial cost, but also very high payoff in the future. Cost-benefit analyses have typically shown eradication to be an economically desirable strategy. However, this must be technically feasible, requiring both a concerted national effort and regional Cupertino. A worst-off-all-worlds outcome is possible if a major eradication effort is attempted at great expense but fails and loses community support.

2.3 Variables to be included in cash flows

It is a far from simple task to determine what cost and benefit variables should be included when carrying out project evaluation. In fact, a major step in the analysis will be identify which costs and which benefits are relevant. The project definition stage will help to some extent. As well, a few guidelines can be provided as to how to treat some common cash-flow items.

Capital outlays. Initial outlays and not depreciation allowances should be included in the cash flows. That is, the 'cash' flows of financial transactions should be recorded at the time they are made, rather than making periodic allowances for the services yielded by capital items or the decline in their values over time.

Salvage value. Where buildings are constructed and plant and equipment are purchased for a project, an allowance for items on hand may be made as a capital inflow for the final year of project life, e.g. a scrap value of 10% of initial outlays for machinery items.

Working capital. Often it is appropriate to make an allowance for working capital which is tied up during a project. This allowance (e.g. 2% of the capital outlays) can be treated as a cash outlay at the beginning of the project, with the full amount treated as a cash inflow at the end of the project.

Taxation payments and subsidies. Direct and indirect taxation payments and subsidies should not be included as cash flow items, since these are transfer payments from the private to the public sector and are not a net gain or loss to society.

Interest payments. Interest charges should not be included as a cost, since these too are transfer payments, e.g. between producers and banks (both in the private sector). In any case, the discounting procedure in effect simulates interest payments.

Externalities. Externalities or impacts on firms and public agencies other than that carrying out the investment should be included to the extent possible.

It would seem desirable to develop standard lists of cost and benefit categories which can be referred to when carrying out any CBA. To some extent this is possible, although each project tends to have its own unique costs and benefits, hence checklists are a useful starting point, but should not be relied upon too heavily.

2.4 Defining the 'with project' and 'without project' cases

The cash flows for project evaluation are sometimes referred as incremental cash flows, which stresses that they are the differences between cash flows predicted with the project and those which would have arisen in the absence of the project. In this context, the present situation may not correspond to the 'without project' case. For example, suppose a particular animal health program is under consideration. If the program is carried out, disease levels will be reduced, with impacts on livestock performance, producer costs and so on. But if the program is not carried out, it may not be realistic to assume the current disease incidence will continue. Current measures (e.g. a vaccination of extension program) may reduce outbreak frequency gradually, but not as rapidly as under the proposed new measures. Defining the 'without project' case can be quite difficult.

2.5 Determining the planning horizon

The number of years for which cash flows are estimated is referred to as the project's planning period or planning horizon. This depends on the planning horizon of the decision maker, and the realistic life of the project. If the cash flows generated by a project cut out after a small number of years, then this is the project planning horizon. But often the impacts of a project will continue almost indefinitely. In such cases, we need to decide how many years of cash flows need to be considered to obtain a reliable measure of economic performance.

No firm guidelines can be laid down for choosing the planning horizon. The greater the number of years, the more extensive the data compilation task. Also, cash flow estimates a number of years into the future become rather speculative. As well, governments are typically elected for periods of three to five years, and it can be difficult for them to take a long-term view when evidence of achievement is needed by the time another election comes around.

As a general guideline, the aim should be to adopt as short a planning horizon as practicable. Ideally, the number of years will be sufficient for a stable result in the sense that if the number were increased this would have no effect on the recommendations drawn from the analysis. Sometimes CBAs are reported in which 50-year planning horizons have been adopted. This does not seem to make a great deal of sense, since experience indicates that for any realistic discount rate, cash flows after about 20 to 30 years have little impact on net present value; their present values are very small relative to present values of cash flows in

earlier years.

Suppose a proposed national program to eradicate a livestock disease is to be evaluated. The minimum planning horizon could then be the predicted period needed for the eradication program to be completed. A problem here would be that the planning horizon would then include all program costs, but benefits may have scarcely commenced. Hence if the eradication program were expected to take 10 years, a planning horizon of at least 20 years probably would be required.

