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Basic methods of economic analysis

R.B.M. Huirne & A.A. Dijkhuizen

Department of Farm Management, Wageningen Agricultural University, Wageningen, the Netherlands

Objectives

From this chapter the reader should gain knowledge of:

- the need for farm accounting systems
- the concept of farm enterprise budgets
- the basic economic methods: partial budgeting, cost-benefit analysis and decision analysis

3.1 Introduction

In Chapter 2 it was stated that the application of veterinary services is rarely an all-or-nothing affair. Usually several programs or measures are available, each of them offering a different degree of protection and requiring a different level of investment. The basic economic principle for determining the optimal level of input is called the **equimarginal principle**: the input should be allocated to its most profitable uses, such that the returns from the last unit (marginal returns) is not only equal or higher than the costs of the last unit of resource (marginal costs), but also the same in each of the alternative uses.

The principle is simple, but its application becomes more complicated when the number of inputs to decide on and the range of options to choose from increase. Methods are available, however, to help to carry out these more complicated analyses. In this chapter some basic methods are presented, including partial budgeting, cost-benefit analysis and decision analysis. More advanced methods follow in Chapters 5 to 9. All these methods make use of information, and that is why the need for farm accounting systems is discussed first. Furthermore, the concept of enterprise budgets and gross margin analysis is introduced. This is because the basic economic methods are usually applied to only a part of the farm, ie, to a single enterprise.

3.2 The need for farm accounting systems

Accurate and efficient decisions on animal health management require extensive information. Some of this information can be acquired from farm records, while other data must be obtained from firms with which the farmer deals, or other public and private agencies (Boehlje & Eidman, 1984). Record keeping and accounting can be tedious, complex and time-consuming. However, it can also be very rewarding when it provides the essential data for performance evaluation and assessment of progress that are important in managing animal health.

While there are many reasons for keeping farm accounts, the use of accounts in animal health management can be summarized under two headings: (1) to provide data for forward planning, and (2) to help control the operation.

Farm accounts can provide data on production levels of livestock enterprises, the amount of inputs used, the prices paid for inputs, and the costs and returns of (animals in) individual enterprises. Records can also be summarized to indicate the costs and returns on a monthly basis. The data can be used for developing both short-run and long-run plans for animal health management. The data are unique to the individual business. Farm and enterprise planning typically requires that the data available from previous years be supplemented with additional data on expected prices, input requirements and production levels for some possible decisions. Nevertheless, the data available from the past provide a starting point for the planning procedure (Boehlje & Eidman, 1984).

Farm managers develop, on their own or together with their veterinarian or extension worker, operational (short-term), tactical (medium-term), and strategic (long-term) plans (Figure 3.1), which usually include animal health plans. After such plans have been developed, the managers are concerned with implementing them, with monitoring and controlling the actual outcome over time, and with making adjustments in the plan if conditions change. In this way farm management is considered a **cyclical process**, as is outlined in Figure 3.1 (Huirne, 1990).

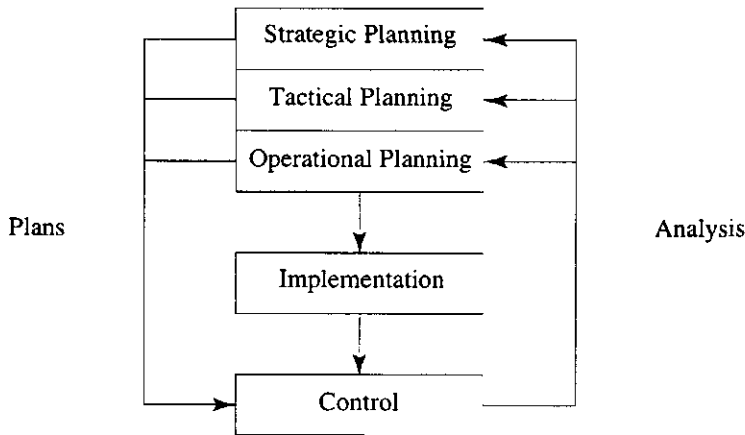


Figure 3.1 The management cycle

In developing plans for the enterprise, the farmer sets physical and financial standards of performance. Accounting systems can be developed to record data on the physical and financial performance measures that have been set for the enterprise. These data provide the farmer with an opportunity to compare the actual outcome with the performance standards (Huirne *et al.*, 1992). It is not unusual to set standards that are financial in nature. Farmers prepare projected costs and returns on a, for instance, monthly basis for the coming year and compare the actual costs and returns with the projections that have been made.

