The nature of animal health economics in relation to veterinary epidemiology

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Summary: Animal health economics is being formally integrated into such institutions as sub-Saharan African universities and Veterinary Services. Unfortunately, the nature of the relationship between economics and epidemiology is not clearly understood. Economics has an extensive theoretical apparatus and an array of methods and techniques. Animal health economics has two interrelated branches: economics for the planning and management of animal health services and economic analysis of diseases and interventions.

Epidemiology and economics, although separate scientific areas, are complementary when the goal is efficient management of animal health and associated delivery systems. In performing economic analyses, an 'economic model' should determine data requirements (epidemiological and socio-economic), as such analyses invariably require epidemiological inputs. The core concepts in economic analysis are as follows: conceptual models, opportunity cost of resources, marginal analysis and partial analysis. Important methods include statistical models, mathematical programming, budgets, cost minimisation, decision analysis, variants of cost-benefit analysis and simulation.

Given the nature of animal health economics, veterinarians who want to practise as economists need a thorough training in economic principles and methods, in addition to training in basic epidemiology.


INTRODUCTION

Progress in any subject depends largely on the way in which that subject is perceived by practitioners in the discipline, and the way in which future practitioners are trained. Animal health economics appears to be a fashionable subject in Africa at present, as shown by the development of Veterinary Epidemiology Units in countries such as Kenya, Tanzania and Zambia, and by the establishment of epidemiology and economics courses at both undergraduate and post-graduate levels in sub-Saharan African universities (38, 39; J. Cleese, personal communication).
On an historical note, veterinarians, especially epidemiologists, being practical in approach, have not wanted to limit veterinary work purely to technical areas and, as a result, have also entered the field of the socio-economics of animal health. Unfortunately, there appears to be some misconception as to the nature of animal health economics (what it is and how it should be applied to increase the efficiency of animal production systems and product marketing chains) in relation to veterinary epidemiology. To quote Grindle, ‘The rigor which epidemiologists apply to their own scientific area should apply when they cross the disciplinary boundaries into financial and economic analysis’ (19). This paper addresses the issue, in addition to exploring the implications for the practice of and training in economics.

ANIMAL HEALTH ECONOMICS

Economics is a science of making choices. It analyses allocation of scarce resources in the realm of competing human demands. Economics is divided into microeconomics, which deals with economic principles and methods relevant to a particular sector of the economy, and macroeconomics, which studies the economy as a whole, i.e. economic aggregates and interrelationships between sectors. The field of agricultural economics has been developed to deal with problems in the agricultural sector, including links between agriculture and other sectors of the economy (7).

Economics comprises both economic theory and methods, which form the framework or tool kit used to analyse economic problems or to plan for the future (12, 30). To apply economic principles to agriculture effectively, the economist must also understand the biology of agricultural production (12).

Animal health economics is the area of economics or, more particularly, of agricultural economics that applies the principles and methods of economic analysis to animal health problems. The need for veterinarians with economic skills in sub-Saharan Africa has already been described (35, 37).

Institutional economics is a useful addition to neo-classical economics when analysing animal health problems. Institutional economics may be described as the economic analysis of organisations and other economic agents, taking into consideration transaction costs and the roles of incentives and social institutions (28). Institutionalists seek to understand what motivates economic agents in order to develop effective reform strategies, e.g. privatisation of delivery systems (44).

In animal health economics, the task is either to analyse the consequences of a change, e.g. introducing a new vaccine or policy, or to make a judgement on how desirable such a change would be. The former activity falls into the category of positive economics, whereas the latter is normative economics (26). Normative economics, or welfare economics, evaluates the consequences of proposed changes and makes recommendations on the desirability of such changes. It is prescriptive and value judgements are involved. Economic policy may be placed in the category of normative economics.

As regards the scope of animal health economics, most of the work reported in veterinary journals has been in the area of losses due to diseases and cost-benefit analysis of control strategies. This work may be called the economic analysis of animal diseases and intervention strategies. In the past, little use was made of economic principles and methods to analyse veterinary delivery systems and the management of
such systems (animal health services economics). This situation appears to be changing, with recent contributions from livestock development specialists, political scientists, economists and veterinarians, who are all concerned with the management of veterinary delivery systems, especially in developing countries. Economics has made a positive contribution to the analysis of:

- financing of veterinary delivery services in Africa (2)
- provision of Veterinary Services and the roles of the State and the private sector in such provision (9, 10, 27, 28, 36, 47)
- planning for staff, budgeting and public finance (25).

