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Selected Methods of Financial Analysis for Agriculture Investments

H. C. Hogg, W. W. L. Lau,
P. V. Garrod, and G. R. Vieth

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THE AUTHORS

HOWARD C. HOGG was Agricultural Economist, U.S. Department of Agriculture, Honolulu, and is Agricultural Economist, U.S. Department of Agriculture, Washington, D. C.

WESLEY W. L. LAU was Research Assistant, Department of Agricultural and Resource Economics, College of Tropical Agriculture, University of Hawaii.

PETER V. GARROD is Assistant Agricultural Economist, Hawaii Agricultural Experiment Station, and Assistant Professor of Agricultural Economics, College of Tropical Agriculture, University of Hawaii.

GARY R. VIETH is Assistant Agricultural Economist, Hawaii Agricultural Experiment Station, and Assistant Professor of Agricultural Economics, College of Tropical Agriculture, University of Hawaii.

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Farm management studies dealing with the feasibility of new enterprises are frequently confusing. Two factors may be responsible for this confusion. First, the conventional cash flow analysis often disregards the cost of capital or is treated on a residual ability to repay any borrowed capital basis. Second, the lumpy nature of the capital investment, the time-lag before returns are realized, and the contrived nature of depreciation schedules cause difficulties. To solve the first problem, the method of analysis presented in this paper directly takes into account the cost of capital. Supplementing a conventional enterprise or crop budget--representing a normal full-production year or crop year--with a cash-flow analysis of the type described in this paper will help solve the second.

The objectives of this paper are to (1) define the alternative measures of investment feasibility; (2) discuss the methods of evaluation and pricing procedures that are applicable; and (3) demonstrate, with an example, a computer program designed to perform the necessary calculations. The procedures developed here will serve useful purposes both in making internal management decisions and in obtaining project financing. Based upon credit conditions, lending institutions are sometimes tightening their requirements for loans, and a well-organized, conceptually sound loan application is a necessity.

Several types of investment can be evaluated with these procedures. The most important distinction is whether the investment is for expansion of an existing activity or addition of a new activity to an existing firm, or whether it is for development of a new business or firm. The evaluator must decide in each case which costs are variable (that is, will change with the investment decision) and which costs are to be included in the analysis.

MEASURES OF INVESTMENT FEASIBILITY

The basic measure of investment worth, the first alternative, is the benefit-cost ratio (B/C), which is defined as "the present value of gross benefits divided by the present value of gross costs." The costs incurred and the benefits received during each year of project life are stated as present values and totalled; then the benefit total is divided by the cost total. If this ratio is greater than 1/1, the project is judged feasible. The interest rate used in calculating the present values is the borrowing rate for the investment.

A related measure, the second alternative, is the (potential) net present value (NPV) of the enterprise. This measure is calculated by first subtracting total cost from gross benefits for each year of the project and then stating the difference as present values. The sum of these annual values is the NPV. A positive NPV indicates feasibility. As before, the interest rate used in the present value calculations is the borrowing rate for the investment. A positive NPV simply shows that the rate of return on the investment is greater than the borrowing rate. This varies from a conventional cash flow analysis in that a positive nondiscounted cash flow may or may not cover the cost of borrowing.

Another measure, the third alternative, is the rate of return (RR), defined as "that interest rate at which the NPV is zero." The RR is calculated by determining the NPV with various interest rates until a zero value is obtained. If the RR is greater than the borrowing rate of interest, the project is judged feasible. The difference between the rates can be viewed as a return to uncertainty. If the rate of return for an investment that modifies, expands, extends, or contracts an existing operation is to be calculated (i.e., the internal rate of return, IRR, is to be calculated), the procedure is identical to that of the RR, except the included benefits become the change in benefits resulting from the new activity and the costs become the change in costs associated with the new activity.

For example, suppose a farmer has 5 acres of idle land and is considering the addition of a tomato enterprise that would use existing farm equipment. Production costs in this case would include additional fertilizers, labor, chemicals for pest control, and equipment operating costs. Benefits would be revenues derived from the sale of tomatoes. If this were to be a new 5-acre farm unit, costs would include land purchase, real property taxes, and equipment purchase because these costs are now variable to the investment. Benefits in this case would remain unchanged.