When a significant difference between planned and actual costs or returns occurs, this will immediately be clear to the farmer. This gives farmers the opportunity to take corrective actions before a serious economic problem can develop. In the development of longer-term plans, standards are set at the rate of return on investment and the rate of return on equity capital on a yearly basis (Boehlje & Eidman, 1984).

3.3 Enterprise budgets in gross margin form

Most farmers are in business to make a profit. The simplest and quickest method of calculating farm profit is to work out a budget along the lines of conventional costs and returns. This can be valuable because it can serve as an initial test of farm profitability. It omits so many details, however, that it is virtually useless for more accurate control. The biggest shortcoming of this approach is that it treats the business as a single, homogeneous unit, whereas most farm businesses can be seen as combinations of enterprises. An enterprise is a division of the business, usually identified by the type of product (Warren, 1986), for example, crops, swine and dairy herd. In planning and controlling the business, it is vital to be able to monitor each of the enterprises individually.

For the purposes above, a method of budgeting for profit which provides details on enterprises but bypasses the difficulties of allocating overhead costs is required. It must also avoid confusion between those costs which vary as a result of a change in the enterprise, and those which do not. One such method is preparation of budgets in **gross margin** form.

With this method, only certain costs are allocated to individual enterprises, the so-called **variable costs**. A variable cost is a cost that satisfies the following criteria (Warren, 1986): (1) it tends to vary directly with small changes in the size of the enterprise, and (2) it can relatively easily be allocated to a specific enterprise. Any cost which does not satisfy both of these criteria is termed a **fixed cost**. Usually no attempt is made to divide such a cost among the various enterprises.

Table 3.1 Examples of variable and fixed costs

Variable costs	Fixed costs
Veterinary services and AI	Regular labour
Feedstuffs (including forage)	Power and machinery running costs (except contract hire)
Fertilizers	Machinery and building depreciation
Seeds	Rent and/or landowning costs
Sprays	Interest charges
Casual labour	
Contract hire of machinery	

The costs of veterinary services and artificial insemination (AI) can easily be allocated to a dairy herd enterprise, and will vary with small changes in the size of the enterprise. That is why they are called variable costs. The cost of diesel fuel used in drilling wheat, for instance, will vary with enterprise size, but will be difficult to allocate without very

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detailed recordings (machines are used in other enterprises as well). It is thus classified as a fixed cost. A list of assorted variable and fixed costs is shown in Table 3.1.

A profit budget in gross margin form is built up as follows: for each enterprise, variable costs are deducted from enterprise output to give the enterprise gross margin. The gross margins of the various enterprises are added to give a total gross margin. From this the fixed costs of the entire business are deducted, resulting in the net profit for the business as a whole (see Figure 3.2).

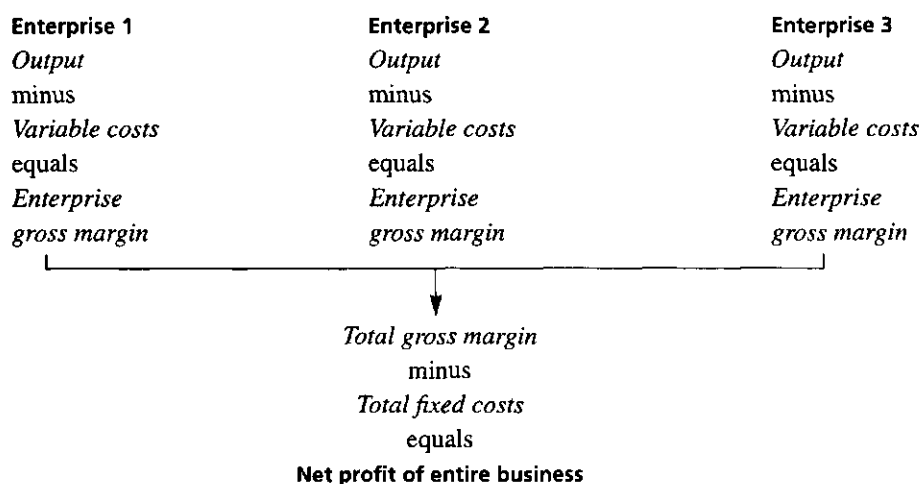


Figure 3.2 Profit budget in gross margin form (derived from Warren, 1986)

3.4 Partial budgeting

If the proposed analysis concerns a simple economic comparison of disease control measures on a farm, and the outcome does not involve a specific time pattern nor a high degree of uncertainty, then partial budgeting is the method of choice. Partial budgeting is simply a quantification of the economic consequences of a specific change in farm procedure, eg, a herd health program. It is closely related to the enterprise budget in gross margin form described in the previous section. Partial budgets are used to estimate the **change** that will occur in farm and enterprise profit from some change in the farm or enterprise plan by considering only those items of returns and costs that change. Partial budgets do not calculate the total income and the total expense for each of the plans, but list only those items of returns and expenses that change to estimate the difference in profit expected from the plans.