In the case of animal health research projects, it is necessary to predict how long the benefits will continue before they become obsolete, to be replaced by new technology or management generated by subsequent research. Also, a judgement is needed as to whether subsequent research will build on that being carried out a present (so that benefits of current research will continue), or will replace that being carried out now.

The Australian international aid agency (AusAID, formerly AIDAB), which commissions financial and economic evaluations of irrigation, water supply and other overseas projects for which Australian concessional finance is provided, suggests ‘a minimum of a 20 year planning horizon is generally considered appropriate’ (AIDAB, 1993). It is suggested here that, as a starting point, a period of 20 years be adopted, and that checks be carried out to determine whether this can be reduced or needs to be extended.

2.6 Handling price and cost changes

Usually, cash flows are calculated in terms of present day prices; that is, no allowance is made for price increases during the life of the project. That is, the general principle is to exclude inflation, and to use constant rather than current dollar values. This is consistent with using a discount rate that does not make allowance for inflation, as discussed below. Of course, prices and costs can change over time due to factors other than inflation, e.g. prices may rise rapidly due to greater demand associated with increasing incomes or changing tastes. If it is thought that there will be changes in real prices or costs (i.e. net of inflation), then differential price and cost movements could be factored into the analysis. This could be the case if there were a change in consumer tastes in favour of animal proteins, or a program to encourage greater milk consumption among children, for example.

2.7 Discount rate considerations

The discount rate adopted in CBA has a major impact on estimated values of the performance criteria, especially in projects with long planning horizons. To illustrate this, consider Table 1, which presents present values for an amount of $1m to be received at different times in the future and for various interest rates. The present value of $1m 20 years' time is $377,000 if the discount rate is 5%, but only $148,000 if the discount rate is 10% and only $26,000 if the discount rate is 20%. Extending the time period can dramatically reduce the present value: at a discount rate of 20%, $1m received in 100 years' time has a present value of only one cent!

Table 1 Present values of $1m for various time periods and discount rates

Time period (yrs)	Discount rate			
	5%	10%	15%	20%
20	376889	148644	61100	26084
30	231377	57309	15103	4213
50	87204	8519	923	110
100	7604	73	0.85	0.01

Deciding on an appropriate discount rate is often a difficult task. As noted above, the *real* and not the *nominal* rate should be used.[1] The nominal rate is the prevailing public sector rate in an economy, e.g. the long-term bond rate. The real rate is obtained by adjusting the nominal rate for the rate of inflation. If the real rate in an economy were say 8% and the nominal rate were 14%, using the latter could greatly distort the DCF performance criteria.

To determine the real rate of interest for CBA, it is necessary to adjust the nominal rate to remove the inflation component. The way this is done depends on the relationship assumed between the real rate and inflation rate. In this context, two different models are possible. First, these may be assumed to be *additive*:

$$1 + n = 1 + i + f, \text{ or}$$

$$i = n - f$$

where n is the nominal rate of interest (e.g. market or long-term bond rate)

f is the inflation rate

[1] If cash flows were expressed in current dollars, then it would be appropriate to apply the nominal interest rate in discounting.

i is the real rate of interest,

and all rates are expressed on an annual basis, and in decimal form. For example, if the nominal interest rate is 11% and the inflation rate is 3% then

$$i = 11\% - 3\% = 8\%$$

More often, a *multiplicative* model is adopted of the form

$$1 + n = (1 + i)(1 + f), \text{ or}$$

$$\text{i} = (1 + n)/(1 + f) - 1$$

For example, if the nominal rate is 11% and the inflation rate is 4% then the real rate is

$$i = (1 + 0.11)/(1 + 0.04) - 1 = 0.0777 \text{ or } 7.77\%$$

It is to be noted that the real rate is slightly less under the multiplicative model than under the *additive* model. Use of the former is recommended in the guidelines for cost-benefit analysis laid down by the Australian Department of Finance (1991).