EVALUATING AN AGRICULTURAL INVESTMENT--THREE METHODS

Although this is a hypothetical investment example designed to demonstrate use of the program, it can be discussed in terms of a real investment situation.

A vegetable farmer in Kailua-Kona with some idle land asks his County Cooperative Extension Agent if adding a small plastic greenhouse for ornamental production is profitable. Working together, they determine a house that will last 10 years can be built for $7500. The structure is not needed, however, until the second year when the seedlings are fully matured. An initial-year investment of $5000 is needed for pots, racks, and plastic tubing for irrigation, which will last 6 years and then be discarded. Repair of tears in the house and other maintenance will cost $60 per year after the third year. Production costs include the additional, variable costs that are incurred in production. Gross benefits include an $833 salvage value for undepreciated racks, pots, and tubing in the twelfth year equal to one-sixth of their cost, as well as the value of products sold.

Table 1 demonstrates the use of the feasibility measures by incorporating the various financial components of the hypothetical project.

Table 1. Hypothetical example of agricultural investment

Year	Enterprise costs			Gross benefits	Cash flow		
	Capital	O & M[a]	Production		Current	Present value[b]	Accumulated
1	$ 5,000	$ --	$ 300	$ --	$-5,300	$-4,807.25	$-4,807.25
2	7,500	30	500	3,000	-5,030	-4,138.20	-8,945.45
3	--	60	700	6,000	5,240	3,910.17	-5,035.28
4	--	60	700	6,000	5,240	3,546.64	-1,488.63
5	--	60	700	6,000	5,240	3,216.91	1,728.28
6	--	60	700	6,000	5,240	2,917.83	4,646.11
7	5,000	60	700	6,000	240	121.22	4,767.32
8	--	60	700	6,000	5,240	2,400.51	7,167.83
9	--	60	700	6,000	5,240	2,177.34	9,345.16
10	--	60	700	6,000	5,240	1,974.91	11,320.07
11	--	60	700	6,000	5,240	1,791.30	13,111.37
12	--	60	700	6,833	6,073	1,883.05	14,994.42
Total	$17,500	$630	$7,800	$63,833	$37,903	$14,994.42	

[a]Operation and maintenance costs--repair and maintenance of the greenhouse and associated equipment--associated with the capital investment.

[b]Interest rate assumed is 10-1/4 percent.

Each table item is entered in the year it is actually expended or received. The table is structured so that capital costs, maintenance of the investment, and production costs are separate entries. Gross benefits are price X total output (including any salvage value in the final year of operation). Cash flow is the difference between the annual gross benefit and the sum of all cost entries for each year; the accumulated cash flow column indicates the breakeven year (Year 5 in this case). All of the entries in Table 1 either are input data or can be calculated by hand. Dividing the current cash flow for a given year, t, by $(1 + 0.1025)^t$ restates it in present value form. This procedure is called discounting, and means that at 10-1/4 percent interest (0.1025), $5240 received 3 years from now is worth $3910.17 ($5240 - $[1 + 0.1025]^3$ = $3910.17). The net present value of the investment is the sum of the entries in the present value column.

The interest rate is then increased, and these calculations are repeated until the net present value equals zero. This rate is the internal rate of return. The benefit/cost ratio is calculated by discounting the gross benefits and enterprise costs, then dividing the sum of the present value of the gross benefits by the sum of the present value of the enterprise costs.

For this example, these calculations give the following values for the feasibility measures:

B/C = 1.85

NPV = $14,994

and IRR = 37.75%.

Restating the example shown in Table 1 as an investment in a new operation (or farm unit) would involve additional costs. These costs might include land purchase, vehicle expenses, and other irrigation costs, which, in the previous example, were already "fixed" costs of the basic farm unit. In either case, the analysis is the same, but the specific cost-return entries vary. In the case of the new operation, the rate of return (RR) is calculated as defined in the section on Measures of Investment Feasibility.

PRICING PROCEDURES

The example shown in Table 1 uses constant prices for products and inputs over the life of the enterprise. If this procedure is followed when prices are expected to change, however, a serious problem occurs. This problem can be handled in several ways; in most cases, the pricing procedure shown in Figure 1 is preferred. A historical price series is fitted with a time trend to remove random fluctuations; prices read from the trend line are called normalized prices.

