Investment appraisal and decisions: machinery and buildings

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INVESTMENT appraisal is the process of gathering all available information about possible investments. The investment decision is the process of choosing among alternatives, according to a criteria established by the manager. In practice, most farm managers do not separate these two processes into distinct operations, nor do they always have simple, mathematically clean criteria upon which to decide. In this paper I shall discuss, first, some of the terms and concepts that are needed in any treatment of investment problems. After this, I shall discuss some of the kinds of information required, and the ways of using it in appraising investments in machinery and buildings.

Concepts and terms

Money is a thing possessed by people, either individually as farm managers and others, or in groups such as banks and other financial institutions. Money is not alive, let alone a sentient thing, and cannot make any sort of decisions. It is allocated according to the decisions of people who possess it.

One of the common assumptions of economics is that each of us prefers to possess a dollar today, rather than to have the promise of such possession some time in the future. Economists call this assumption "time preference". It means that I am likely to give up possession of a dollar today, only if I am promised the possession of something more than this dollar at some future time. This additional amount that I am promised is called "interest". Usually, it is expressed as the percentage of the dollar that is to be paid to me each year that I forgo its return to my possession.

The act of giving up a present possession of money, in the expectation of receiving the money back with interest, is called "investment". So we may say that interest is the return paid to the investor for the use of his money over some time period.

An investment is made with the expectation of a future flow of returns, but the future always is uncertain. For this reason, the investor will require that the payment he receives includes a premium for the risk he faces, the risk that his expected flow of returns will not be realised. Risk is a combination of the investor's confidence in the person with whom he invests his money, and of the period of time over which he expects to wait to have his investment returned. Risk increases with time, since the conditions two or ten years hence are more difficult to anticipate than those of next year.

Fortunately, the individual farm manager is not required to go into the details of estimating the risk components of various investments, nor even of establishing his own time preference for money. For most investment appraisals, he can use an interest rate that includes both components, and that is established in the general investment market place. Thus, if the manager is considering an investment in a building or a machine, he can use the rate that a commercial investor (usually a bank) would charge for that investment.

"Simple interest" is the name given to the payments for those investments for which interest is paid in cash, at some stated rate, for every year that the investment is held. The interest payment in any given year is given by:

Q times r,

Where Q is the quantity of money in the investment, and r is the interest rate. The total interest payment expected over the life of the investment is this annual interest payment multiplied by the number of years to maturity.

If the annual interest is to be added to the investment each year, then this will draw interest too, in the years following that in which it is credited. This system is called "compounding". The accumulated value of an investment at compound interest is given as:

$$V = Q(1+r)^n,$$

where the exponent n is the number of years to maturity, and V is the value of the investment at maturity. The reason for using one plus the interest rate, rather than the total quantity Q, is that standard tables are in the general terms of $(1+r)$.

Since the interest rate r is the same as the time preference for money of the investor (plus a risk premium), then one can use this formula to calculate the value today of some flow of money to be received in the future. This procedure is called "discounting

to present value", and is the inverse of the preceding, namely:

$$V = \frac{Q}{(1+r)^n}$$

where V is the present value of the quantity of money Q to be received over n years into the future. Compounding a present investment to some maturity value is exactly the inverse of discounting some future flow of money to a present value. This can be illustrated as follows:

The accumulated value of a present investment of $1,000, compounded over ten years at 8 per cent interest is:

$$V = 1{,}000\ (1 + .08)^{10} = \$2{,}159.$$

The present value of $2,159 to be received ten years hence, with a time preference of 8 per cent is:

$$V = \frac{2159}{(1 + .08)^{10}} = \$1{,}000.$$

Thus, if the manager is given the choice of retaining possession today of $1,000, or of giving up that possession on promise of a return of $2,159 ten years hence, he should be able to make his choice by a random flip of a coin. He should be indifferent between these two choices, in so far as his decision is that of a pure investor.

But farm managers seldom are pure investors, as are bankers and other professional lenders. Farm managers must make investment decisions in which money will be allocated to the purchase of capital components, to be used in the farming business. The results of this decision can only be known over future time, and therefore are uncertain at the time the decision is made. The investment will be made in buildings or machinery in the expectation that the manager can use the item profitably in his farming business. Thus, the pure investment decision becomes a standard against which the farm manager can compare the return from a pure investment with the expected return from his investment in machinery and equipment.

Since the farm manager makes the decision to invest, or to retain his money in cash form, he gets the profit or loss that comes from the investment leading to an excess or a shortage of returns. Thus, the management return is the difference between the discounted present value of an investment and the quantity of money to be invested.

