SECTION F

Evaluating investment decisions

Overview

RATIONALE

Without an evaluation and clear indicators, it will be difficult for policy-makers to make an objective decision regarding opportunities to invest in animal breeding programmes, and investors will not be encouraged to invest. Opportunity will be lost, and this will negatively affect the outputs of the country's AnGR.

OBJECTIVE

Provide the investor (government or private) with a clear indication of the benefit of investing in animal breeding programmes.

INPUTS

In order to evaluate the benefit of a given breeding programme, tangible and non-tangible inputs and outputs need to be considered, including non-monetary and non-quantifiable benefits.

OUTPUT

The output will be an objective evaluation of the economic benefit and other impacts of a given breeding programme.

TASKS

The following tasks need to be undertaken in order to achieve the above objective:

1. Identify the perspectives and evaluation criteria.
2. Identify and derive cost and returns.
3. Analyse cost and benefit.
4. Evaluate the benefit and decide on investments.

Tasks and actions

TASK 1: IDENTIFY THE PERSPECTIVES AND EVALUATION CRITERIA

Action 1: Decide on evaluation criteria

Breeding plans may be developed at various levels – national, regional, cooperative, company or community. They need to be evaluated in a way that is appropriate to the level in question. There may be important differences between the evaluation criteria that are relevant at each level. While strict economic criteria (profit, return on investment) will be important from the perspective of a company, broader socio-economic criteria will be important from a community's point of view. From a national perspective, a range of policy criteria will probably need to be taken into account.

Ideally, all criteria should be described and analysed in economic terms, i.e. on the basis of cost-benefit analyses. However, this may not always be possible because of the nature of the inputs and outputs involved, the difficulty of collecting the relevant information or a lack of expertise to perform the analyses. Therefore, depending on the perspective and objective, breeding plans will need to be evaluated not only in terms of formal economic indicators, but also in terms of additional criteria that allow considerations of the less tangible inputs and outputs (e.g. impacts on malnutrition or on gender roles). The weight given to the various criteria will need to be agreed upon by the working group.

Action 2: Decide on the perspectives for the evaluation

The outcomes of the evaluation will depend on the perspectives taken. The following discussion considers these perspectives: (1) national, regional and sectoral, cooperative, company and community levels; and (2) retrospective and prospective.

The main differences among the perspectives listed under (1) relate to the inputs and outputs that are taken into consideration, the planning horizon and the discount factor applied (Box 41). For example, a company-based breeding plan will normally include only measurable costs and revenues. It will have a short planning horizon and apply a large discount factor. Conversely, a community-based breeding plan will consider additional inputs and outputs, have a longer planning horizon and apply a smaller discount factor. A particular breeder may have a planning horizon related to his or her personal family business expectations.

The difference between a retrospective and a prospective analysis is that the former is based on historical data on performance, prices and returns, while the latter uses predictions of genetic gains and prices. Less tangible inputs and outputs will be evaluated on the basis of previous experience or probable outcomes, respectively.

BOX 41

Planning time horizons and discount factors

The planning horizon *h* describes the period of time over which costs and returns will be considered and summarized. The discount factor *d* is a number between 0 and 1 (usually between 0 and 0.1). It is used to discount a profit of *x* monetary units next year to a current value of $y = \frac{x}{(1+d)}$. Likewise, *x* monetary units in *t* years' time is worth at $y = \frac{x}{(1+d)^t}$ current value.

The use of a discount factor can be justified in a variety of ways. For example, if the interest rate is 100*d* percent, then it would be possible to obtain the same profit by investing *y* in a bank today. High values of *d* indicate short time horizons, as profits obtained in the more distant future are given considerably less weight. Conversely, if values of *d* are low, future profits are given more weight. It must be recalled that the discount factor does not take inflation into account. Economic expertise may be required to help define appropriate values of *h* and *d*.