2.8 Choice of discount rate

There is considerable debate in the CBA literature over the appropriate discount rate concept to adopt. The Department of Finance (1991, Ch. 5) discusses the concepts of *social time preference rate* (STPR) corresponding to society's preference for present as against future consumption, and *social opportunity cost of capital* (SOC) corresponding to the rate of return on investment elsewhere in the economy. Adoption of the *project-specific cost of capital* is recommended. This involves using the cost of borrowing, which is in most cases the long-term bond rate. For projects in Australia, the national government recommends a rate of 8%, comprising a risk-free rate of 5% and a risk margin of 3%. In a rapidly developing Asian country, a slightly higher rate might be appropriate.

For discounting purposes, a constant rate of interest is normally applied throughout the planning horizon. While the rate will no doubt vary over time, the current rate is usually adopted. However, if interest rates are expected to change in a particular direction in the short term, then this may be taken into account in the choice of rate. It is to be noted that because cash flows further removed in the future have less impact on present values than cash flows

in the short term, predicting an appropriate rate over the first five to 10 years is more important than long-term predictions.

It is usually recommended that sensitivity analysis be performed with respect to the discount rate, to determine whether errors in prediction of the rate are likely to have much impact on the values of performance criteria or the conclusions which can be drawn from the CBA. If the real rate is approximately 8% then rates of say 5% and 11% could be used in sensitivity analysis.

2.9 Choice of performance criterion

Various performance criteria may be derived in a CBA. Benefit-to-cost ratios and the internal rate of return have the attraction that they indicate a rate of economic payoff, c.f. net present value merely indicates whether or not a project or program is economically viable. In this context, B/C ratios and the IRR are useful criteria for comparison between alternative animal health programs or between a particular animal health program and investments elsewhere in the economy. The IRR is subject to particular computational and theoretical difficulties. Further, it has been demonstrated that B/C ratios do not necessarily provide a correct ranking of alternative programs (e.g. see McInerney, 1991). For these reasons, it is recommended that the NPV always be calculated, and sensitivity analysis be performed with respect to the NPV, but that other criteria including the IRR if possible and the payback period also be derived.

2.10 Benefit transfer approaches

Sometimes it is possible to use standard values from past studies for cash-flow variables, particularly those non-market social and environmental values which are the most difficult to evaluate. Thus for example, standard values may be available for reduced cases of livestock disease transfer to humans, improved animal welfare, or improved child nutrition. Benefit transfer can greatly expedite project appraisal, but difficulties arise when an attempt is made to transfer values between regions or countries with different populations, value systems, disease incidence and so on.

2.11 Shadow pricing

In general, prices of inputs and outputs used in CBA are those prevailing in markets at the time of the analysis. However, sometimes these may be regarded as unsuitable for the analysis, and we may instead choose to use *shadow prices*. ‘A shadow price is an imputed

valuation placed on a project input or output when a market price does not exist or is significantly distorted' (AIDAB, 1993). If some of the labour used in a disease control program would otherwise be unemployed, then it is not appropriate to apply the full wage rate to this labour as a cost to the animal health program. Rather, a discount rate of say 20%-30% may be used to arrive at a shadow price for labour[2]. In the case of export revenue, governments spend considerable amounts to promote exports, implying that export revenue is of greater importance on a dollar-for-dollar basis than domestic revenue. The justification for promoting exports of say meat products may be financing economic development or servicing foreign debts. It has been suggested that a premium of up to 50% be applied to export revenue (Ellis, 1993). Care must be taken, however, not to use shadow pricing to inflate benefits and thereby justify a non-viable project. Where there is uncertainty as to what are realistic prices, sensitivity analysis may be advisable to determine what impact variations in prices make to overall project profitability.

2.12 Handling uncertainty

The effectiveness of any AHP may be highly uncertain. Vaccination coverage rate is difficult to predict, and depends on extent of Cupertino by landholders, weather conditions, availability of vaccines when needed, and efficient distribution. Re-entry of a disease may occur from legal or illegal stock movements from a neighbouring country. A new virus strain may be encountered. The application of CBA needs to recognize these uncertainties. Methods of taking account of project risk are dealt with in a subsequent discussion paper.

