Investments

UNIVERSITY OF NOTTINGHAM

School of agric

Department of Agricultural Economics

SEPTEMBER, 1966 F.R. 161

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METHODS OF APPRAISING NEW CAPITAL INVESTMENT IN AGRICULTURE

by

H. W. T. KERR, M.A.(Cantab.)

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St. Michael's House
SUTTON BONINGTON
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SEPTEMBER, 1966 Price 5s. 0d.

FOREWORD

The great increase in land prices, the substitution of capital for labour as agricultural wage-rates move to higher and higher levels and the enlargement of the size of farm businesses to counteract the fall in profit margins per unit of output—all these have brought about a situation in which capital investment in agriculture has taken on a new significance, of a quite different order of magnitude from that which prevailed a generation ago.

In these circumstances it has become imperative for farmers and others who invest money in agriculture to examine closely the expected return on any proposed investment and to relate it to possible alternative returns on other investments.

In this bulletin Mr. Kerr describes certain methods of appraising capital investment which have gained a wide acceptance. He gives examples which take account of the main features which are characteristic of agricultural investment—uncertainty and irregularity of returns and the long periods of time over which benefits accrue. The description and the examples are intended to be of practical value. At the same time we realise that much experience of these and other methods has still to be gained, and we would welcome observations by farmers or other practitioners.

D. K. BRITTON,
Professor of Agricultural Economics.

ACKNOWLEDGEMENTS

This publication began as a talk to National Agricultural Advisory Service Officers in the East Midlands Region. The author would like to thank the many people who have made helpful comments and criticisms both in the Department and outside and he would particularly like to mention Mr. H. A. Thomas, the N.A.A.S. Regional Farm Management Adviser and Mr. J. B. Hardaker and Mr. H. J. Gunn of the Farm Economics Branch, University of Cambridge.

METHODS OF APPRAISING NEW CAPITAL INVESTMENT IN AGRICULTURE

INTRODUCTION

Until the end of the last decade, much of the capital employed in agriculture was owned by the operator or borrowed from his relatives. Rickard, Luxton and Morris (1) showed that between the years 1949-50 and 1958-59 in a sample of 72 farms in the South West, 98 per cent. of the living expenses and farm investment was provided from the farmers' own resources. At a time when increased production was the main object and interest rates were relatively low, almost any investment could show some return provided it resulted in higher output. Lately, emphasis has been placed on reducing costs rather than increasing output and interest rates have tended to rise. The pressure of economic and technical change has stimulated a need for capital which has outstripped the farmer's ability to supply it from his own resources. In these circumstances he has had to turn more to outside sources. Between 1958 and 1966 bank advances rose from £213 million to £510 million (2). Much of this investment has been put into machinery and buildings, and according to the National Plan (3) it is expected that, compared with 1963, a further £20 million per annum will be spent on buildings and another £11 million on vehicles and machinery by 1970. Some, at least, of this will have to come from outside sources. The lenders of capital require interest to be paid on money they advance and clearly the borrower must earn a higher return than this if his investment is to be worthwhile. It is hardly surprising, therefore, that the farming community is becoming more alive to the importance of obtaining a reasonable return on capital investment as well as a satisfactory income.

However, attention has been mainly directed towards return on past investment, either on the total capital or on the operator's share of it. While this may have some value as a comparative measure of the efficient use of capital between agricultural businesses, it has little use for management and planning purposes. Far more important is the sound appraisal of the anticipated return on new investment. This constitutes looking into the future and it is therefore bound to contain an element of speculation, however accurate the method of assessment. It is the purpose of this publication to examine the various methods which can be used and to consider their relevance to agriculture.

There are three basic methods of assessment, (i) Pay Back Period (ii) Rate of Return (iii) Discounted Cash Flow. Until recently the pay back and rate of return methods, both rather crude, have generally been employed in industry and agriculture. But discounted cash flow, a more sophisticated technique, is now gaining favour. The chief advantage is that it permits variations in annual income resulting from the investment to be taken into account.

The Aim of Capital Investment

The object of all capital investment is to recover the original expenditure and to obtain an additional remuneration, after deduction of the costs incurred, commensurate with the risks involved. Two inherent subjective assessments must be made; an estimate of the project's life, and the return required having regard to the risk. Both of these require some degree of speculation.

Capital Depreciation

One of the main costs incurred is the loss of value, or depreciation, which results from the ownership and use of most capital assets. Such confusion surrounds the subject that it is perhaps worth considering depreciation and the associated problem of sinking funds and taxation allowances from a cash and accounting point of view, before continuing further. An example is given below of an investment of £1,000 written off over a project life of five years, using straight line depreciation.

DEPRECIATION AND NET CASH FLOW

TABLE 1

Year	Balance Sheet End of Year Value	Trading Profit and Loss Account		Repayment of Capital	Profit
		Expenditure Depreciation	Income Net Cash Flow		
	£	£	£	£	£
1	800	200	300	200	100
2	600	200	300	200	100
3	400	200	300	200	100
4	200	200	300	200	100
5	Nil	200	300	200	100
	TOTAL	1,000	1,500	1,000	500

The two middle columns show the effect on the trading profit and loss account. The net cash flow shown on the income side is the difference between the additional cash income and additional cash expenditure resulting from the investment. The individual items of income and expenditure would of course normally appear on the appropriate side of the account. The difference between the net cash flow and depreciation, £100 per annum, is the annual profit. The net cash flow is made up of repayment of capital and profit, the two columns on the right hand side of the table. The repayment portion of the net cash flow thus offsets the depreciation charge in the account. In terms of cash the £1,000 laid out at the beginning of the project is returned in annual sums of £200 over the five year period,[1] which become avail-

[1] For simplicity the repayment of capital is made in equal instalments here. This need not necessarily be so, but a sufficient sum equal to the original cost, less any terminal value must be earned during the life of the asset, to cover its loss of value.

able for reinvestment. The initial payment of £1,000 is not entered directly in the account, but appears as an annual depreciation charge spread over the life of the asset.