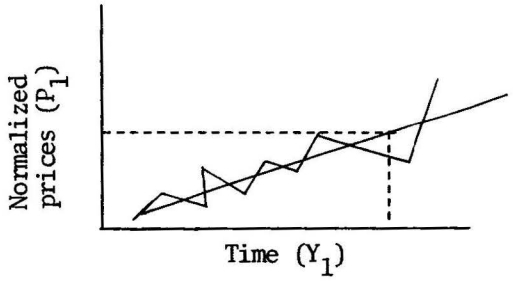

Fig. 1. Price trend

The price, P_1, (a normalized price) for the evaluation base year, Y_1, is used for the entire project life, and the process is followed for both prices paid and received. This procedure assumes that with a positive net return, costs rise faster than benefits, resulting in the same net return from production during each year of project life.

A second pricing procedure is appropriate for handling the problem if a constant rate of inflation is assumed for both benefits and costs. This type of price change can be accommodated by modifying the discount factor. This is done by dividing (1 + i) by (1 + r) where i is interest

rate and r is the rate of inflation. Virtually any pattern of price variation can be accommodated by simply developing an output price and/or cost series for the life of the project and entering it as data. One disadvantage of this procedure is that data entries for each year of the study period must be made. If normalized prices are used, operation and maintenance costs, production costs, and product price for only those years to which entries are constant except for salvage value need to be included.

FEATURES OF THE COMPUTER PROGRAM

The solutions given in Table 1 of this paper were calculated by using the computer program presented in the Appendix. The data requirements and methods of calculation are presented in this section.

The following parameters are read in from a single card with the specified format:

1) Number of years capital investment is made (II)
2) Project life in years (JJ)
3) Year number beyond which entries are constant (JC)
4) Interest rate decimal equivalent (DR)
5) Salvage value of capital, if any (SV)
6) Format (3I5, F5.4, F10.2)

Project data and formats include:

1) Capital costs by year (10F8.0)
2) Operation and maintenance costs by year (10F8.0)
3) Production costs by year (10F8.0)
4) Product price by year (16F5.2)
5) Project output (10F8.0)

Program output lists the components of Table 1 and the measures of project viability. The program and output are shown in the Appendix. In formal terms, the alternative measures of feasibility are defined as follows:

Benefit-Cost Ratio

$$B/C = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}} \qquad (1)$$

Net Present Value

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} \qquad (2)$$

Rate of Return (RR) is an interest rate such that

$$\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0 \qquad (3)$$

Where

B_t = Gross benefits in the t-th year

C_t = Gross costs in the t-th year

n = Number of years

and i = Interest rate

A sensitivity analysis can be conducted by comparing the results of subsequent program runs based on different price and performance assumptions. The discount rate can also be varied, but this should not normally be necessary because the borrowing rate and rate of return are known.