2.13 Recognising variables which cannot be factored into the CBA

While substantial progress has been made in development of techniques for measuring market and non-market costs and benefits, it must be recognised that there are some factors which simply cannot be included in the economic analysis. In particular, a number of social and environmental impacts may defy quantification but nevertheless be important. These need to be noted in reporting of a CBA study. An example of this is the Australian government's appraisal of AusAID projects, where descriptive sections of the appraisal reports are prepared by 'social and gender' and environmental specialists. It is probable that consumer and community health impacts of AHPs would present major estimation problems.

[2] The social cost of unemployed labour taken up by the project could be viewed as the difference between the wage rate in the project and unemployment benefits rate.

2.14 Coping with time and data limits

In practice, cost-benefit analysis usually has to be carried out in a protracted period, and in situations where much of the data one would desire simply is not available, that is, the analyst has to deliver credible results under severe time and data restrictions. This is a less- than-ideal situation, but it is usually a fact of life. A consequence is that

- all relevant and available data need to be assembled quickly.
- a number of assumptions have to be made, and these should be clearly documented in any reporting.
- a sensitivity analysis with respect to the major sources of uncertainty should be conducted.

3. SOME FURTHER ISSUES ARISING IN CBA METHODOLOGY

A number of further complexities which sometimes arise in CBA are listed in Box 2, which will now be reviewed.

Box 2: Further issues sometimes arising in CBA

ECONOMIC VERSUS FINANCIAL VIABILITY
INDIVIDUAL AGENCY VS NATIONAL PERSPECTIVE
TIME-PHASED INVESTMENT PROJECTS
EVALUATION OF R&D PROGRAMS
ALLOWING FOR EXCHANGE RATES
MULTIPLIER EFFECTS
EFFECT ON INCOME DISTRIBUTION
VALUING ENVIRONMENTAL IMPACTS

3.1 Economic versus financial analysis

CBA of public sector projects can be carried out at the financial or the economic level (AIDAB, 1993). The former examines the commercial viability of projects or programs, e.g. whether they are likely to attract international loan finance. For financial analysis, current market prices are usually adopted. Economic analysis determines whether a project is developmentally sound, i.e. whether it is likely to lead to a net gain for a society. Shadow pricing is relevant to economic analysis, and adjustment may be made for any subsidies and

for controls over imports and exports. The perspective in the discussion here is that of economic and not financial analysis.

3.2 Individual agency versus public sector perspective

Often projects are financed by more than one public agency. For example, an AHP may be funded by a livestock development department and also receive assistance from university researchers and perhaps overseas donor countries. Economic analysis of the program could then be carried out with respect to all sources of finance or with respect to funding by a particular agency only. Neither approach is incorrect, the choice depending on the purpose of the analysis. The former type of analysis would indicate the overall economic viability of the project; the latter would indicate the effectiveness with which the particular agency's funds are deployed.

3.3 Discounting and intergenerational equity

It is sometimes argued that discounting should not be used because it places attention on how resources should be used at present without making adequate allowance for future generations. This argument is made in particular for projects which use up natural resources or pollute the environment, of for which the future impacts are uncertain. Suggestions may be made to lower the discount rate, or to use a zero discount rate. The response of economists to these arguments is that risk and uncertainty and increasing values of environmental goods can be factored directly into the analysis, rather than allowed for indirectly by tampering with the discount rate, e.g. see Pearce and Turner, 1990. Where projects use up natural resources which are not replaceable by man-made substitutes, it may be desirable to impose resource-use constraints which ensure that adequate levels of these resources are preserved.

Within fairly wide bounds, it is not an easy matter to criticise dogmatically any particular interest rate. It is interesting to note that State forest services usually opt for a very low discount rate, sometimes of the order of3%. For very long-term investments- and major disease eradication programs fall in this category - reducing the discount rate can make all the difference in terms of demonstrating that an investment is profitable.

3.4 Time-phased investment projects

Projects sometimes consist of several stages, some of which may not take place for a number of years into the future. The decision then arises as to whether to evaluate the overall project

or only one or a small number of initial stages. A particular problem arises where infrastructure is "oversized" in the first stage so that it is adequate for later states. For example, a diagnostic laboratory or vaccine production plant could be built larger than needed immediately, in anticipation of increased future domestic demand or contract work for neighbouring countries. In such a situation, it may be inappropriate to attribute the full infrastructure cost to the first stage of the project; part of the overhead cost could be attributed to later projects.