Balance Sheet

The end of year value in each year is shown in the left hand column of the table, namely £1,000 (initial cost) less cumulative depreciation.[1] At the end of year three, the asset is worth £400, but £600 of the original investment has again become available for reinvestment. The original £1,000 is then still intact, but as the years pass in differing proportions of asset value and cash or other investment. Although the cash repayment portion of the net cash flow becomes available for reinvestment it can also be spent on current consumption, so consuming capital.

Sinking Fund

A sinking fund is often confused with depreciation. The purpose of a sinking fund is to put aside money out of income to purchase an asset in the future. The cash repayment shown in Table 1 could be put into such a fund for replacement of the original asset. In this case the depreciation charge and the cash put into the fund would be the same amount (£200). Depreciation and a sinking fund are not, however, the same thing. If properly placed the fund will earn interest and the annual sum required to produce a total of £1,000 at the end of five years will be less than £200 by the amount of compound interest which could be earned by the fund (ignoring problems of inflation and replacement of original asset by an asset of different quality).

Tax

The tax situation has also clouded the issue. Tax remission on capital expenditure is based on depreciation charges. The initial and depreciation allowances are not concessions; since depreciation is a cost the income covering it should not be subject to tax. In an income tax account the total depreciation charged over the life of the project is equal to its actual loss of value, because of the final adjustment made in relation to its book value upon sale. The old investment allowance and the new investment grant are, however, encouragements to invest in certain assets and have nothing to do with depreciation. The idea of an investment grant makes this clearer as it is a straightforward grant not tied to tax remission. Depreciation is usually calculated on a diminishing balance basis for income tax purposes and this together with any initial allowances weights tax remission towards the earlier years and gives a more realistic value at any point in time than straight line depreciation.

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[1] Depreciation referred to here is "imputed" not "real". "Real" depreciation can only be determined at the end of an asset's life. "Imputed" is equated in an account with "real" depreciation by showing a "profit" or "loss" on the book value upon sale of the asset.

METHODS OF ASSESSMENT

(1) Pay Back Period

The pay back period is the time taken to repay capital *before* charging depreciation. In the example shown in Table 1 the pay back period is $3\frac{1}{3}$ years. This method is adequate if the investor has little confidence in the future and the speed of repayment is all important. But quick repayment is not the only criterion of successful investment and no account is taken of subsequent profitability. For example, if a project with an initial cost of £3,000 had an actual life of three years and annual cash flows of £1,000, the capital would be repaid in three years which might be considered acceptable. But if the actual life of the asset was only three years the return on capital would be nil.

(2) Rate of Return

The rate of return is the additional annual margin resulting from the investment *after* deduction of the depreciation charge, expressed as a percentage of the capital. The capital is sometimes taken as the initial capital, sometimes half the initial capital, representing the average capital invested in the project. The use of half the initial capital is an attempt to allow for the capital repayment portion of the net cash flow becoming available for reinvestment over the life of the project. Where the annual cash flows vary the annual margin is sometimes taken as the peak, sometimes as the average. Using the example in Table 1 the return on initial capital after deduction of depreciation would be:

$$\frac{100}{1{,}000} \times 100 = 10 \text{ per cent}$$

and the rate of return on half the capital:

$$\frac{100}{500} \times 100 = 20 \text{ per cent.}$$

Therefore if a rate of return of 15% was considered necessary to undertake the project, its acceptance or non-acceptance would depend on the method employed to calculate the return. In addition, variable annual cash flows cannot be taken into account adequately, nor can projects of different length of life be compared satisfactorily.

(3) Discounted Cash Flow

The discounted cash flow method based on the principle that present money is worth more than future money, is able to allow for variable cash flows. The effect of taxation, fluctuating price and other factors causing variability in the cash flows can therefore be included in the calculations. Projects with different flow patterns, lengths of life and starting dates can be compared and ranked. The technique measures return on the capital outstanding in the project at any one time, and therefore allows for the availability for reinvestment of the capital repayments made over the project's life.

There are several intermediate variants, making use of the compounding or discounting principle, but which cannot deal easily with variable flows. Two of these are discussed later.

Compounding and Discounting

Compounding and discounting are based on the principle that £1 today is worth more than £1 in the future. This has nothing to do with inflation and assumes constant money values. It can be looked upon as a financial version of the old proverb "A bird in hand is worth two in the bush". In other words a bigger sum is required in the future than would be accepted now, as inducement to wait and accept the risks involved. It is expressed as an annual compound interest on the original sum. The sum required as an inducement to wait for a given period can be found by compounding at the appropriate rate determined by time preference and the risk involved. Conversely the present value of the original sum at the end of the period is discovered by discounting. Tables are available to do this. Table 2 shows the factors for computing the present value of a sum receivable *n* years ahead.

The present value of £300 five years hence discounted at 7 per cent.[1] is :

$$300 \times 0.712 = £213.6.$$

The discount factor of 0.712 is to be found in the year 5 row under 7 per cent. column (heavy type) in Table 2.

Table 3 shows the factors for computing the present value of an annuity over a period of 10 years.

The present value of an annuity of £300 for five years (£300×5=£1500) discounted at 7 per cent. is £300×4.10=£1,230. The discount factor of 4.10 is to be found in the year 5 row and the 7 per cent. column (heavy type) in Table 3.

Using the example in Table 1 and discounting at 7 per cent. (the appropriate discount factors being obtained from Table 2) the present value of the sum of the net cash flows of £300 per annum can be determined as shown in Table 4.

DISCOUNTING NET CASH FLOWS

TABLE 4

Year	Net Cash Flow £		Discount Factor @ 7%		Present Value £
1	300	×	0.934		280.2
2	300	×	0.873		261.9
3	300	×	0.816		244.8
4	300	×	0.762		228.6
5	300	×	0.712		213.6
	1,500				1,229.1
Annuity calculation	300	×	4.10	=	1,230

The effect of discounting is to weight the value of each cash flow according to its distance in time from the commencement of the project.