Animal health economics should encompass the following components:

- animal health services economics (management and economics of delivery systems, veterinary finance and animal health policy analysis)
- economic analysis of animal diseases and intervention strategies, including the efficiency and equity of veterinary interventions.

THEORY, CONCEPTS, MODELS, METHODS AND TECHNIQUES IN ANIMAL HEALTH ECONOMICS

There is a need to distinguish between economic theory (concepts and models), methods and techniques.

A concept is an idea or general notion which is an abstraction from the particular. Concepts help to simplify and classify our observations about the real world (21). Some examples of important concepts in economics are the notions of the marginal principle, the opportunity cost and the disease cost. The disease cost concept evaluates the losses caused by a disease, plus the expenditure incurred in lessening the effect of that disease (32).

Methods are general and widely applicable procedures or plans of action or enquiry for solving problems (e.g. budgeting), whereas techniques are typically variations of particular methods, and apply to relatively specific contexts, for example, partial budgeting (16). Techniques abound in applied fields.

Economic theory is a collection of interrelated propositions or hypotheses. These hypotheses take the form of models of economic behaviour, with each model capable of being tested empirically. Economic models are abstract, logical constructs comprising two components: assumptions and the implications of such assumptions (43). Theory may be used to describe, explain or predict the economic behaviour of agents or economic variables. Furthermore, theory guides research. It is theory, therefore, that guides economists in choosing appropriate concepts, models, methods and techniques for investigating economic problems and for analysing data in both basic and applied work.

Most of the work on animal health delivery systems uses extensive economic theory with little statistical analysis (2, 9, 10, 27, 28, 36, 47) but, as the field develops, one would expect to see the application of more statistical and econometric methods and techniques. Methods and techniques in animal health economics will be discussed after this paper has analysed the relationship between animal health economics and
veterinary epidemiology. This analysis will place the two closely related applied sciences in context and guide the reader in designing appropriate research programmes to generate data required in economic analyses of animal health problems.

**ANIMAL HEALTH ECONOMICS AND VETERINARY EPIDEMIOLOGY**

There are two principal ways of classifying the relationship between animal health economics and veterinary epidemiology: the hierarchical classification and the methodological classification.

**Hierarchical classification**

Under hierarchical classification, two approaches have been used. First, some consider that animal health economics is an integral part of veterinary epidemiology (1, 21, 22). This is also implicitly acknowledged in some veterinary epidemiology texts, in which there is, usually, only one chapter devoted to animal health economics (48, 49).

For example, one textbook defines epidemiology as the study of the behaviour and determinants of disease and impaired productivity in populations; a study whose purpose is to recommend actions for prevention, control or treatment of the problem being studied (1). Epidemiology is further described as an eclectic field, primarily combining concepts, methods and methodologies of medicine, biology, mathematics, statistics, economics and management to achieve objectives.

The second approach is to regard animal health economics and veterinary epidemiology as complementary subjects in the wider field of animal health. This is the view taken by three textbooks (33, 45, 50). Interestingly, most leading texts of medical epidemiology do not cover topics of medical economics (20, 29, 34). Such topics are covered in separate texts, such as those by Drummond and Drummond et al., thus making a clear distinction between medical epidemiology and health economics (14, 15). However, the economics texts do emphasise the role of epidemiology in economic analysis.

**Methodological classification**

In the literature on animal health economics – more specifically on the economics of disease and disease control – again, one finds two types of approach.

First, there is the ‘epidemiology-centred approach’, whereby economic values (such as costs and revenues) are attached to epidemiological results to obtain the cost of diseases or the economic benefit from controlling diseases.

The ‘economic model-centred approach’ argues that the economic framework, usually a model, is the most fundamental component in the economic analysis of diseases and disease control. The model should, where appropriate, be informed by both economic and epidemiological data. The main proponents of this approach are economists. There is also a new breed of ‘veterinary economists’ who employ this method. The case for the ‘economic model first approach’ has been well argued by Howe, Grindle, McInerney et al. and Buhr et al. (5, 19, 23, 30, 32).
It is almost universally accepted that epidemiological theories and methods are distinct from economic theories and methods and, in fact, one may perform an epidemiological study without the use of economics. The reverse is difficult to prove even in purely theoretical analysis.