Investment choice with specific cash returns

An investment may be contemplated because the farm manager expects that the machine or building acquired by the investment will increase the income flow, or will make possible a new source of income to the farm business. In all three cases the manager wants to appraise the expected net flow of cash, over the maturity of the investment, and to discount this flow to its present value. When he has done this for all investment alternatives he can decide which investment is best, on the basis of the differences between investment required, and discounted present values of the net income flows expected.

Discounting cash flows to the same present value eliminates the effects of differing income flows, and of differing maturities. It allows the manager to make his decision in terms of present quantities of money, as if the results of the investment were instantaneous. An hypothetical example will illustrate the appraisal and decision procedure.

Alternative ‡1

Let us suppose that a farm manager is considering two alternative ways of improving his income from a pig enterprise. He can invest $17,000 in buildings and feeding machinery, and convert from a pasture to a confined breeding system. He has reason to believe that the specialised buildings and equipment will be useable for a period of 13 years, with no additional investment required. The manager estimates the annual maintenance and repair costs, the additional feed costs, the reduced labour costs, and the additional cash income that he will generate from the land freed from use as pasture for pigs. He estimates a net increase in cash flows of about $2,700 each year from this change in his pig enterprise. His banker would charge nine per cent interest on money lent for such a purpose.

Alternative ‡2

The manager wishes to consider the alternative of improving his pigs pasture so that it will feed more animals. An investment of $15,000 is required for tillage and reseeding. The estimated net cash flow will vary over the life of the investment. Thus, the flow will reflect an increase in pig capacity in the early years, a more or less level period, and then a decline as the original measures lose their effectiveness. The manager expects the pasture capacity to be back to its present level after ten years.

The manager can combine the information he has developed into a table showing the net cash flows each year, the present values of these, and the net present value of the investments. These data are given in Table 1 for both of the alternative investments. He uses a discount rate of 9 per cent for the present value calculations of both investments.

One can see that both investments are economic—that both are expected to generate cash income flows whose present values are larger than the required investments. Under the conditions of equal risk as assumed in this example, the manager will choose Alternative ‡1, since the management return is larger than that for Alternative ‡2.

If the market place should put a lower rate of interest on one type of investment than on the other,

as frequently happens, then the farm manager would use different discount rates in his appraisal, and his decision might change. For example, if the pasture improvement programme were considered to be less uncertain than the investment in buildings and equipment, then the discount rate for Alternative ‡2 would include a lower risk component. Suppose that this is the case, that the discount rate for the second alternative is 7 per cent, while that for the first alternative remains at 9 per cent. Then the discounted present value of the net cash flow from the pasture improvement investment will be $18,899. The manager's return above the cost of the investment will now be $3,899. Under these conditions the second alternative would be chosen over the first.

Investment with uncertainty

In many cases a proposed investment will generate a net cash flow whose annual values are uncertain in the present. This may be due to expected variability in prices, yields, levels of production, or other factors. There are many factors of cost and price affecting net cash flows that are nearly unique to a given farm and farm manager. The normal investment market does not provide an adequate risk component in its interest rate to cover such special situations.

The farm manager can guess at this higher or lower risk component, modify the given market rate accordingly, and use the resulting figure as his special discount rate for present values. The practical problem here is that few farm managers are proficient at the finely-tuned judgments in the establishments of risk-premiums. If the professional investors cannot determine an adequate rate, then there is little reason to expect the farm manager to do so. In fact, there is reason to avoid requiring him to do so, because of the sensitivity of investment decisions to changes in the discount rate (as in the previous example).

In these special situations, the preferred appraisal method requires that the manager use the interest rate quoted by the market for the general type and maturity of investment under consideration. The difference between the present value and the required investment now includes both the managerial return and an additional risk component payment. The manager must judge from this result whether or not he is willing to risk the required money investment, in order to receive this indicated return. In general, the farm manager is better at judging quantities of money, and the particular uncertainties of his farming operation, than he is at specifying the percentage of extra-risk to be added to a discount rate.

The manager may be able to establish various levels of possible net cash flows from a contemplated investment, such as a minimum, maximum, and average expected level. The minimum level may be negative, since there may be some possibility that the machine or building will not turn out well in the enterprise for which it is to be added, and will result in an income flow that is less than that of costs.

To each level of possible cash flow, the manager must attach his best estimate of the probability of that level turning out to be the actual one. The subjective probabilities modifying each income level are expressed as percentages. They must add to one, since some result is certain to obtain.

The appraisal system requires that the cash flows for each level be discounted to present values, and then multiplied by the subjective expectation attached by the farm manager. He then must add these modified present value sums for all levels of expected cash flows, to get an estimate of the most likely result of his proposed investment.