3.5 Evaluation of R&D programs

A number of special issues arise when CBA is applied to research and development (R&D) programs (e.g. see McGregor et al., 1994). These issues are relevant to animal health research work: some are examined below.

Probability of project success. Projects which involve agricultural or industrial research in general cannot be considered to have 100% chance of success. For example, an attempt to develop minimum-disease intensive livestock systems or to breed livestock with greater disease or pest resistance may have only limited chance of success; the research could take longer than planned, or produce less impressive results than hoped. It is a wise precaution to adjust project benefits by the probability of research success when evaluating such projects.

Research versus development. Even when research lives up fully to expectations, considerable further development and adaption may be needed before the results of the research can be translated into useable technology. The delay, which could be a matter of years, can have considerable impact on returns from the research, and should be taken into account in the analysis (e.g. see Harrison et al., 1991).

Rate and timing of adoption of new technology. When a project (e.g. an R&D project) involves development or new technology or management systems, it is likely that this new technology will not be adopted immediately. Further, only a proportion of the potential users are likely to adopt the new technology. For this reason, the potential benefits in each year should be modified by the predicted actual adoption as a proportion of total potential adoption in each year.

Extension costs. Some type of research and development projects, including those in the livestock health areas, involve substantial extension components, aimed at convincing

producers to act in a particular manner, e.g. to use a new vaccine. Allowance needs to be made for expenditure on extension activities.

3.6 Exchange rates

A fall in value of the domestic currency can make many apparently profitable investments into financial disasters. This applies particularly with respect to the cost of capital. Governments and firms which borrow offshore can be caught with higher than predicted repayments. Care must therefore be taken when making conversions for foreign currencies in investments. It may be advisable to take a conservative view of exchange rates, include allowance for the cost of hedging or insurance against exchange rate depreciation, or carry out a risk analysis in which the probabilities of unfavourable movements in exchange rates are taken into account.

3.7 Multiplier effects

It is not unusual for proponents of particular projects to argue on the basis or indirect of flow-on benefits, e.g. job creation, more spending hence improved local business activity, improvements to local real-estate prices, extra foreign exchange earnings. Investment in intensive livestock production could generate a number of jobs and provide a substantial stimulus to a regional economy. These are the kinds of benefits which can be examined with interindustry *input-output* analysis, in which employment, income and output multipliers are derived. While these benefits are real enough from a local viewpoint, the case for them is not so strong when we take an overall social perspective. We have to ask the question 'Would investment in one particular industry or area create greater indirect benefits than investment elsewhere in an economy?' If not, then we have to decide whether there is any reason to go to the bother of estimating indirect benefits for the particular project. It is sometimes argued that the main use of multiplier effects is to examine the adjustment problems when an activity is reduced or curtailed in an area.

3.8 Effect on income distribution

Public sector projects will often have an effect on income distribution in the community. Some people are likely to become better off and others worse off. Intuitively, it would be appealing if a project improved the lot of the poor. We might wish to give greater weighting to a project which helped the poor than one which benefited mainly the middle class. Improvements in animal health will improve the welfare of villagers, who are often low

income earners, i.e. it will give rise to greater income equality and poverty reduction. This could lead to reduced reliance of various types of formal and informal credit and welfare payments, and empower villagers to carry out development activities. Estimation of benefits of changes in income distribution involves major difficulties, including theoretical problems in interpersonal comparisons of utility or welfare. The best mechanism for making this trade-off is the political process. While the economist has a role in identifying the likely impacts on income distribution, judgements about desirability of changes to income distributions 'are almost always most appropriately made by Government at the political level' (Department of Finance, 1991).