[1] No significance should be attached to the five year life period or the 7 per cent interest rate. They are merely used to demonstrate the mechanics of the method; the problem of deciding project life and interest rate is discussed later.

TABLE OF DISCOUNT FACTORS
FOR COMPUTING THE PRESENT VALUE OF A FUTURE SUM RECEIVABLE
n YEARS LATER, GIVEN r THE DISCOUNT RATE OF INTEREST

$$(V_{n/r} = (1+r)^{-n})$$

TABLE 2

Years (n)	Percentage (r)										
	1	4	5	6	7	8	9	10	11	12	13
1	.990	.961	.952	.943	.934	.925	.917	.909	.900	.892	.884
2	.980	.924	.907	.889	.873	.857	.841	.826	.811	.797	.783
3	.970	.888	.863	.839	.816	.793	.772	.751	.731	.711	.693
4	.960	.854	.822	.792	.762	.735	.708	.683	.658	.635	.613
5	.951	.821	.783	.747	.712	.680	.649	.620	.583	.567	.542
6	.942	.790	.746	.704	.666	.630	.596	.564	.534	.506	.480
7	.932	.759	.710	.665	.622	.583	.547	.513	.481	.452	.425
8	.923	.730	.676	.627	.582	.540	.501	.466	.433	.403	.376
9	.914	.702	.644	.591	.543	.500	.460	.424	.390	.360	.332
10	.905	.675	.613	.558	.508	.463	.422	.385	.352	.321	.294
11	.896	.649	.584	.526	.475	.428	.387	.350	.317	.287	.260
12	.887	.624	.556	.496	.444	.397	.355	.318	.285	.256	.230
13	.878	.600	.530	.468	.414	.367	.326	.289	.257	.229	.204
14	.869	.577	.505	.442	.387	.340	.299	.263	.231	.204	.180
15	.861	.555	.481	.417	.362	.315	.274	.239	.209	.182	.159

Years (n)	Percentage (r)										
	14	15	16	17	18	19	20	25	30	35	40
1	.877	.869	.862	.854	.847	.840	.833	.800	.769	.740	.714
2	.769	.756	.743	.730	.718	.706	.694	.640	.591	.548	.510
3	.674	.657	.640	.624	.608	.593	.578	.512	.455	.406	.364
4	.592	.571	.552	.533	.515	.498	.482	.409	.350	.301	.260
5	.519	.497	.476	.456	.437	.419	.401	.327	.269	.223	.185
6	.455	.432	.410	.389	.370	.352	.334	.262	.207	.165	.132
7	.399	.375	.353	.333	.313	.295	.279	.209	.159	.122	.094
8	.350	.326	.305	.284	.266	.248	.232	.167	.122	.090	.067
9	.307	.284	.262	.243	.225	.208	.193	.134	.094	.067	.048
10	.269	.247	.226	.208	.191	.175	.161	.107	.072	.049	.034
11	.236	.214	.195	.177	.161	.147	.134	.085	.055	.036	.024
12	.207	.186	.168	.151	.137	.124	.112	.068	.042	.027	.017
13	.182	.162	.145	.129	.116	.104	.093	.054	.033	.020	.012
14	.159	.141	.125	.111	.098	.087	.077	.043	.025	.014	.008
15	.140	.122	.107	.094	.083	.073	.064	.035	.019	.011	.006

TABLE OF DISCOUNT FACTORS
FOR COMPUTING THE PRESENT VALUE OF A FUTURE ANNUITY RECEIVABLE IN YEARS 1 TO n INCLUSIVE, GIVEN r THE DISCOUNT RATE OF INTEREST

$$\left(a_{n/r} = \frac{1-(1+r)^{-n}}{r} \right)$$

TABLE 3

Years (*n*)	Percentage (r)											
	1	2	3	4	5	6	7	8	9	10	11	12
1	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.90	0.89
2	1.97	1.94	1.91	1.88	1.85	1.83	1.80	1.78	1.75	1.73	1.71	1.69
3	2.94	2.88	2.82	2.77	2.72	2.67	2.62	2.57	2.53	2.48	2.44	2.40
4	3.90	3.80	3.71	3.62	3.54	3.46	3.38	3.31	3.23	3.16	3.10	3.03
5	4.85	4.71	4.57	4.45	4.32	4.21	4.10	3.99	3.88	3.79	3.69	3.60
6	5.79	5.60	5.41	5.24	5.07	4.91	4.76	4.62	4.48	4.35	4.23	4.11
7	6.72	6.47	6.23	6.00	5.78	5.58	5.38	5.20	5.03	4.86	4.71	4.56
8	7.65	7.32	7.01	6.73	6.46	6.20	5.97	5.74	5.53	5.33	5.16	4.96
9	8.56	8.16	7.78	7.43	7.10	6.80	6.51	6.24	5.99	5.75	5.53	5.32
10	9.47	8.98	8.53	8.11	7.72	7.36	7.02	6.71	6.41	6.14	5.88	5.65
11	10.36	9.78	9.25	8.76	8.30	7.88	7.49	7.13	6.80	6.49	6.20	5.93
12	11.25	10.57	9.95	9.38	8.86	8.38	7.94	7.53	7.16	6.81	6.49	6.19
13	12.13	11.34	10.63	9.98	9.39	8.85	8.35	7.90	7.48	7.10	6.74	6.42
14	13.00	12.10	11.29	10.56	9.89	9.29	8.74	8.24	7.78	7.36	6.98	6.62
15	13.86	12.84	11.93	11.11	10.37	9.71	9.10	8.55	8.06	7.60	7.19	6.81