Partial budgeting is particularly useful for analysing relatively small changes in the business such as considering a shift in the replacement policy of dairy cows or a new breeding method (ie, artificial insemination), or when participating in a certain herd health program. The general format for a partial budget is made up of four sections: (1) **additional returns**: a list of items of returns from the alternate plan that will not be received from the base

plan, (2) **reduced costs**: a list of items of costs for the base plan that will be avoided with the alternate plan, (3) **returns foregone**: a list of items of returns from the base plan that will not be received from the alternate plan, and (4) **extra costs**: a list of items of costs of the alternate plan that are not required with the base plan. To use the four sections in a consistent manner, the user of the partial budgeting procedure must first select one plan (for instance, the current one) as the basis for comparison, and the other as the alternative (proposed change). The change should be adopted if the sum of (1) and (2) is greater than that of (3) and (4).

As an example data were used to quantify the economics of caesarean section for a dairy cow. When represented in a partial budgeting format they are as follows:

1. Additional returns result from heavier weights of calves: US\$25
2. Reduced costs include that less feed is required because of the drop in milk production: US\$10
3. Returns foregone result from the drop in milk production: US\$30
4. Extra costs include cost of surgery and an increase in culling rate: US\$160

The net result (sum of (1) and (2) = US\$35 minus sum of (3) and (4) = US\$190) is negative: US\$ -155. This means that caesarean sections as such are not desirable from an economic point of view. Should the calf (or cow) die otherwise, then its value should be included as additional returns.

As with other models, it is not always possible to identify clearly the returns and costs associated with the change in question. Many decisions may be rejected or accepted based on other criteria. Furthermore, special attention should be paid to the question whether it fits into the total farm or enterprise strategy.

The term partial budgeting does not imply that fewer details are required than for a total enterprise budget. This is not the difference between the two methods of budgeting; the difference is the impact of the proposed change on the farm organization. If the proposed change will affect the entire enterprise (or even the whole farm business), a total enterprise budget is needed. The partial budget is appropriate when some of the returns and costs will remain constant; it involves identifying those returns and costs that will change and the degree or amount of change.

Exercise

The example on caesarean section mentioned before in this chapter is worked out in more detail in the computer exercise given in Chapter 19. In this exercise you have to calculate the values of the different sections of a partial budget one by one, and use these to draw a conclusion. You will go through a sensitivity analysis to determine how stable your conclusions are. This exercise takes about 30 minutes.

3.5 Cost-benefit analysis

If the subject of research deals with more long-term disease control programs at regional or national level, then cost-benefit analysis is typically the analytical structure of choice. Cost-benefit analysis is a procedure for determining the profitability of programs over an extended period of time, ie, sufficiently long so that addition of an extra year does not materially influence the comparative ranking. There are three main elements involved: (1) enumeration of benefits (returns) and costs, (2) determination of the appropriate discount rate, and (3) specification of a decision criterion.

When the effects of a program have been estimated in physical terms, such as a decrease in production because of a disease, these effects must be translated into economic terms. Since the time at which costs or benefits occur generally differs between programs or alternatives, it is important that these future costs and benefits are 'discounted' to make them completely comparable, which results in the **present value** of costs and benefits. This is due to the time preference of money. A benefit of US\$100 to be received in one year has less value today than a benefit of US\$100 received immediately, because of (potential) interest yields. The formula used to calculate the Present Value (PV) of a future cost or benefit (FV), where r is the annual 'interest rate' (in %) and n is the number of years in the future is:

$$PV = FV / (1 + r/100)^n$$

The 'interest rate' used in cost-benefit analysis is called the **discount rate**, since it makes future values smaller than present values. The higher the discount rate, the more a program with high initial costs and a low level of benefits over a long period of time will be penalized. Conventionally, the discount rate does not allow for inflation of prices, and future prices are calculated at current prices rather than inflation-adjusted prices. This avoids the difficulty of predicting future inflation rates, which would in any case have no effect on the real rate of return from the program under consideration. This discount rate used is therefore the so-called 'real rate of interest', being the difference between the market rate of interest and the inflation rate. For example, if the market rate of interest is 9% and the inflation rate is 4%, the real rate of interest is 5%.