Although the weighted probability method seems arcane, it is not found to be difficult by most knowledgeable farm managers. They soon discover that the necessity to establish all possible levels of cash flows, and then to assign probabilities to each, is a help in the disciplining of their own thinking about investments. The procedure often helps to clarify the manager's thinking of possible outcomes, and of reasons for them, and may suggest an outcome that he otherwise would not have thought to include in his appraisal system. An example will illustrate this procedure.

Let us suppose that a dairy farmer is contemplating an investment in an automatic feed grinding and mixing system. It will cost him $25,000 to buy and install the bulk silos, the grinding equipment, and the storage bin for the batches of mixed feed. This is an investment of the efficiency, or cost reducing, type. The additions to the manager's net cash flow will be the result of his being able to buy feed components in large quantities, at times when they are least expensive, thereby realising a cost savings over his present practice of buying feed already mixed by dealers.

The farm manager has talked with potential suppliers of bulk feed components in order to gather his information on prices to be expected. He knows that the extent to which he will reduce his actual feed costs will depend on price variations of components, and on the possibilities that suppliers of mixed feed will reduce their delivered prices in the future. His banker is willing to lend money for this investment at 7 per cent interest, but would require additional security. This indicates that there should be an added, but unknown, risk premium included with the 7 per cent discount rate. The useful life of the system is estimated at 15 years.

The manager now considers possible outcomes, if he should make this investment.

The worst possible outcome is that the prices of mixed dairy feed will fall, to the extent that he will realise no savings through buying components and mixing his own feed. In this case, the net additions to his cash flow would be zero, and the investment would be a total loss. The manager estimates that the

best possible outcome would be that his annual savings would average out to about 10 per cent of his current feed costs of $66,700. The worst prospect, the manager thinks, is only about 5 per cent likely, while the best prospect is about 20 per cent probable. To complete his appraisal, the manager estimates that an annual average reduction in his feed costs of 3 per cent is about 40 per cent probable. Further, he thinks that a 7 per cent reduction in feed costs is about 35 per cent likely.

One should notice that the levels of feed cost savings are based on information that the manager has gathered from the feed market, while the attached probabilities are his own best estimate of the likelihood that a given level will be the true experience over the next 15 years. It remains only for this management to reduce the four sets of cash flows to present values, to modify these by their appropriate probabilities, and to compare the resulting weighted sum with the investment cost. These procedures are shown in detail in Table 2.

The manager can see that his maximum loss could be the $25,000 that he must invest, while his maximum gain could be $35,720 in addition to his original investment. His most likely return is $8,057 above the required investment. His decision should be based on his willingness to risk the investment for the most likely level of return.

If the manager is in a reasonably sound financial condition, he can accept the one-in-twenty odds for a total loss of his investment, in the strong expectation of doing much better than this. But if the manager is in a relatively weak financial position, loss of the $25,000 investment might put the whole of his dairy business in jeopardy. This possibility might lead him to choose not to risk liquidation or bankruptcy at any odds, irrespective of the potential gains.

Investment in system components

The preceding discussion has dealt with investment appraisal and decisions in cases when a cash flow effect from the investment is discernible. But a good many investments are required in machinery or buildings that are integrated components of a production process. For these items, no net cash flows can be identified separately from the flows for other components. This is the classical problem that economists call "joint product" evaluation. The manager cannot set his investment appraisal on any firm basis, since there is no way of establishing that part of the expected net cash flow that is the specific result of this or that machine in the production process.

There is some hope that the particular net income effect of a machinery investment can be estimated, using the depreciation allowance against income tax liabilities as a proxy. But this is very complex, and may be particular to tax laws in the United States. For practical farm management purposes, an investment is a component of an integrated production system can only be appraised in terms of whether or not it is necessary, and whether the manager can afford to make the required investment. He is forced to assume that, if these conditions are met, and if his prospective net cash flows are not reduced, then the proposed investment is somehow an economic one.

One can see that the art of investment appraisal and decisions is not yet reduced to an unexciting mechanism of numbers and formulae. There is still a continued need for the hunches, guesses, and inspired observations of good managers, and the opportunity of significant managerial returns to such good managers. The contribution of teachers and researchers of management decision processes will no doubt continue to be that of identifying and organising information, and of suggesting how new information can be included in the processes of investment appraisal that managers use.

I hope that this paper helps some managers to clarify and improve their decision processes. I am sure that we are a long way from finding substitutes for the central ingredient in decisions—the mind of a competent manager.