The hierarchical classification and the methodological classification are not exclusive. Moreover, and importantly, these two ways of regarding the relationship between epidemiology and economics are not mirror images, in terms of the further divisions to be found within each method. The methodological classification is more profound than the hierarchical classification. Most articles on veterinary economics in veterinary journals show this distinction between the two approaches (23, 32). This issue has a bearing on the development of veterinary epidemiology and economics in sub-Saharan Africa, as choices have to be made among different graduate programmes required to train professional staff. Training courses in sub-Saharan Africa are likely to reflect the particular approach favoured by the developers of these courses.

METHODS AND TECHNIQUES IN ANIMAL HEALTH ECONOMICS

Choice and opportunity costs

In the traditional area of the economics of disease loss and disease control, many methods and techniques have been used for analysis. The idea of choice is central to any economic analysis. The basic premise in analysis is to compare a single disease control strategy with the consequences of doing nothing.

In allocating resources to one activity (say, activity A), rather than to other activities (ranging from B to Z), a cost is incurred. Economists call this the opportunity cost of a decision, i.e. the benefit that one foregoes by not selecting the best alternative course of action among the choices available (B). The benefit obtained from performing A can then be compared with the associated economic cost of carrying out B, i.e. the opportunity cost. As long as this benefit exceeds the cost of B, project A is worth undertaking. In animal health one examines the marginal gain of this allocation against the marginal cost (the opportunity cost). Using this methodology, one can rank different activities on the basis of net benefit value, in descending order of preference.

Although the opportunity cost is real, it is convenient, when analysing the costs of economic activities, to value such activities in common monetary accounting units, such as the dollar (43). In economies without distortions, the economic cost will be equal to the historic cost using actual prices paid. Where there are distortions, the two types of costs diverge. It is therefore important that any economic analysis should be consistent in pricing inputs and outputs. This consistency can be achieved either by using historic prices (financial analysis – which may be regarded as an exercise in accounting) or by using the real economic cost (the opportunity cost), in which case all price distortions must be identified and corrected.

The marginal principle

When shifting resources from one activity to another, one should examine what happens at the margin by comparing the extra benefit that will result from this shift
and the opportunity cost of the extra resources. Economic theory states that one should spend more and more resources until the point at which an additional dollar spent earns exactly one dollar. This is the marginal principle of all economic analyses (32). Thus, in carrying out economic evaluation of animal diseases, one has to apply the two concepts of opportunity cost and marginal principle consistently. McInerney further argues that in animal health economics one should examine the avoidable losses and not the total cost of disease (30, 32).

**Partial analysis**

In economic and financial analyses, comparing the situation without the project to the situation with the project (the ‘with and without project methodology’) is preferable to comparing the situation before the project with the situation after the project (the ‘before and after methodology’). By using the ‘with and without project methodology’, one can correctly attribute the net benefit to the project in question (18, 45). This ‘with and without’ methodology is closer to experimental methodology than the ‘before and after’ methodology. The basic structure of the analysis compares (marginal) changes in costs and benefits which result from undertaking the project. This is called the partial analysis approach (45).

**Level and type of analysis and data requirements**

Within any economy, animal diseases will affect the following groups: producers, consumers, associated agribusiness, government and society. In any analysis, therefore, one must:

- decide on whose behalf the analysis is being conducted
- identify the relevant costs and benefits to these groups (11, 46).

Table 1 provides a guide.

In order to measure the effect of disease on economic agents, the following information is required:

- data on changes in productivity and production (e.g. mortality, daily weight gain, etc.)
- socio-economic data (e.g. use of labour and services) on the farm and off the farm, depending on the level of analysis.

It is not an easy task to isolate and quantify the impact of an animal disease because the effects:

- are not always obvious and pronounced
- are influenced by other factors, such as management and environment (i.e. production and productivity losses can have causes other than diseases and are thus multifactorial)
- will be different at different stages in time, thus adding to the complexity of evaluating the impact of the disease
- are often seen in a complex with other diseases (40).