After having calculated the - expected - flow of costs and benefits resulting from the program and allowing for the time at which they occur, a **decision criterion** must be used to make a decision. An overall measure of value is required. Three such measures are commonly used, each of which has specific advantages and disadvantages:

1. **Net Present Value (NPV)**, which expresses the difference between the total present value of benefits and costs (present value of net benefits). It represents the value of the program at today's prices. It indicates the scale of the net benefits, but does not show the relative size of the benefits and costs. Expensive programs will tend to have a high NPV, even if the benefits are only a few percentage points more than the costs. An NPV of US\$100 000 from US\$10 million benefits and US\$9.9 million costs is quite different from the same NPV from US\$1 million benefits and US\$0.9 million costs.

2. **Benefit-Cost Ratio (B/C ratio)**, which is calculated by dividing the total present value of the benefits by the total present value of the costs. It represents the relative size of the costs and benefits. It gives no indication, however, of the scale of investment, which should be considered if alternative projects are compared. Following the example under number 1, the B/C ratios are US\$10 million / 9.9 million = 1.01 and US\$1 million / 0.9 million = 1.11 respectively.
3. **Internal Rate of Return (IRR)**, which reflects the interest rate which would make the total present value of the benefits equal to that of the costs; in other words, the interest rate which would have to be charged to reduce the net present value to zero. This measure is useful because it is easily comparable with (real) interest rates in alternative applications, and because it avoids the necessity of selecting a discount rate. The main disadvantage is that there is no simple formula, and it can only be calculated by trying different rates until the correct one is found. In some cases, there is no rate that will satisfy the condition, for example, if the annual costs never exceed the annual benefits.

The following example is to illustrate the cost-benefit approach for a vaccination program (Table 3.2). The monetary values are in millions of US\$ and the annual real interest rate equals 5%. The NPV of this program turns out to be US\$-1.2m (46.8 - 48.0), hence a negative NPV (while the undiscounted benefits exceed the undiscounted costs). The B/C ratio is 0.975 (46.8/48.0), slightly below the required minimum value of one. Finally, the IRR can be calculated by iteration as about 3.7%.

Table 3.2 Application of cost-benefit analysis

Year	Discount factor	Undiscounted		Discounted	
		Costs	Benefits	Costs	Benefits
1	0.95 ^a	27	0	25.7 ^b	0.0
2	0.91	15	10	13.7	9.1
3	0.86	10	20	8.6	17.2
4	0.82	0	25	0.0	20.5
total		52	55	48.0	46.8

^a $0.95 = 1 / (1 + 5/100)^1$

^b $25.7 = 0.95 \times 27$

One variant of cost-benefit analysis is **cost-effectiveness analysis**, to be used when the expected benefits are excessively difficult to quantify. It is aimed at producing the desired result at minimum discounted cost. For example, an extension program may be evaluated by looking at how many people adopted the new technology. Preference is given to a program that, given its costs, will benefit the largest number within the target population.

Some benefits and costs may, however, be difficult to quantify, even in physical terms. The satisfaction of having a healthy herd, reducing animal suffering and human health risks, and

minimising the environmental damage caused by use of chemicals against insect parasites are some examples of such benefits and costs. Although it may not be possible to include these effects in an economic comparison, it is important that they are taken into account by decision makers. Despite the fact that some costs and benefits cannot be quantified, a cost-benefit analysis is useful in situations in which there are two or more ways of achieving a given objective.

Exercise

Do the computer exercise on cost-benefit analysis in Chapter 19. With this model you can practise how to calculate the discount factor to determine the present value of future costs and benefits. This is done with an example of enzootic bovine leucosis. After the calculation of the present values, you have to use different decision criteria (ie, NPV, BIC ratio and IRR) to draw your conclusion. Subsequently, a calculation is done with a different interest rate. This exercise takes about 40 minutes.

3.6 Decision analysis

If there are multiple possible outcomes of the proposed courses of action and chance is an important factor in determining which outcome occurs, then decision analysis is the approach of choice. Decision analysis is defined as any framework or strategy for handling complex decisions so that they can be more readily evaluated by the human mind. It is commonly thought to include four techniques (Gregory, 1988): (1) mathematical equations, (2) payoff matrices, (3) process diagrams or process flow charts, and (4) decision trees.