Years (*n*)	Percentage (r)											
	13	14	15	16	17	18	19	20	25	30	35	40
1	0.88	0.87	0.86	0.86	0.85	0.84	0.84	0.83	0.80	0.76	0.74	0.71
2	1.66	1.64	1.62	1.60	1.58	1.56	1.54	1.52	1.44	1.36	1.28	1.22
3	2.36	2.32	2.28	2.24	2.20	2.17	2.13	2.10	1.95	1.81	1.69	1.58
4	2.97	2.91	2.85	2.79	3.74	2.69	2.63	2.58	2.36	2.16	1.99	1.84
5	3.51	3.43	3.55	3.27	3.19	3.12	3.05	2.99	2.68	2.43	2.21	2.03
6	3.99	3.88	3.78	3.68	3.58	3.49	3.40	3.32	2.95	2.64	2.38	2.16
7	4.42	4.28	4.16	4.03	3.92	3.81	3.70	3.60	3.16	2.80	2.50	2.26
8	4.79	4.63	4.48	4.34	4.20	4.07	3.95	3.83	3.32	2.92	2.59	2.33
9	5.13	4.94	4.77	4.60	4.45	4.30	4.16	4.03	3.46	3.01	2.66	2.37
10	5.42	5.21	5.01	4.83	4.65	4.49	4.33	4.19	3.57	3.09	2.71	2.41
11	5.68	5.45	5.23	5.02	4.83	4.65	4.48	4.32	3.65	3.14	2.75	2.43
12	5.91	5.66	5.42	5.19	4.98	4.79	4.61	4.43	3.72	3.19	2.77	2.45
13	6.12	5.84	5.58	5.34	5.11	4.90	4.71	4.53	3.78	3.22	2.79	2.46
14	6.30	6.00	5.72	5.46	5.22	5.00	4.80	4.61	3.82	3.24	2.81	2.47
15	6.46	6.14	5.84	5.57	5.32	5.09	4.87	4.67	3.85	3.26	2.82	2.48

The present value obtained in this example where the flows are constant is the same, allowing for rounding up, as that given by using the discount factor obtained from the annuity tables in Table 3. It is usually assumed that the net cash flows occur as lump sums at the end of each year.

Discounted Cash Flow Calculations

The principle of discounted cash flow can be used in two ways, either to find the net present value of the sum of the cash flows or the discounted yield. The object of the net present value calculation is to discount the sum of the cash flows to its present value at a predetermined discount rate.[1] The initial investment is then subtracted from the present value of the sum of the cash flows. If the answer is positive the investment can be considered worthwhile.

The aim of the discounted yield calculation, on the other hand, is to find the rate of discount which would make the present value of the sum of the cash flows equal to the original investment. If the cash flows vary the answer can only be found by trial and error.

Net Present Value

An example of this method is given in Table 5 below.

NET PRESENT VALUE CALCULATION

TABLE 5

Year	Net Cash Flow £		Factor @ 7% Discount		Present Value £
1	500	×	0.934		467.0
2	300	×	0.873		261.9
3	200	×	0.816		163.2
4	200	×	0.762		152.4
5	300[1]	×	0.712		213.6
	1,500				1,258.1
Difference between present value and initial capital	1,258.1	–	1,000	=	+258.1

[1] £100 Cash Flow+£200 terminal value of investment

In this example the cash flows vary but the total over the five years (£1,500) is the same as the previous example given in Table 4, where the asset also had no value at the end of the five years. Here it is assumed that it is worth £200 at the end and this is included in the net cash flow in the fifth year. The terminal value of the asset together with any recoverable working capital should always be added to the cash flow of the final year. The cost of capital is taken as 7 per cent. The difference between the original sum invested and the present value of the sum of the cash flows is positive so the investment is worthwhile.

[1] There is some difficulty in deciding exactly what rate should be taken. The problem is discussed later in the section headed "Cost of Capital".

Discounted Yield

The same example used for the net present value method is worked out in Table 6 below by the discounted yield method.

TABLE 6

DISCOUNTED YIELD CALCULATION

Year	N.C.F. £	Discount Factor @ 10%	Present Value £	Discount Factor @ 20%	Present Value £
1	500	0.909	454.5	0.833	416.5
2	300	0.826	247.8	0.694	208.2
3	200	0.751	150.2	0.578	115.6
4	200	0.683	136.6	0.482	96.4
5	300	0.620	186.0	0.401	120.3
	1,500		1,175.1		957.0

Interpolation: Present Value @ 10% = 1,175.1
− Present Value @ 20% = 957.0

= 218.1

Present Value @ 10% = 1,175.1
− Capital = 1,000.0

175.1

$$\frac{175.1}{218.1} \times 10\% = 8.0\%$$

∴ Rate = 10+8.0 = 18.0%

The cash flows are discounted at 10 per cent. and 20 per cent. having estimated previously that the rate should fall somewhere between these two points. The present value of the sum of the cash flows at both rates is determined. The discounted yield rate is obtained by interpolation as shown above assuming that there is a linear relationship. The relationship is not, in fact, linear and more accurate values can be obtained by taking narrower upper and lower limits. However, in practice, it is easier to take wide limits to avoid having to recalculate. The greatest error would occur when the value falls midway between the limits, but it is unlikely to be significant. In this case the actual rate would be 17.9 per cent. instead of the approximate rate given.

If the cash flow is constant as in Table 4 the discounted yield rate can be easily calculated with the assistance of the annuity tables (Table 3). The object here is to find by what factor the annual net cash flow has to be multiplied to equate its sum over the project's life to the original investment. This can be done as follows:—

Divide the initial sum by the annual net cash flow to find the annuity factor:

$$\frac{1,000}{300} = 3.33$$

Look in the annuity tables along the five year row to find the nearest figure to 3.33. Read off the percentage at the top of the column. The answer is 16 per cent.

Assessment of Risk

The risk involved in a project can be allowed for either in the length of life or pay back period chosen for the project, in the discount rate chosen for the net present value method or assessed in the discounted yield interest rate calculated for it. Sometimes allowances are made both in the length of life and in the interest rate. It is probably better to take the project's length of life as its economic life (the anticipated real life allowing for wear and tear and obsolescence which is often considerably less than its physical life). Risk can then be assessed clearly by the interest rate.