Action 3: Decide how economic returns should be presented

The operational actions in the later tasks will derive the costs and returns for each year of the planning period. There are at least two options for combining these in order to evaluate investment: (1) maximize revenues minus cost (i.e. maximize profit); (2) maximize revenues per unit of cost (i.e. maximize return on investment). Livestock keepers and cooperatives may relate more easily to maximizing profit. An investor in a breeding company will require a measure of the return on investment. The policy-makers for whom the evaluation is being performed should take the decision as to which option is most appropriate.

TASK 2: IDENTIFY AND DERIVE COST AND RETURNS

Action 1: Identify major components of the animal breeding programme

The major components of the animal breeding programme will have been identified when describing the production system, identifying the LDOs and developing the straight-breeding and/or cross-breeding programme(s). Items to be considered include:

- inputs per animal (e.g. feed, vaccines and other veterinary treatments);
- outputs per animal (e.g. market and non-market products);
- inputs per holding (e.g. housing, labour by gender and age, machinery, extension advice, credit, recording costs);
- outputs per holding (e.g. fuel, draught power, social networks);
- inputs per sector (e.g. genetic evaluation, marketing organizations);

- outputs per sector (e.g. food security, nutritional objectives);
- inputs per country (e.g. subsidies, grants, enterprise schemes, start-up schemes); and
- outputs per country (e.g. employment, exports and foreign exchange, fulfilling rural-policy objectives).

Note that the level at which particular inputs or outputs should be considered will not necessarily correspond to the level at which it appears in the list above. For example, in some scenarios genetic evaluations could be considered farm-level rather than sector-level inputs.

The importance given to the different items in the evaluation process will depend on the perspective of the policy-makers and the type of breeding programme.

Action 2: Wherever possible, identify the costs of inputs and returns on outputs

The approach taken to identifying costs and returns will depend on whether the perspective is prospective or retrospective. For the former, the costs and returns will have been forecast when identifying the LDO (Section B); in the latter, however, costs and returns will be a matter of historical record.

Identification of costs and returns can be done by appropriately trained staff within research institutions, universities, the relevant government ministry or private companies. Although some of the items identified during the previous action will not be easy to cost, they may be very important components of the programme. The evaluation of such items will be dealt with in Action 4 of Task 4, below.

TASK 3: ANALYSE COST AND BENEFIT

Action 1: Determine costs and revenues in each planning term period, for each stakeholder

Action 2 of Task 2 involved listing the inputs and outputs of the breeding programme. For the inputs and outputs to which monetary values can be attached, costs and revenues need to be calculated for each period of the planning term.

At this point, it is important to recall the outputs of Actions 1 and 2 of Task 1 (criteria and perspectives for the evaluation), because they will indicate which stakeholders should be considered in the cost and revenue calculations. From a national perspective, and considering the inputs and outputs that have monetary values, the costs incurred and revenues received must be calculated for each stakeholder. For the evaluation of an investment made by a single livestock keeper, only the individual's own costs and revenues need to be considered. A simplified example is presented in Table 8.

Calculating genetic outputs involves considering the flow of genes through the population over time and the accumulation of genetic gain over all age groups in every period. This can be done by means of the following steps:

- Calculate the genetic value for each trait in each age group for each period (genetic value is the starting genetic value plus the genetic gain achieved).

- Calculate the costs of animal inputs for each age group, for each period and for each stakeholder. (A livestock keeper, for example, will incur feed intake and veterinary costs; take into account the input provided by all household members.) Be sure to include only costs that are additional to those associated with the normal breeding activities.
- Based on the genetic values, calculate the value of sales and home use of products for each age group, for each period and for each stakeholder. For example, milk will be sold to the retailer by the livestock keeper, and the retailer will sell products to the public.
- Add additional costs and revenues not related to the animal inputs and outputs considered in the two previous steps. Add the costs and revenues to the period in which they were incurred. Use the list of costs and revenues as a checklist (Action 1).
- For each period and for each stakeholder, add up the costs and the revenues separately.