A **mathematical equation** is an approach that involves the presentation of data on the decision options, states of nature, probabilities and outcomes in a mathematical form (equation) and uses maximizing or optimizing criteria in selecting the action that represents the decision maker's preference. For example, to select among the decision options, A_1, A_2, \dots, A_i , information may be presented in the following mathematical form:

$$A_i = f(A_i, S_1, S_2, \dots, S_j, P_1, P_2, \dots, P_j, V_{i1}, V_{i2}, \dots, V_{ij})$$

where

- A_i = decision option (action);
- S_j = state of nature;
- P_j = probability of occurrence of state of nature (S_j); and
- V_{ij} = value of outcome for each action and state of nature.

Assuming that one desires to use the expected monetary value (EMV) as the decision criterion (see below), then the EMV for each action (A_i) will be: $EMV(A_i) = \sum_j(P_j V_{ij})$, with the highest EMV being preferred.

As an example, assume that a farmer wants to know whether it is profitable or not to inseminate the sows twice during the same oestrus (24 hours after the first insemination) instead of once. So there are two options:

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- A₁ = inseminate once
- A₂ = inseminate twice

After the insemination, the sow can be in two different states of nature:

- S₁ = pregnant
- S₂ = not pregnant

Assume further that eighty-three percent of the sows are pregnant after one insemination. This percentage increases to 86% when the farmer decides to inseminate twice during one oestrus. Finally assume that all the sows that do not conceive during this oestrus, will conceive the next time. The cost of delay of conception of one cycle is assumed to be US\$50. The cost of insemination is US\$4 per insemination. Now a mathematical equation can be used to calculate whether or not this second insemination is profitable. The selection criterion is the expected monetary value of the costs:

- A₁ = EMV (inseminate once; pregnant, not pregnant; 0.83, 0.17; US\$4, US\$54)
- A₂ = EMV (inseminate twice; pregnant, not pregnant; 0.86, 0.14; US\$8, US\$58)

Thus, $EMV(A_1) = \sum_j (P_j V_{1j}) = 0.83 \times 4 + 0.17 \times 54 = \text{US\$}12.50$
 $EMV(A_2) = \sum_j (P_j V_{2j}) = 0.86 \times 8 + 0.14 \times 58 = \text{US\$}15.00$

A₁, inseminating once, has the lowest EMV_{costs}, so the farmer should decide to inseminate only once per oestrus period. It is also possible to calculate the break-even point. This is the point where 'not profitable' changes to 'profitable', so EMV(A₁) is equal to EMV(A₂):

$$EMV(A_1) = 12.50 = EMV(A_2) = X \times 8 + (1-X) \times 58$$

where

- X = proportion of sows pregnant after two inseminations during one oestrus

The solution of this equation is: X = 0.91. So at least 91% of the sows should become pregnant after two inseminations during one oestrus to make this strategy profitable.

A **payoff matrix** is a tabular presentation of data on the decision actions (as presented above) and provides a better visual presentation of the data. The presentation of data may take the form presented in Table 3.3.

Table 3.3 A payoff matrix

State of nature (S_j)	Value of outcome (V_{ij}) for different actions choices (A_i)				Probability of occurrence (P_j)
	A_1	A_2	....	A_i	
S_1	V_{11}	V_{21}	....	V_{i1}	P_1
S_2	V_{12}	V_{22}	....	V_{i2}	P_2
S_j	V_{1j}	V_{2j}	....	V_{ij}	P_j

Using some decision criteria, a visual or mathematical computation is then made to select the preferred action.

A more concrete example of a payoff matrix is given below, in which three strategies A, B and C to control contagious disease outbreaks are distinguished. Total payoff (in millions of US\$) of the strategies depends on the region of the outbreak under consideration, ie, North, South, East and West, as is summarized in Table 3.4.

Table 3.4 Example payoff matrix for contagious disease control

State of nature	Strategy A	Strategy B	Strategy C	Probability
Outbreak North	120	80	30	0.1
Outbreak South	110	70	60	0.5
Outbreak East	90	60	60	0.3
Outbreak West	40	50	60	0.1

A **process diagram** or **flow chart** is a technique in which the selection process is presented in a dynamic sequence of events, information flows, information processing steps and decision-making steps. This approach is used in computer programming and is gaining ground in diagnostic work and areas of artificial intelligence. An example is given in Figure 3.3. In diagnostic work, the different stages of the flow chart become the procedures that one goes through in identifying a specific disease. Thus by answering questions related to the symptoms of the disease and going through 'yes' and 'no' arrows, one ends up at a point where a particular disease is defined.