The Cost of Capital

The net present value calculation demands that the discount rate should be pre-determined, but what the exact rate should be is by no means easy to decide. In industry the cost of servicing equity has been used. This is quite straightforward since no tax allowances or repayments of capital are involved. But in agriculture where loan rather than equity capital is employed, the opportunity cost of capital may be more appropriate. This could be taken as the farmer's personal discount rate, the rate of interest at which he is prepared to invest off the farm, or the lowest acceptable return for on-farm investment. For individual projects the lowest acceptable return allowing for risks involved in the project could be taken, but care should be exercised not to pitch the expected return too high otherwise some perfectly worthwhile investment might be rejected.

The choice of expected rate is bound to be personal and subjective. As a guide it is suggested that a gross return of not less than 15 per cent. could be expected from new projects involving a degree of risk normally associated with agricultural investment, but that 10 per cent. might be acceptable for cost-saving investment having a lower degree of risk. This is equivalent to a net return of 10 per cent. and 7 per cent. respectively at the standard rate of taxation.

Advantages and Disadvantages of the Two Methods

The advantages of the discounted yield method are that the answer is given as a percentage return on capital, which has more meaning than a lump sum, and no assessment of the cost of capital is necessary for the calculation. Of course, a subjective assessment has to be made of the return required to cover risk. However, the answer can be rendered meaningless by the occurrence of large negative cash flows (resulting from further capital investment) in the later years of a project's life. They may produce multiple solutions to the yield calculation, but such situations are likely to be very rare in practice. Small negative flows are unlikely to disturb the answer significantly. If there is any doubt the extended yield method can be employed. This involves discounting the negative flow back one year at the assumed cost of capital and subtracting it from the cash flow in that year. If the answer is positive the adjusted flows are used for the yield calculation. If the answer is still negative, discounting back is continued until a positive answer is obtained.[1]

Negative flows in the middle of a project will not upset the calculation provided the present value at the yield rate of the subsequent cash flows inclusive of the year of investment is positive. Again, situations where the answer is negative are unlikely to be common in practice.

The discounted yield can also be affected by the quantity of capital invested. Very small investments can show high returns and the discounted yield may then give a different order of ranking to the net present value calculation for the same projects. It has been suggested that this can be overcome by ranking according to the product of the discounted yield and the capital investment.

Finally, it can be shown that even when comparing projects with similar investment requirements, the discounted yield method may sometimes give an incorrect order of ranking (4). For this to happen the difference between the yields of the alternatives must be small. In practice, a choice is unlikely to be made between projects with yields differing by small amounts on this consideration alone.

The net present value method, on the other hand, is not subject to these complications and is easier to calculate. But it presents the answer as a lump sum, not as a percentage, and there are difficulties in deciding what the rate of discount should be.

Although discounted cash flow has been used for some time, a vigorous debate is still being conducted in an attempt to decide which is the better of the two methods. It is not the intention to embark on this controversy here. Wider practical use may give a clearer indication of the respective merits of the two methods. But, because of errors which may occur when using discounted yield, the net present value method should be employed for ranking a range of alternatives. The discounted yield method may be more appropriate for appraising the worthwhileness of a project since business men seem to find it easier to assess a percentage return rather than a lump sum difference. Provided he is aware of the limitations of each, the assessor is in a position to choose whichever method will suit him best for any particular problem. Where the arithmetic can be done by machine, it would not be difficult to make both calculations so that one would complement the other. This procedure has in fact been followed in the examples given later.

Objections to Discounted Cash Flow

The main objection to discounted cash flow centres on the interest rate that can be earned on the capital repaid during the life of the project. It is pointed out that discounted cash flow assumes that the rate earned on the capital repaid is the same as the yield rate (4) (5).

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[1] A full explanation of this method can be found in MERRETT, A. J. and SYKES, ALLEN *The Finance and Analysis of Capital Projects*. 1963. Longman's, Green and Co., London, pp. 163-165.

It is true that this might be significant if the returns on alternative investment are high, but presumably this should be taken into account in assessing the interest rate required from the project. Indeed, if it were so, all the capital should perhaps be invested in the alternative rather than in the ones under consideration. In fact, so far as the project is concerned, the discounted cash flow calculation does not require interest from the capital once it has been repaid because it is held that it is available for investment elsewhere. Opportunities presented by different projects for alternative investment of the repayments would have to be assessed separately.

Variants using Compounding and Discounting

Two methods, sinking fund rate of return and annuity charge method, which make use of compounding and discounting are considered in this section in relation to discounted cash flow.

Sinking Fund Rate of Return

An annual sinking fund allowance is substituted for the depreciation charge used in the rate of return method and subtracted from the net cash flow. The difference is expressed as a rate of return on the initial investment. An example is given below assuming an initial investment of £1,000, a net cash flow of £388 per annum and a 5 per cent. sinking fund.

SINKING FUND RATE OF RETURN CALCULATION

TABLE 7

Year	N.C.F. £	Sinking Fund at 5 per cent £	Surplus £
1	388	317[1]	71
2	388	317	71
3	388	317	71

Sinking Fund Return =

$$\frac{71}{1,000} \times 100 = 7.1 \text{ per cent}$$

[1] £317 is the annual sum which at 5 per cent compound interest will provide a total of £1,000 at the end of three years.

If the sinking fund is assumed to accumulate at the same rate as the discounted yield then the return is identical with that given by discounted yield. If the sinking fund interest rate is less than the discounted yield then the return will be less; if the interest rate is more the return will be more. As with rate of return the drawback of this method is that it cannot take variable cash flows into account.