A number of mathematical and ‘simulation’ models have been developed in an attempt to try to isolate the effect of disease on livestock and the livestock industry.
TABLE I  
* Losses due to animal diseases, considered at different economic levels

<table>
<thead>
<tr>
<th>Economic level</th>
<th>Endemic disease (A)</th>
<th>Non-endemic disease (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Farm or herd (individual producer)</td>
<td>Direct relationship between loss and degree of occurrence of the disease per farm or herd</td>
<td>Large incidental loss, even if the farm or herd is not affected by the disease (possible compensation for destroyed animals)</td>
</tr>
<tr>
<td>2. Sector (national herd)</td>
<td>Loss, insofar as the price does not adapt. In a sufficiently large market (e.g. the EU), hardly any relation between level of disease and income of producers, owing to price adjustment</td>
<td>Significant loss, particularly in the case of export products, resulting from dropping prices due to decreasing demand</td>
</tr>
<tr>
<td>3. Supply and processing industries; service and trade *</td>
<td>Pro memoria</td>
<td>Pro memoria</td>
</tr>
<tr>
<td>4. Consumer</td>
<td>Loss due to higher prices; in case of zoonoses, loss due to morbidity and mortality</td>
<td>Incidental advantage</td>
</tr>
<tr>
<td>5. Society (national economy)</td>
<td>Loss due to inefficient use of resources</td>
<td>Disadvantage considerably less than loss to sector (national herd) (2.B1)</td>
</tr>
</tbody>
</table>

* Possible effects have not been specified. Price changes are presumed to pass to the consumer immediately and completely.

EU: European Union

Source: Adapted from Renkema (46), with minor modifications
Useful models are those that treat disease as an economic phenomenon, and identify all the ways in which the disease impinges on economic values. Such models should start from the animal herd, developing links that encompass the entire livestock sector and the wider economic system. This entails linking epidemiological models and adding data to the economic models (Fig. 1).

**FIG. 1**

Linking epidemiological models and data to economic models in animal health economics

The economic model then indicates what type of data and what level of aggregation are required. The data, in turn, are obtained via socio-economic surveys and epidemiological investigations. Hence, economic analysis demands the integration of both epidemiology and economics (5, 30). Models used include theoretical economics models (e.g. farm-level models and industry-level conceptual models) and those given below.

**Techniques**

*Quantitative modelling techniques*

Quantitative modelling techniques may be used to forecast technical and socio-economic quantities or to study associations. Statistical and epidemiological models are explained by Ngategize and Kaneene (40), whereas Hurd and Kaneene review in detail the application of 'simulation' models (24). Vagsholm, Vagsholm et al., Carpenter and Buhr et al. show the usefulness of econometric methods in dealing with repeated measures and simultaneous relationships in both epidemiology and economics (5, 6, 51, 52). The use of 'economic' quantitative modelling techniques in livestock health and disease control decision-making is reviewed by Bennet (3), Dijkhuizen et al. (11), Ngategize and Kaneene (40), Renkema (46) and Ellis and James (17).
**Decision analysis**

Decision analysis techniques are helpful when making choices under conditions of uncertainty, especially with complex but poorly structured economic problems. Risk analysis is incorporated in the technique. Data on risk probabilities (empirical or imputed) are essential. The technique can be used at the producer level or at higher levels of aggregation. Techniques used may be divided into the following:

- mathematical
- process diagrams
- pay off matrices
- decision trees.

Ngategize et al. give a good description of decision analysis in animal health programmes (41). Davidson et al. also provide an example of this approach in relation to thrombo-embolic meningo-encephalitis in feedlot cattle (8).

**Simulation**

Simulation attempts to mimic real-life occurrences of variables (states and quantities) over time. Figure 1 demonstrates the link between the epidemiological model/input and the economic model. Epidemiological simulation can take one of two forms. Either individual animals within a herd are ‘observed’ over time, their states changing stochastically, i.e. as governed by the laws of probability. Alternatively, a herd of animals is moved through time, with these animals changing states deterministically using fixed transition coefficients. In stochastic modelling, risk is taken into consideration by the use of probability distributions (i.e. Markov chain models) or by using random numbers drawn from probability distributions (i.e. Monte Carlo simulation). Simulation is a non-optimising method useful in analysing variable dynamics in different scenarios. Economic variables may also be simulated (3).