Decision-tree analysis is probably the most frequently used technique of decision analysis. A decision tree is defined as a graphical method of expressing, in chronological order, the alternative actions available to the decision maker and the choices determined by chance (Figure 3.4). The first step is to arrange the problems that must be solved and to characterize the information needed to translate the decision into a structure resembling a tree. In the decision tree, choices (A_i) such as whether or not to treat, are represented by squares called **decision nodes**. Chance events or states of nature (S_j), such as response to treatment, are

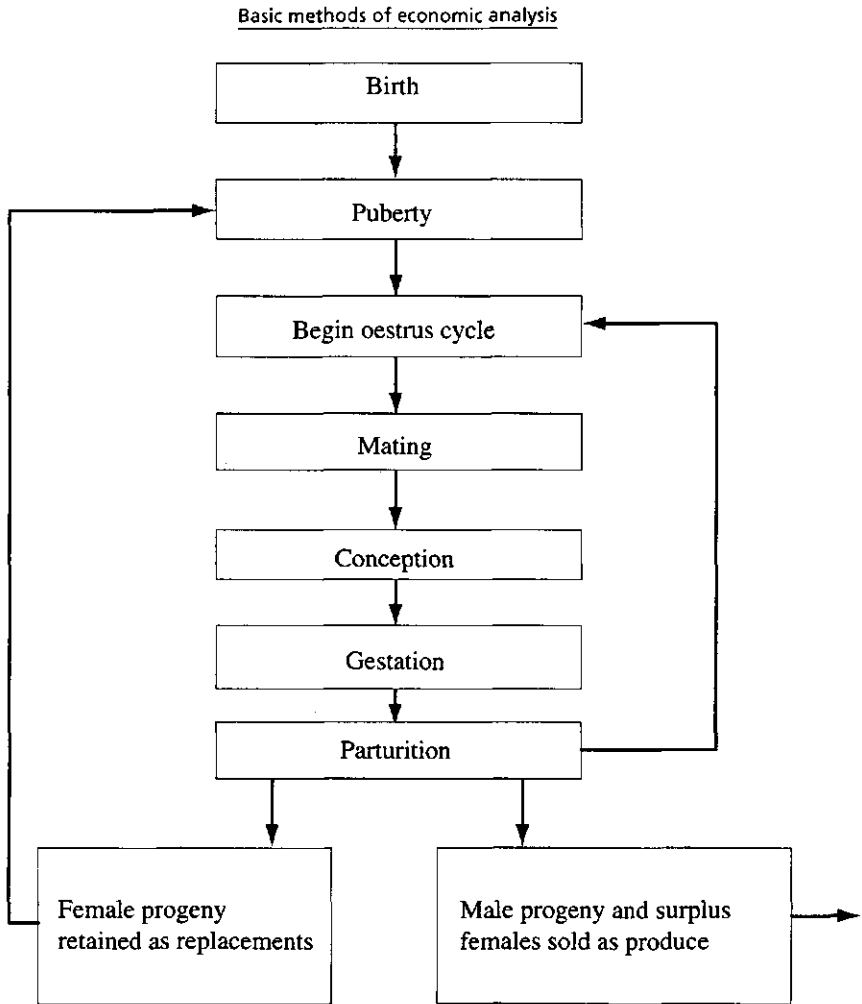


Figure 3.3 An example of a flowchart: the lifetime generator (Marsh, 1986)

represented by circles called **chance nodes**. Lines, or branches, follow each node and lead to the next event. The branches following each decision node must include all possible outcomes, and be mutually exhaustive.

After each chance node, there is a probability (P_i) that an event occurs. The probabilities following a chance node must add up to 1.00. These probabilities can be assessed from literature, experimental data or expert opinion. Expected outcomes (V_i), usually monetary, are entered at the far right of the tree branches. In Figure 3.4, the contagious disease example from Table 3.4 is presented in the form of a decision tree.