Annuity Charge Method

An equal annual charge is obtained for the investment by calculating annual depreciation and compound interest on the capital outstanding in the project in the same way as mortgage annual charges are computed (6). The project will be considered acceptable if the net cash flow is greater than the annual charge calculated over the estimated life of the project at an acceptable interest rate. If the annual charge of an investment of £1,000 over a period of five years at an acceptable rate of interest of 8 per cent is £250, provided the annual cash flow is greater, the investment will be considered worthwhile. This is really a version of the net present value calculation for constant flows worked the other way round. Again, however, it is not possible to allow for variable flows and it would therefore seem better to use a method capable of dealing with both variable and constant flows. Nevertheless, the annuity charge can be useful for calculating a cost to include in budgets comparing incomes or margins from different systems rather than return on capital.

Connection between Discounted Yield and Rate of Return on Initial Capital

There is a connection between the discounted yield and rate of return, although it can only be demonstrated simply when the cash flows are constant. The relationship is shown in Figure I on page 16.

The rate of return on initial capital is given on the horizontal axis and the discounted yield on the vertical axis. The curves indicate the discounted yields for projects of different lengths of life and the broken line rate of return on initial capital. If the return on initial capital is 10 per cent. the discounted yield on a five year project would be just under 15 per cent. and for a 20 year project about 12½ per cent. The discounted yield will fall between the rate of return on initial and rate of return on half the capital. The longer the life of the project the more the discounted yield tends towards the rate of return on initial capital. If the cash flows are weighted towards the earlier years the discounted yield will move towards the rate of return on half the initial capital; if in the later years, towards the rate of return on initial capital. There is, therefore, something to be said for the common practice of using rate of return on half the capital when considering machinery investment in agriculture where the life of the asset is less than 10 years and the cash flows are weighted in the earlier years by tax allowances. But it would lead to an overestimate of return when considering long term investment.

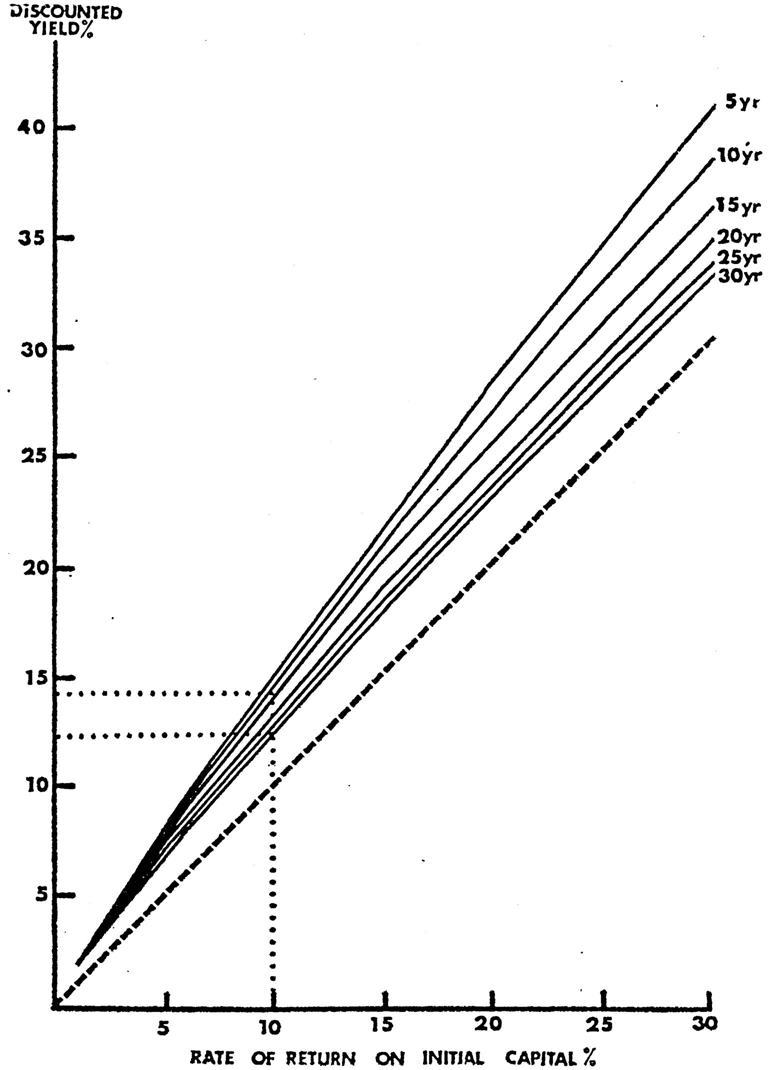
PRACTICAL APPLICATION TO AGRICULTURE

Where the cash flows are constant or can be reasonably averaged, the rate of return on initial capital is always lower than the discounted yield return. Therefore it is safe to consider acceptable any project which shows a satisfactory return on this basis. But, as already shown, it is a simple matter to calculate either net present value or discounted yield if the flows are constant to give the more accurate answer.

If the flows are variable a satisfactory answer can only be obtained by using discounted cash flow. Agricultural projects involving variable flows are probably more common than has been generally realised and examples of three likely situations follow. It is assumed here that each project has passed a test of feasibility before considering return on the capital investment.

FIG. 1

Discounted yield and rate of return (on initial capital) compared for projects with constant earnings.



Source: MERRETT, A. J. and SYKES, ALLEN. *Finance and Analysis of Capital Projects.* 1963. Longman's, Green & Co. Ltd., London.

Example I: Allowing for the Effect of Taxation

This example allows for the effect of taxation on an investment in machinery. It is assumed that a machine, say a tractor, costing £1,000 and qualifying for the 10 per cent. investment grant generates an additional margin due to cost saving of £300 per annum. The second-hand value of the tractor after five years is £200. The calculation of the net cash flow after allowing for tax reliefs and payments is given in Table 9. The tax payable is calculated on the previous year's taxable income at the standard rate of 8s. 3d. in the £ allowing 2/9ths for earned income. It is assumed that the investment grant is paid in three equal annual instalments. Diminishing balance depreciation at $28\frac{1}{8}$ per cent. is calculated from an initial £900, i.e. £1,000 less £100 grant.[1] The grant itself is not liable to tax.