**Optimising mathematical models**

Optimising mathematical models makes use of linear programming and variants which, although purely mathematical procedures, are useful aids in resource allocation work where constraints abound (3, 11, 40).

**Budgeting techniques and cost analysis in animal health economics**

Budgets are a planning tool in animal health economics (Table II). Partial budgets use the partial analysis methodology.

**Cost-benefit analysis**

When the planning framework covers more than one year, cost-benefit analysis, employing the methodology of partial analysis, is the technique used. The main variations are given in Table III.
TABLE II  
Budgets and cost analysis in animal health economics

<table>
<thead>
<tr>
<th>Level of analysis</th>
<th>Technique</th>
<th>Indicator</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm/producer/herd</td>
<td>Enterprise budget</td>
<td>Gross margin</td>
<td>(53)</td>
</tr>
<tr>
<td></td>
<td>Total disease cost minimisation</td>
<td>Loss expenditure frontier and avoidable losses</td>
<td>(32)</td>
</tr>
<tr>
<td></td>
<td>Partial budget</td>
<td>Incremental net gain as net profit or gross margin</td>
<td>(32)</td>
</tr>
</tbody>
</table>

As the plan covers more than one year, adjustments should be made for time value of money (opportunity cost of capital), inflation and uncertainty (about values of variables and relationships between variables in dynamic processes) (Table IV). The analysis should also take into consideration the attitude of the ‘decision-maker’ to risk.

TABLE III  
Cost-benefit analysis in animal health economics

<table>
<thead>
<tr>
<th>Level of analysis</th>
<th>Technique (indicator)</th>
<th>Basic concept</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm/herd level</td>
<td>Net present value (NPV) *</td>
<td>Partial budget set up over time</td>
<td>(17)</td>
</tr>
<tr>
<td>National or sub-national herd</td>
<td>As above but higher level of aggregation (NPV)</td>
<td>Shifts in supply and demand possible</td>
<td></td>
</tr>
<tr>
<td>Industry level analysis</td>
<td>Cost-benefit analysis (NPV)</td>
<td>Shifts in supply and demand</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>Social cost-benefit analysis (NPV)</td>
<td>Differential weighting of costs and benefits according to socio-economic strata of stakeholders affected</td>
<td>(4)</td>
</tr>
<tr>
<td>All levels</td>
<td>Cost-effectiveness (natural units, e.g. number of animals vaccinated per $100 spent)</td>
<td>Goal is to produce desired outcome at least cost</td>
<td>(15)</td>
</tr>
</tbody>
</table>

* McInerney (31) shows the superiority of the NPV criterion over the internal rate of return and the benefit cost ratio when ranking projects. The NPV is based on marginalist principles, whereas the other two are not
TABLE IV
Techniques for incorporating time value of money, inflation uncertainty and uncertainty into an analysis

<table>
<thead>
<tr>
<th>Problem</th>
<th>Technique</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time value of money</td>
<td>Discounting using interest rates</td>
<td>Have comparable monetary flows</td>
</tr>
<tr>
<td>Timing consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation</td>
<td>Use real values</td>
<td>Remove the effect of inflation</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Sensitivity analysis</td>
<td>To test the effect of variations in the basic assumptions used in economic analysis</td>
</tr>
<tr>
<td>Risk (probability of outcome known subjectively or empirically)</td>
<td>Risk analysis (26) Decision analysis (see above)</td>
<td>To compute the value of different courses of action by incorporating risk (probabilities) and attitude towards risk into the analysis</td>
</tr>
</tbody>
</table>

IMPLICATIONS FOR INSTITUTIONALISATION OF ANIMAL HEALTH ECONOMICS

Mlangwa and Kisauzi have described the need to teach economics in the undergraduate curriculum in sub-Saharan Africa, in addition to examining the organisation of such courses, the curriculum and the resources required (35).