Action 2: Use the agreed discount factor to convert costs and revenues to net present value

The policy-makers will have decided on the discount factor to be used. If the value is zero, then the costs and revenues calculated in the previous action will be left unchanged. If the discount factor is greater than zero, the costs and revenues for each stakeholder and period need to be converted to a net present value equivalent to $y= \frac{x}{(1+d)^t}$ where x is the cost or revenue, d is the discount factor and t is the time since the start of the planning term.

Action 3: Calculate benefit according to the desired profit function

For each stakeholder, sum the net present values of costs over all periods in the planning term (denote this total C) and sum the net present values of revenues over all periods in the planning term (denote this total R). If the objective is to calculate profit, calculate R minus C for each stakeholder. If the objective function is return on investment, calculate R divided by C for each stakeholder. For the overall scheme, add up the C values and R values over all stakeholders, then calculate either profit (R – C) or return on investment (R / C) based on the totals.

Action 4: Where appropriate, test the sensitivity of the cost-benefit analysis

If the investment decision is prospective, the key assumptions on which the model is based will involve a degree of uncertainty. The sensitivity of the results should be tested by varying the future commodity prices and the anticipated genetic gains used in the calculation.

The cost-benefit analysis should be repeated with both pessimistic and optimistic assumptions concerning prices and anticipated genetic gain. Break-even points can be investigated – for example, what proportion of the anticipated genetic gain has to be realized for the additional revenues of the breeding scheme to be equal to the additional costs?

Action 5: Report results of the cost-benefit analysis to the policy-makers

The results of the analysis should be summarized and given to the policy-makers. Ensure that the outcomes for different stakeholders are described in the report.

TABLE 8

Investment evaluation for a simplified sheep breeding programme

Tier/ Feature	Year since birth of first improved progeny in the nucleus															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NUCLEUS																
Average fibre diameter[1]	19	18.8	18.6	18.3	18	17.6	17.3	17	16.7	16.4	16.1	15.8	15.5	15.1	14.8	14.5
Annual income[2]	0	540	1 080	1 754	2 564	3 542	4 183	4 934	5 710	6 505	7 292	8 032	8 809	9 584	10 359	11 128
Annual discounted income[3]	0	504	943	1 432	1 956	2 526	2 788	3073	3 323	3 538	3 707	3 816	3 911	3 977	4 017	4033
Annual costs[4]	6 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800
Annual discounted cost[3]	6 800	1 682	1 572	1 469	1 373	1 283	1 199	1 121	1 048	979	915	855	799	747	698	652
BASE																
Average fibre diameter[5]	20	19.9	19.8	19.6	19.4	19.1	18.9	18.6	18.4	18.1	17.8	17.5	17.2	16.9	16.6	16.3
Annual income[2]	0	2 236	4 471	8 201	13 424	19 418	24 436	30 607	36 746	42 678	49 029	55 471	62 103	68 647	75 232	81 969
Annual discounted income[3]	0	2 089	3 905	6 694	10 241	13 845	16 283	19 061	21 387	23 214	24 924	26 354	27 575	28 486	29 176	29 709
TOTAL																
Annual discounted profit[6]	–6 800	912	3 276	6 657	10 824	15 087	17 871	21 012	23 662	25 773	27 715	29 315	30 687	31 716	32 495	33 090
Accumulated discounted profit[7]	–6 800	–5 888	–2 612	4 045	14 869	29 956	47 827	68 839	92 502	118 275	145 991	175 305	205 992	237 708	270 203	303 294

Description of the programme: A livestock-keeping community with 3 000 ewes decides to select the best 300 ewes for a ram-producing nucleus, where replacements are selected on the basis of reduced fibre diameter. The best rams are used in the nucleus and average rams are used in the base. Flock statistics are: 80 percent weaning rate, no mortality, 5 ewe age groups (5 lambings, 6 shearings) and 2 ram age groups.

Interpretation: It can be seen that costs start early and revenues build up later. However, by Year 3 the programme is already profitable. With a planning horizon of 15 years the profit (revenue – costs) of the programme (nucleus + base) is US$303 294 and the return on investment (revenue / costs) is US$14 to US$1.