3.9 Valuing environmental impacts

In recent years, considerable attention has been paid to the environmental impacts of development projects, and a variety of methods have been devised for placing economic values on these impacts (Hollick, 1993; Hanley and Splash, 1993; OECD, 1994; DEST, 1995; NSWEPA,1995). Rural industries sometimes have a number of adverse environmental impacts. Waste products and odours of intensive livestock industries are examples. Sometimes the costs of these adverse environmental impacts are factored into the CBA. Improved animal health could lead to expansion of animal industries relative to cropping. In some ways, livestock industries are less efficient in production of human food than crops: there is an additional stage of energy conversion from biomass to animal tissues or other products. Hence improved animal health can indirectly impose greater pressure on use of natural resources to support a population (Tisdell and Harrison, 1995). Also, expansion of intensive livestock production, which may only become possible when disease control is improved, can have adverse environmental impacts such as odours, noise and nutrient enrichment of watercourses. Economic valuation methods for environmental impacts are outlined in a subsequent discussion paper.

4. COMMON MISUSES OF CBA

This chapter would not be complete without sounding a warning about misuses of CBA. Given the complexities discussed above, it is easy inadvertently to use the technique incorrectly. More seriously, CBA is often used strategically, for example to demonstrate that a particular investment is worthwhile and to assist in obtaining funding. Some common misuses are listed in Box 3.

Box 3: Some common misuses of CBA

PROJECT JUSTIFICATION
OVER-OPTIMISTIC CASH FLOWS
OMITTING IMPORTANT COST AND BENEFIT CLASSES
ATTRIBUTING PROGRAM BENEFITS TO PROJECT COSTS
USING THE NOMINAL INTEREST RATE

4.1 Over-optimistic cash flows

It is easy to overestimate cash flows inadvertently, e.g. out of enthusiasm for a program which will no doubt have positive benefits for a community. The project benefits need to be based on the most likely or expected outcomes, not the optimistic ones.

4.2 Project evaluation versus project justification

There can be a strong temptation to seek optimistic benefit levels which ensure a positive NPV or an IRR above the cost of capital. An unrealistically low discount rate may be adopted to present a project in a favourable light. Where agency goals to obtain approval for a new project are strong, considerable suasion may be placed on an economist to come up with 'good figures'. How this is handled may become a difficult question of personal integrity versus loyalty to the organisation. If the economist disagrees with the figures that are being proposed, then he or she has a responsibility to communicate clearly the basis of this disagreement.

4.3 Omitting important cost and benefit classes

While it is never possible to include all cost and benefit variables which are affected by a project, care must be taken not to omit important categories. It is quite common to overlook some of the cost items, so that when a program is implemented capital outlays tum out to be more than budgeted. When evaluating research, it has often been the case that costs of further development, adaption and extension needed to ensure adoption have been overlooked. Critical reviews of animal health CBAs point to the omission of changes in consumer surplus due to change in prices of livestock products. Environmental impacts (e.g. from more intensive livestock production) could also be relevant but are rarely factored into the analysis.

4.4 Attributing program benefits to project costs

When carrying out a CBA of a particular project, it is a common pitfall to ascribe benefits which arise at least in part from other related projects. Care is needed therefore in determining exactly what the technical outputs of a project are, and what the practical outcomes that these bring about are. For example, in estimating the benefits of a vaccination program, it would be easy to overlook that some of the reduction in reported disease cases could be due to stricter saleyard procedures for sick animals, new controls on stock movements or better on-farm disease prevention practices. Often, a broad program will be in place, for which it would not be valid to attribute overall benefits to any particular project or component.

4.5 Use of nominal interest rates

As noted earlier, if project benefits and costs are estimated at constant prices (rather than building an inflation rate into them), the interest rate adopted for discounting purposes should be the real rate (also net of inflation). Sometimes nominal rates are used inadvertently; this oversight can penalize heavily a program with long time lags in achievement of benefits.

5. SUMMARY

This discussion paper has reviewed a number of issues which frequently arise when carrying out cost-benefit analysis. Some of these are issues of economic logic, e.g. excluding depreciation allowances, taxes, subsidies and interest charges from cash flows. Some are largely a matter of judgement, e.g. choosing the most appropriate planning horizon and discount rate. Others amount to being aware of vested interests and attempts to bias the analysis. It is important to keep these issues in mind when carrying out a cost-benefit analysis.

Because of the risk of inaccurate estimates of cash flows, including unanticipated changes in the environment (in the broad sense) in which a project operates, it is important to carry out some form of sensitivity or risk analysis to determine the impact of changes in levels of key cash flow variables on program performance.

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