The authors have described how economic analysis is the application of economic methods based on the theoretical framework (i.e. concepts and principles). Veterinarians wanting to practise as economists (working in research, animal health policy formulation and evaluation or economic analysis of interventions) should be thoroughly trained in economic theory and methods, preferably via courses in agricultural economics, including macroeconomics or the links between macro and micro economics. These courses should be supplemented by training in epidemiological principles and methods. Sub-Saharan Africa needs to institutionalise animal health economics and policy, and to offer graduate-level courses in veterinary economics (39, 42). The objective must be to ensure that agricultural economists become interested in animal health economics, or that veterinarians are trained as animal health economists, or both. Since conversion courses (foundation or remedial economics courses) are now available in a number of universities, the option of training veterinarians in economics is quite feasible, and indeed there are several veterinarians who are already well trained in economic theory and methods. Dorn predicts that more veterinarians with graduate training in economics will be needed (13).

The need for, and training of, economists should be given due attention by veterinary epidemiology and economics units in universities, government and the private sector. It is not simply a question of asking a person who has been trained as an epidemiologist to work as an economist. At the same time, epidemiologists should be encouraged to take basic courses in economic theory and methods in order to collaborate effectively with economists.
CONCLUSION

For the successful institutionalisation of animal health economics in veterinary delivery systems, it is essential that the nature of economics and the relationship between economics and epidemiology is understood. Whether one regards economics as a part of epidemiology, or as a distinct discipline, the theoretical basis of economics is so comprehensive and so fundamentally different from the basis of epidemiology that any person wishing to practise as an economist must undergo a thorough training in the theory and methods of this discipline.

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Résumé : En Afrique subsaharienne, l'économie de la santé animale est une discipline actuellement traitée au sein d'institutions telles que les universités et les Services vétérinaires. Malheureusement, la nature des relations entre l'économie et l'épidémiologie n'est pas toujours clairement comprise. L'économie est un système théorique très élaboré qui comprend également une multitude de méthodes et de techniques. L'économie de la santé animale comporte deux branches étroitement liées : l'économie de la planification et de la gestion des services de santé animale, d'une part, et l'analyse de l'impact économique des maladies et des interventions prophylactiques, d'autre part.

Tout en constituant deux disciplines distinctes, l'épidémiologie et l'économie sont complémentaires dès lors qu'il s'agit de gérer efficacement la santé animale et les programmes zoosanitaires. Lors des analyses éconorniques, un « modèle économique » permet de déterminer les besoins en données (épidémiologiques et socio-économiques), car ce type d'analyse nécessite systématiquement des informations épidémiologiques. Les concepts de base de l'analyse économique sont les suivants : modèles conceptuels, coûts d'opportunité des ressources, étude de rentabilité et analyse partielle. Les principales méthodes incluent les modèles statistiques, la programmation mathématique, l'élaboration des budgets, la réduction des coûts, l'analyse des décisions, les variantes des analyses coûts-bénéfices et la simulation.

Etant donné la nature de l'économie de la santé animale, les vétérinaires qui se veulent économistes doivent acquérir, outre des connaissances de base en épidémiologie, une formation complète sur les principes et les méthodes économiques.

Resumen: A nivel formal, la economía de la sanidad animal es una disciplina que instituciones tales como universidades y Servicios veterinarios del África sub-sahariana han ido integrando. Lamentablemente, la naturaleza de las relaciones existentes entre economía y epidemiología no ha sido comprendida aún con claridad. La economía posee un vasto aparato teórico y dispone de múltiples métodos y técnicas. La economía de la sanidad animal tiene dos ramas relacionadas entre sí: la economía de la planificación y gestión de los servicios de sanidad animal y el análisis económico de las enfermedades e intervenciones sanitarias.

Aunque constituyan dos campos científicos independientes, la epidemiología y la economía resultan complementarias cuando el objetivo es un manejo eficaz de la sanidad animal y de los sistemas asociados a ésta. La realización de análisis económicos exige la utilización de un «modelo económico» que determine las necesidades existentes en cuanto a datos (epidemiológicos y socioeconómicos), pues este tipo de análisis requiere invariablemente informaciones de tipo epidemiológico. En la realización de análisis económicos, los conceptos fundamentales son los siguientes: modelos conceptuales, coste de oportunidad de los recursos, análisis marginal y análisis parcial. Los métodos más importantes comprenden modelos estadísticos, programación matemática, realización de presupuestos, minimización de costes, análisis de decisiones, variantes del análisis de costes-beneficios y simulaciones.

Dada la naturaleza de la economía de la sanidad animal, los veterinarios que quieran ejercer de economistas necesitan una formación completa en materia de principios y métodos de economía, además de una formación en epidemiología básica.


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