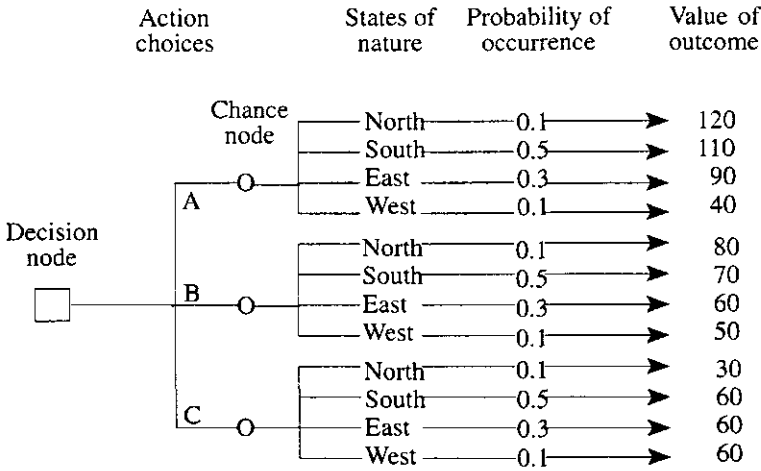


Figure 3.4 A hypothetical decision tree representing action choices (strategies A, B, C), states of nature (outbreaks in North, South, East and West), the associated probabilities and monetary values of outcome

The choice of preferred action is based on the decision criterion, eg, highest expected monetary value (EMV). The EMV criterion can be used to choose the decision (A_w) that maximizes the expected monetary value. This can be done as follows: $A_w = \max EMV(A_i) = \max \sum_j (P_j V_{ij})$. $EMV(\text{strategy A}) = 0.1 \times 120 + 0.5 \times 110 + 0.3 \times 90 + 0.1 \times 40 = 98$, $EMV(\text{strategy B}) = 0.1 \times 80 + 0.5 \times 70 + 0.3 \times 60 + 0.1 \times 50 = 66$, and $EMV(\text{strategy C}) = 0.1 \times 30 + 0.5 \times 60 + 0.3 \times 60 + 0.1 \times 60 = 57$. This means that strategy A has the highest EMV, and is the preferred one.

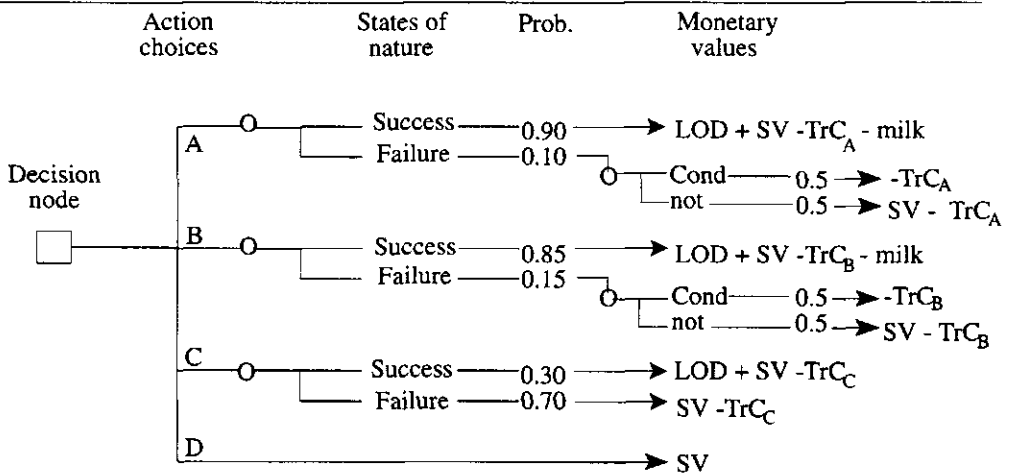
Another example deals with treatment of left-displaced abomasum, which primarily occurs in high-producing older dairy cows that have recently calved. Right-flank omentopexy, left-flank abomasopexy, and right-paramedian abomasopexy can all be used as treatments by skilled veterinarians with high degrees of success. The closed surgical techniques of blind stitch abomasopexy and the bar suture technique are only slightly less successful. A non-surgical method of rolling the cow to effect physical replacement of the abomasum has a high rate of recurrence of the condition and a lower rate of recovery, but this method may be preferred by farmers because it is noninvasive and inexpensive (Ruegg & Carpenter, 1989). Key question is: when are the losses minimal? Decision-tree analysis as a technique can help to make the choice. To construct the decision tree, the following assumptions are made, namely:

1. Surgery (right-flank omentopexy, etc.) costs the farmer US\$215 and closed surgical techniques US\$100. Rolling the cow costs US\$60.
2. Losses in case of premature disposal occur when cows are replaced before reaching their economically optimal age. The extent of the losses highly depends on age and productive capacity of the cows concerned. For the cows in this example the corresponding losses are summarized in Table 3.5.