The net present value and discounted yield calculations are shown in Table 8. It will be noted that the tax payments are lagged one year so giving rise to a negative cash flow in the sixth year. This is not large enough, however, to disturb the discounted yield calculation, the extended yield answer only differing from it by 0.4 per cent.

The discount rate for the net present value is taken as 7 per cent., the after-tax return required for a cost saving project.

NET PRESENT VALUE AND DISCOUNTED YIELD CALCULATIONS

TABLE 8

Year	N.C.F.	Net Present Value		Discounted Yield			
	£	7%	Resultant £	12%	Resultant £	17%	Resultant £
1	333	0.934	311.0	0.892	297.0	0.854	284.4
2	318	0.873	277.6	0.797	253.4	0.730	232.1
3	295	0.816	240.7	0.711	209.7	0.624	184.1
4	246	0.762	187.5	0.635	156.2	0.533	131.1
5	434	0.712	309.0	0.567	246.1	0.456	197.9
6	(−)139	0.666	(−) 92.6	0.506	(−) 70.3	0.389	(−) 54.1
			1,233.2		1,092.1		975.5

Net Present Value:

£1,233.2 − £1,000 = (+)£233.2
∴ Investment is worthwhile

Discounted Yield:

Present Value at 12% = 1,092.1
(−) Present Value at 17% = 975.5
= 116.6

Present Value at 12% = 1,092.1
(−) Capital = 1,000.0
= 92.1

$$\frac{92.1}{116.6} \times 5\% = 3.9$$

Discounted Yield = 12 + 3.9 = 15.9%

For simplicity, taxation is ignored in the remaining examples, but its effect could equally well be accommodated.

[1] At the time of writing the exact way in which the investment grant payment will be made is still rather obscure. The course adopted here is based on the reply by the Minister of Agriculture to a question in Parliament. (House of Commons Weekly Hansard, 21st Feb. 1966; and Inland Revenue, B.P.I., Feb. 1966).

NET CASH FLOW ALLOWING FOR TAXATION

TABLE 9

Year	A	B	C	D	E	F	G
	Additional Cash Flow Before Tax £	Depreciation £	Taxable Income (A−B) £	Tax Payable £	Cash Flow Less Tax (A−D) £	Investment Grant £	Net Cash Flow (E+F) £
1	300	253	47	—	300	33	333
2	300	182	118	15	285	33	318
3	300	131	169	38	262	33	295
4	300	94	206	54	246	—	246
5	500	68	432	66	434	—	434
6	—	—	—	139	(−)139	—	(−) 139

Example II: Contract schemes, such as the Egg Contract Scheme, causing variation in the cash flows, or fluctuating prices

This example shows an investment appraisal of a conversion from deep-litter egg production to batteries allowing for the effect of the contract scheme and probable fluctuation in price over a period of 10 years (7).

The present capacity of deep litter is 1,000 birds and of batteries 2,600 birds. The cost of conversion is £1,000, and additional working capital of £1,600 would be required, making a total investment of £2,600. The anticipated life of the conversion is 10 years with total recovery of working capital at the end.

TABLE 10 NET PRESENT VALUE AND DISCOUNTED YIELD CALCULATIONS

Year	Cash Flow £	Net Present Value		Discounted Yield			
		Factor at 16%	Resultant £	Factor at 20%	Resultant £	Factor at 30%	Resultant £
1	600	.862	517.20	.833	499.80	.769	461.40
2	650	.743	482.95	.694	451.10	.591	384.15
3	800	.640	512.00	.578	462.40	.455	364.00
4	700	.552	386.40	.482	337.40	.350	245.00
5	600	.476	285.60	.401	240.60	.269	161.40
6	600	.410	246.00	.334	200.40	.207	124.20
7	650	.353	229.45	.279	181.35	.159	103.35
8	600	.305	183.00	.232	139.20	.122	73.20
9	600	.262	157.20	.193	115.80	.094	56.40
10	2,300[1]	.226	519.80	.161	370.30	.072	165.60
Total		—	3,519.60	—	2,998.35	—	2,138.70

£3,520 − £2,600 = £920
∴ Investment is worthwhile.

Present value at 20% = 2,998.35
(−) Present value at 30% = 2,138.70
= 859.65

Present value at 20% = 2,998.35
(−) Capital = 2,600.00
398.35

$$\frac{398.35}{859.65} \times 10\% = 4.6\%$$

Discounted Yield = 20 + 4.6 = 24.6%

[1] Including recovery of £1,600 working capital.

Additional margins are expected to be as follow:

First Year

From original 1,000 birds, extra eggs	2s. 0d.	per bird
Food saved	1s. 6d.	„ „
Labour saved	6d.	„ „
Total	4s. 0d.	„ „

=£200 for 1,000 birds.

For additional 1,600 birds penalised under contract scheme
1,600×5s 0d.=£400

Total additional margin=£400+£200=£600

Future Years

The margin is assumed to increase initially due to the contract scheme, then to fluctuate according to price conditions around a trend of declining profitability. A discount rate of 16 per cent. is used for the net present value calculation as being the appropriate rate allowing for the risk involved.

Example III: Projects involving investment in buildings with a slow build-up to peak and possibly further injections of capital

In this example the expansion of a dairy herd necessitating investment in buildings and stock both at the beginning of the project and in later years is considered. The farm is at present carrying 80 cows plus replacements on a forage acreage of 180 acres. It is intended to expand the herd to 130 cows buying in replacements on the same forage acreage in three phases:

(1) Spend £2,200 on buildings, and increase to 100 cows rearing replacements. Of the additional 20 cows, 10 down-calving heifers purchased at £100 each, 10 heifers home-reared.