Notes:

[1] Average fibre diameter, measured in microns (mic), refers to the average of all shorn female age groups. Initial nucleus fibre diameter is 19 mic. Breeding value of new progeny is calculated by adding the averaged male and female replacement genetic selection differentials to the mean of parents. Required assumptions are: fleece weight = 3 kg; CV [coefficient of variation] of fibre diameter = 0.08; heritability of fibre diameter = 0.5.

[2] The extra income is due to higher wool price, as fibre diameter decreases, with a premium of US$1.5 per mic for each kg wool.

[3] Calculated by applying a discount factor of 0.07.

[4] Annual costs: ear tags $US1 each; fleece analyses US$4 each; extra labour US$600. One time–only costs are a scale and fencing, totalling US$5 000.

[5] Average fibre diameter (mic) refers to the average of all shorn female age groups. Initial base fibre diameter is 20 mic. Breeding value of new progeny is the average of base ewes and average of nucleus rams (these being the average of two age classes).

[6] Annual discounted profit is the discounted difference between annual income in nucleus and base, and annual costs incurred in the nucleus.

[7] The accumulated discounted profit indicates the profit of the programme at the respective year (revenue – costs).

TASK 4: EVALUATE THE BENEFIT AND DECIDE ON INVESTMENTS

Action 1: Consider the outcome of the cost-benefit analysis

The cost-benefit report should be carefully reviewed. Consider whether all identifiable costs have been taken into account and whether the assumptions are reasonable. If there are deficiencies that can be rectified, the analysis should be repeated.

If the analysis is considered adequate and the perspective is purely economic, the decision can be made relatively easily. For other perspectives, however, outputs of the programme that are difficult to quantify and have been omitted from the cost-benefit analysis may need to be considered carefully before the final decision is made (see Action 4).

Action 2: Consider whether benefits are equitably shared among stakeholders

The cost-benefit analysis identifies costs and benefits that accrue to various stakeholders (Box 42). There is a need to consider whether the benefits are shared equitably (or are in line with a particular distributive policy objective). If benefits are not equitably shared, consider whether there is a case for redistributing costs. For example, if breeders have a favourable cost-benefit compared to that of the government, yet the government pays for the genetic evaluations, then a case can be made for breeders to take on the costs of the evaluation.

Action 3: Consider the national impact

The breeding programme will do more than achieve genetic improvement; it will create a dynamic in the livestock sector that will have effects at different levels (farm, research station or imports of germplasm). It is essential, therefore, that the evaluation takes these broader perspectives into consideration. For example, the impact that the new information generated will have in terms of improving livestock management and the effects of creating common goals among livestock keepers must be considered. A country with national breeding programmes for its animal resources strengthens its food security policy and provides job opportunities.

Action 4: Consider impacts not included in the cost-benefit analysis

A number of components of livestock breeding programmes will be difficult to include explicitly in the cost-benefit analysis, but may have important effects (Box 43). The following components may need to be considered (potential methods to quantify some of them are described in Section B):

- use of livestock for socio-economic, social and cultural purposes (see Box 5);
- food and livelihood security for the human population, and the degree of dependence on others (e.g. other countries) required to feed the human population;
- improvement to human nutrition;
- output of animal products additional to those included in the cost-benefit analysis;
- environmental impact of the breeding programme;
- impact of importing food on the national balance of trade;
- rural policy goals; and
- gender policy goals.

BOX 42

Example of return on investment in a genetic evaluation scheme considering various stakeholders

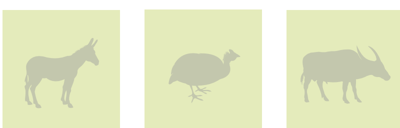
LAMBPLAN is the genetic evaluation scheme for Australian sheep. Both retrospective and prospective cost-benefit analyses of the breeding programme to improve meat quality have been conducted. The table below shows the prospective cost-benefit analysis. Costs and benefits are distinguished according to the stakeholder. Those considered are:

- breeders (the generators of the genetic progress, who contribute funds to and receive services from LAMBPLAN);
- levy payers (commercial sheep and beef producers, who pay breeders for improved rams, and up to 2 percent of gross value to Meat and Livestock Australia, a livestock keeper–owned corporation);
- the government (which matches funds provided by the levy payers for research and development in sheep genetics); and
- processors and retailers (who buy the carcasses from the levy payers at prices matched to the quality of the product and sell them in export or domestic markets).