Table 3.5 Financial losses in case of disposal (US\$)

	Relative production level (% at Mature Equivalent)			
	86-90%	98-102%	110-114%	122-126%
First lactation	72	439	833	1312
Fourth lactation	466	1003	1609	2296

- In case of surgery, milk production is expected to be reduced by 750 kg, which corresponds to US\$315 at a milk price of US\$0.42 per kg. Taking into account a reduction in feed costs because of milk not produced (ie, 375 kg of concentrates at US\$0.22 per kg) provides an expected net loss in milk receipts of US\$315 - US\$82.50 = US\$232.50. In case of closed surgery, milk production is expected to be reduced by 375 kg, because this method is less invasive. No reduction is assumed in case of rolling the cow.
- Cows have to be removed immediately, should surgery be unsuccessful. Meat is expected to be condemned because of antibiotics in 50% of the cases, losing the slaughter value of US\$800.



Where

- A = surgery;
- B = closed surgical technique;
- C = rolling the cow;
- D = culling the cow immediately;

- LOD = loss in case of disposal;
- SV = slaughter value of the cow;
- TrC_i = cost of treatment (with i = A, B or C);
- milk = net loss in milk receipts;
- Cond = meat is condemned because of antibiotics; and
- not = meat is not condemned despite antibiotics.

Figure 3.5 Left-displaced abomasum decision tree

5. The recovery rate after surgery is 85%, and after closed surgical techniques this is 75%. Rolling has a recovery rate of 30%.

The tree shown in Figure 3.5 is based on these assumptions.

Evaluation of the decision tree is started by calculation of the expected monetary value (EMV) for each alternative. These values differ with the financial loss in case of disposal. The outcome is presented in Table 3.6. For each of the different production levels and lactation numbers, the best choice of action is underlined.

For first lactation cows of below-average production level, culling turns out to be the most profitable option. For an average first lactation cow and for an older cow of below-average production level rolling is the most profitable action. First lactation cows producing above average and older cows producing on average or better can best be treated by closed surgery. Surgery is the best option for older cows with a production level of 122 to 126%.

Table 3.6 Expected monetary values (US\$) of the different action choices

Choice of action	Relative production level (% at Mature Equivalent)							
	86-90%		98-102%		110-114%		122-126%	
	Lac1	Lac4	Lac1	Lac4	Lac1	Lac4	Lac1	Lac4
Surgery	525	723	701	1180	1035	1695	1443	<u>2279</u>
Closed surgery	600	862	842	<u>1265</u>	<u>1138</u>	<u>1720</u>	<u>1497</u>	2235
Rolling	762	<u>880</u>	<u>872</u>	1041	990	1223	1134	1429
Culling	<u>800</u>	800	800	800	800	800	800	800

Table 3.6 shows that for an average-producing first lactation cow, the EMV of closed surgery is only slightly lower than the EMV of rolling the cow. A sensitivity analysis shows that with a recovery rate of 23% for rolling the cow instead of 30%, the EMVs of both actions would be equal. For an average-producing cow in lactation 4 the EMV of surgery would be equal to the EMV of closed surgery when the recovery rate of closed surgery equalled 68% instead of 75%. These sensitivity analyses show that the outcome of the calculations is highly dependent on the assumptions made.

Exercise

The example on left-displaced abomasum discussed above is worked out in more detail in the computer exercise in Chapter 19. This example is not built in a spreadsheet format, but in SMLTREE: a computer program especially useful for building decision trees (but not very user-friendly). You have to build the tree partly yourself, then you can evaluate the tree and do some sensitivity analyses on the effect of the producing level of the cow, the prices and the rate of success of the different strategies. This exercise takes approximately 45 minutes.

3.7 Concluding remarks

The basic methods described in this chapter include economic techniques that are relatively easy to understand and apply. Major advantage of these techniques is that they can be performed both by hand and by computer. Hand calculations are especially effective in practical situations (ie, in the field) when there is no computer available. Solving realistic problems by hand with more advanced and complex modelling techniques, such as dynamic programming, linear programming, Markov chains and Monte Carlo simulation (described in later chapters), is almost impossible. The basic techniques presented in this chapter, however, can also be modelled very well (within a reasonable period of time and without too much effort) in spreadsheet computer programs. This gives the decision maker the additional advantage to carry out a sensitivity analysis, in which input variables (assumptions) of the model are systematically varied over some range of interest to determine whether and how the outcomes change. Examples of input variable modifications are interest rates, future price and production levels and probability distributions. With the insights provided by the sensitivity analysis, the decision maker gets a better understanding of the problem in hand and of the effects of alternative actions that are available.

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