(2) Increase to 120 cows buying in replacements in Year 3. Of the additional 20 cows, 10 heifers purchased and 10 home-reared as before. Spend a further £750 on buildings.

(3) Increase to 130 cows buying in replacements in Year 5. Additional 10 cows purchased as down-calving heifers at £100 each.

The capital budget for these changes is shown in Table 11.

CAPITAL BUDGET

TABLE 11 £

Year	Buildings	Purchased Stock	Working Capital	Young Stock Costs	Total
0	2,200	1,000	310	240	3,750
1	—	—	—	—	—
2	—	—	—	—	—
3	750	1,000	165	240	2,155
4	—	—	—	—	—
5	—	1,000	60	—	1,060
Total	2,950	3,000	535	480	6,965

The figures for working capital were obtained by taking one sixth of the variable costs attributable to the cows except fertilisers, and one quarter of the additional fertiliser, labour and machinery costs. The total variable costs of the additional home reared heifers are shown in the year in which they come into the herd at £24 per head and are taken as capital investment. This is not strictly accurate but it is a reasonable enough simplification for practical purposes. The terminal value of the project is shown in Table 12.

TERMINAL VALUE

TABLE 12

	£
Cows 50 at £80	4,000
Working capital	535
Additional value of farm due to buildings	500
	5,035

It is assumed that the average value of the cows will be £80 per head and that the new buildings would add £500 to the value of the farm. The whole working capital would be recoverable at the end of the project. This total is added into the final cash flow.

The net present value and discounted yield are worked out in Table 13 over a period of 15 years. For the net present value calculation the flows are discounted at 15 per cent., the lowest return considered acceptable in this instance.

The budgeted margin is adjusted for the additional capital investment to give the net cash flow. This gives rise to a negative cash flow in year 3 and the discounted resultant is subtracted to arrive at the present value of the sum of the flows.

NET PRESENT VALUE AND DISCOUNTED YIELD CALCULATION

TABLE 13

Year	Budgeted Margin £	N.C.F.[1]	Net Present Value		Discounted Yield			
			Factor at 15%	Resultant £	Factor at 30%	Resultant £	Factor at 40%	Resultant £
1	1,386	1,386	0.869	1,204.4	0.769	1,065.8	0.714	989.6
2	1,386	1,386	0.756	1,047.8	0.591	819.1	0.510	706.9
3	1,616	(−)134	0.657	(−) 88.0	0.455	(−) 61.0	0.364	(−) 48.8
4	1,616	1,616	0.571	922.7	0.350	565.6	0.260	420.2
5	2,396	1,396	0.497	693.8	0.269	375.5	0.185	258.3
6-14	2,396	2,396	(4.77 × 0.497)	5,680.9	(3.01 × 0.269)	1,940.8	(2.37 × 0.185)	1,054.2
15	2,396	7,431	0.122	906.6	0.019	141.2	0.006	44.6
Total				10,368.2		4,847.0		3,425.0

£10,368.2 − £3,750.0 = (+)£6,618.2
∴ Investment is worthwhile

Present value at 30% = 4,847.0
(−)Present value at 40% = 3,425.0
1,422.0

Present value at 30% = 4,847.0
(−)Capital Investment = 3,750.0
1,097.0

$$\frac{1,097.0}{1,422.0} \times 10\% = 7.7$$

Discounted yield = 30+7.7 = 37.7%

[1] Working capital and young stock costs have not been subtracted from the budget margin because they were allowed for in the original budget.

By allowing for later investments in the net cash flows, they are in effect discounted at 15 per cent. in the net present value calculation and at the discounted yield rate in the discounted yield calculation.

If the opportunity cost of capital has been used in the calculation, the net present value result will be correct. But if the discounted yield rate is high as it is in this example, the return will be higher than it should be. This can be shown by discounting the subsequent investments in the capital budget at 15 per cent., the opportunity cost of capital used in the net present value calculation, to find the present value of the total capital investment for computing the yield.

PRESENT VALUE OF CAPITAL INVESTMENT

TABLE 14

Year	Total Capital	Discount Factor at 15 per cent	Resultant
	£		£
0	3,750	1.000	3,750
3	2,155	0.657	1,416
5	1,060	0.497	527
Total Present Value			5,693

The return would be reduced to 31.8% by this procedure. While ranking a number of alternatives with different investment patterns according to discounted yield might be affected if the yields were close together, a decision whether or not a project was worthwhile would not be influenced, since at the critical level the difference between the discounted yield and the opportunity cost of capital would be small.

Comparing the Relative Acceptability of Alternative Projects

In industry discounted cash flow has generally been suggested for comparing a range of alternative investments. Mutually exclusive projects can be ranked according to their net present value to assist choosing between them. Generally farmers do not often have a wide range from which to choose at any one time, except perhaps when entering a farm. Many apparent alternatives can be eliminated for technical or personal reasons. Large concerns, however, which can run enterprises viable in themselves may tend to diversify and in this situation it may be more difficult to choose between alternatives. The need to use discounted cash flow may increase if the return on possible investments falls closer to the critical return level and it therefore becomes necessary to make a more careful appraisal or if the opportunities for alternative investment become greater.

Single or mutually exclusive projects have been the main concern here. But the technique can equally well be used to measure the return from investment in a combination of projects constituting a farm policy. The combined cash flows can be discounted in the same way as for a single project to give the return on the total investment.

Conclusion

Of the methods of appraising capital open to the assessor discounted cash flow will give a more accurate answer from the data available but it can, of course, only be as accurate as the information from which it is calculated. The mechanics of the calculation are not difficult although without the assistance of a machine they may be laborious. It will be apparent that in agriculture the real difficulty lies in working out the budget margins in a dynamic situation. The use of discounted cash flow could, besides providing a better method of assessment, stimulate a more careful consideration of the variability of cash flows and the need for subsequent investment in agricultural projects, leading eventually to an improvement in budgeting methods generally.

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ECHO PRESS LTD., LOUGHBOROUGH