Return on investment in LAMBPLAN (in million $A), 1998–2002

	Breeders	Commercial producers (levy payers)	Government	Processors and retailers	Total
Genetics research and development		0	–1.0		–2.0
LAMBPLAN delivery	–0.6	19	–0.3		–1.2
Breeders cost/return	+37.3	0	–37.3		0
Producer cost/return		0	+73.0	–73.0	0
Cost/return to others		6 800		+263.4	+263.4
Net benefits	+36.7	6 800	+34.4	+190.4	+260.2
% of the benefit by sector	14.0	20	13.2	72.8	100
Benefit-to-cost ratio	62:1		1.9:1	3.6:1	82:1

Source: ICAR/FAO (2000b).



BOX 43

Additional impacts of a breeding programme – a checklist

- Do the improved livestock have a cultural or social value?
- What is the importance of the new or improved products for food diversity and local food availability?
- Do the new or improved products contribute to overcoming current nutritional deficiencies?
- Has consideration been given to products additional to those included in the cost-benefit analyses (e.g. manure, fuel and draught power)?
- Does the breeding programme reduce or increase the stocking rate, demand for water and feed, soil compaction, pesticide requirements or energy requirements?
- Do the new or improved products substitute imports or expand markets?
- Does the breeding programme favour rural development objectives, rural employment or livestock keeper organization?
- What impact does the breeding programme have on women's incomes, particularly if women are required to supply additional input?

The livestock breeding programme may affect several or all of these components. For example, for a product in a *saturated market*, increasing production per animal may reduce the number of animals and hence the number of owners. (Note that this may, in fact, occur at a slower rate than would have happened had there been no investment in the sector and a consequent loss of competitiveness.) Management may need to change to make the most of the opportunities associated with the improved stock. Use of the improved stock may increase the profitability of the remaining enterprises and thus drive a significant downstream economy. All these will affect the social roles of livestock, gender relations, rural employment, poverty alleviation and possibly the environment. The effects on the environment may be negative (e.g. if intensification of production gives rise to more harmful wastes) or positive (e.g. if stocking rates can be reduced while maintaining or improving production).

Such consequences are hard to incorporate objectively into a cost-benefit analysis, although they may permit subjective assessment. Some attempt should be made to bring them into the investment decision. For example, it may be useful to assess the impact of these components (categorizing them as positive, negative or neutral). This may be done with the assistance of experts and based on the opinions of key stakeholders. Results should be presented together with the formal cost-benefit analysis and weighted according to the policy-makers' objectives.

Action 5: Consider a no-investment scenario

Given that competition in markets for agricultural products is likely to increase, it is useful to repeat the cost-benefit analysis based on the assumption that no investment occurs. This may be particularly informative where the perspective is national, sectoral or cooperative. This comparison of investment versus no investment gives an alternative perspective on the decision to be made.

Action 6: Decide on investment and future evaluation policy

Evaluation of investments in animal breeding programmes has shown them to be effective in providing high benefit-to-cost ratios. This is largely because genetic improvement is permanent and cumulative – one round of selection confers improvement on all subsequent generations (while vaccination, for example, needs to be applied to each new group of animals). Subsequent rounds of selection build on improvements already made. If the evaluation of breeding programmes were carried out more regularly, their cost-effectiveness would be recognized more widely, and they would probably be included more often within development strategies.

The results of the cost-benefit analyses and the assessment of non-measurable benefits should be supplied to the policy-makers who will take the decisions regarding investments in the programme.