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Table 1

CHOICE BETWEEN INVESTMENTS

Year	*Alternative 1* $17,000 *Investment*		*Alternative 2* $15,000 *Investment*	
	net cash flow	*present value*	*net cash flow*	*present value*
1	2,700	2,477	0	0
2	2,700	2,273	1,600	1,346
3	2,700	2,085	2,800	2,162
4	2,700	1,913	3,700	2,621
5	2,700	1,755	4,400	2,860
6	2,700	1,610	4,500	2,683
7	2,700	1,477	4,300	2,352
8	2,700	1,355	3,400	1,706
9	2,700	1,243	2,100	967
10	2,700	1,140	900	380
11	2,700	1,046	0	0
12	2,700	960	0	0
13	2,700	881	0	0
Totals	35,100	20,215	27,700	17,077
Management return above investment cost		$3,215	—	$2,077

Table 2

INVESTMENT WITH UNCERTAINTY
($25,000 invested)

Level of Cost Saving	0%	3%	7%	10%
Net Annual Flow	$0	$2,000	$4,667	$6,667
Year	*Discounted Present Values*			
1	0	1,869	4,362	6,231
2	0	1,747	4,076	5,823
3	0	1,633	3,810	5,442
4	0	1,526	3,560	5,086
5	0	1,426	3,328	4,754
6	0	1,333	3,110	4,442
7	0	1,245	2,906	4,152
8	0	1,164	2,716	3,880
9	0	1,088	2,538	3,626
10	0	1,017	2,372	3,389
11	0	950	2,217	3,167
12	0	888	2,072	2,960
13	0	830	1,937	2,767
14	0	776	1,810	2,585
15	0	725	1,691	2,416
Total Discounted Flows	$25,000	$18,217	$42,505	$60,720
Subjective Probability	5%	40%	35%	20%
Weighted Total	$1,250	$7,287	$14,876	$12,144
Present Value of the Most Likely Return — $33,057				
Management Return + Extra Risk Component — $8,057				

INVESTMENT APPRAISAL: MACHINERY AND BUILDING

DISCUSSION SUMMARY

1. A degree of of antipathy towards a formal investment appraisal was expressed, since they involved so much time that practical managers were forced to play their "hunches". This was felt to be particularly true in relation to the modification or expansion of existing enterprises, but less so in respect of major new ventures.

2. Some investment was unavoidable due to legal and social requirements but beyond this the manager could choose whether to invest or not. In many cases the answer would be no, but this would limit the business to a return on the money equal to deposit rates of interest. In order to increase disposal income extra investment was often required either to boost output or reduce costs. Areas of cost "inflation" offered opportunities for investment, for example, where the increasing cost of labour favoured substitution by capital either in the form of machinery or improvements to building layouts. The best current opportunities for investment needed to be isolated and compared on a standard basis.

3. In that respect the Present Net Value (PNV) technique favoured by Dr. Bostwick was criticised, since the PNV of the total return of alternative investments gave no indication of either their initial capital requirements or their duration. Where these varied between projects the PNV returns needed to be carefully interpreted before "ranking" the projects and ideally additional calculations may be required to make them strictly comparable. Reference was made to the first example where, in comparing the Projects $2,000 remained available in Project 2 for investment elsewhere. The income from this investment should be included in the appraisal.

4. It was suggested that the Internal Rate of Return (Internal Yield) technique, which gave a percentage return on total capital, gave a better basis for comparing projects of varying duration and of differing capital requirements. Further, this was an easier concept for managers and bankers to accept and enabled them to make quick comparisons with existing farm and non-farm enterprises. The results of an internal rate of return calculation must be related to the risk content of the investment and not to cut off points, thus a 3-4 per cent. yield on capital invested in land could be acceptable, whereas a 20 per cent. yield from a high risk enterprise might not be acceptable.

5. Dr. Bostwick, although in sympathy with these ideas, stated he had a basic objection to the IRR method. Mainly that it automatically inferred that outcomes were directly due to the capital invested, that the entire economic rent was due to the capital invested. In fact, this rent should be allocated to the other production factors, labour, buildings and management, leaving the invested pound neutral.

6. The duration of investment projects was seen to be critical since in many cases a change from a 7-10 year project device meant a "poor" project became viable. In the USA the minimum period approved by the Inland Revenue for depreciation of assets was normally taken as the life of the project. The critical issue was to balance the risk of overstating the economic life of the asset with its annual income earning capacity. Varying the discount rate in PNV calculations to accommodate risk was an equally sensitive area and even harder to quantify, hence Dr. Bostwick's preference for selecting alternative outcomes and attaching probability estimates.

7. Where assets were appreciating in value, a change in value of the equity was best shown in the terminal value of the asset since this did not obscure the liquidity position; however, the changes in value of the asset could be allocated as it was expected to accrue if required. Use of the technique did not automatically provide clear answers to such critical issues as where the special buildings such as tower grain silos were preferable to general purpose umbrella buildings, since this would depend on the costs, write off periods and salvage value. The value of the technique lay in the rigour with which all the relevant factors could be accommodated and quantified. It did not lessen the manager's requirements for the normal skills and crafts but did improve his ability to attract outside finance.