APPENDIX

Calculation of Investment Feasibility Measures: Computer Program and Output

```
            C
            C        BENEFIT COST RATIO -----   INTERNAL RATE OF RETURN
            C                    FEASIBILITY ANALYSIS PROGRAM
            C
0001              DIMENSION CCOST(100),OMCOST(100),PCOST(100),GREV(100),CFLOW(100)
                 -,PVCFLO(100),PVGB(100),PVGC(100),GCOST(100),XPVGB(100),XPVGC(100)
                 -,ATPVCF(100),P(100),Q(100)
            C   DATA AND BASIC PARAMETERS FOR THE PROBLEM
            C   DR=INTEREST RATE
            C   JJ=PROJECT LIFE
            C   JC=YEARS BEYOND WHICH ENTRIES ARE CONSTANT
            C   SV=SALVAGE VALUE
            C   CCOST=CAPITAL COST
            C   OMCOST=OPERATION AND MAINTENANCE COST
            C   PCOST=PRODUCTION COST
            C   P = PRICE
            C   Q = QUANTITY
0002              TCCOST=0.
0003              TOMCST=0.
0004              TPCOST=0.
0005              TGREV=0.
            C READ THE BASIC PARAMETERS
0006              READ(5,10) JJ,JC,DR,SV
0007           10 FORMAT(2I5,F5.4,F10.2)
            C READ CAPITAL COSTS BY YEAR
0008              READ(5,11) (CCOST(I),I=1,JJ)
0009           11 FORMAT(10F8.0)
0010              JD=JC+1
            C READ OPERATION AND MAINTENANCE COSTS BY YEAR
0011              READ(5,13) (OMCOST(I),I=1,JC)
0012           13 FORMAT(10F8.0)
0013              DO 15 I=JD,JJ
0014              K=I-1
0015          100 OMCOST(I)=OMCOST(K)
0016           15 CONTINUE
            C READ PRODUCTION COSTS BY YEAR
0017              READ(5,16) (PCOST(I),I=1,JC)
0018           16 FORMAT(10F8.0)
0019              DO 18 I=JD,JJ
0020              K=I-1
0021          101 PCOST(I)=PCOST(K)
0022           18 CONTINUE
            C READ PRICE AND QUANTITY BY YEAR
0023              READ(5,19) (P(I),I=1,JC)
0024           19 FORMAT(16F5.2)
0025              READ(5,20) (Q(I),I=1,JC)
0026           20 FORMAT(10F8.0)
0027              DO 201 I=1,JC
0028          201 GREV(I)=P(I)*Q(I)
0029              DO 22 I=JD,JJ
0030              K=I-1
0031              IF(I.EQ.JJ) GO TO 21
0032          102 GREV(I)=GREV(K)
0033              GO TO 22
0034           21 GREV(I)=GREV(K)+SV
0035           22 CONTINUE
0036              DO 23 I=1,JJ
0037              TCCOST=TCCOST+CCOST(I)
0038              TOMCST=TOMCST+OMCOST(I)
0039              TPCOST=TPCOST+PCOST(I)
0040              TGREV=TGREV+GREV(I)
0041           23 CONTINUE
            C EVALUATE
0042              TCFLOW=0.
0043              TPVCF=0.
```

```
0044              TPVGB=0.
0045              TPVGC=0.
0046              DO 30 I=1,JJ
0047              DF=((1.+DR)**I)
0048              GCOST(I)=CCOST(I)+PCOST(I)+OMCOST(I)
0049              CFLOW(I)=GREV(I)-GCOST(I)
0050              TCFLOW=TCFLOW+CFLOW(I)
0051              PVCFLO(I)=CFLOW(I)/DF
0052              TPVCF=TPVCF+PVCFLO(I)
0053              ATPVCF(I)=TPVCF
0054              PVGB(I)=GREV(I)/DF
0055              TPVGB=TPVGB+PVGB(I)
0056              PVGC(I)=GCOST(I)/DF
0057              TPVGC=TPVGC+PVGC(I)
0058           30 CONTINUE
0059              WRITE(6,60) JJ,JC,DR,SV
0060           60 FORMAT(1H1,9X,
                 -28H YEARS OF PROJECT LIFE      =I5,/10X,
                 -28H YEAR WHEN ENTRIES CONSTANT=I5,/10X,
                 -28H INTEREST RATE              =F7.4,/10X,
                 -28H SALVAGE VALUE              =F10.2)
0061              WRITE(6,61)
0062           61 FORMAT(////T33,'PROJECT COSTS',T90,'PROJECT REVENUES',//T117,
                 -'ACCUMULATED',/T33,'OPERATION',T100,'PRESENT VALUE',T116,
                 -'PRESENT VALUE',/T3,'YEAR',T11,'CAPITAL COSTS',T28,
                 -'MAINTENANCE COSTS',T49,'PRODUCT COSTS',T66,'GROSS BENEFITS',
                 -T89,'CASH FLOW',T102,'CASH FLOW',T118,'CASH FLOW')
0063              DO 63 I=1,JJ
0064           63 WRITE(6,64) I,CCOST(I),OMCOST(I),PCOST(I),GREV(I),CFLOW(I),PVCFL
                 -O(I),ATPVCF(I)
0065           64 FORMAT(T3,I3,T11,F12.2,T28,F12.2,T49,F12.2,T66,F12.2,T86,F12.2,
                 -T99,F12.2,T115,F12.2)
0066              WRITE(6,65)
0067           65 FORMAT(T2,'TOTAL')
0068              WRITE(6,66) TCCOST,TOMCST,TPCOST,TGREV,TCFLOW,TPVCF
0069           66 FORMAT(T11,F12.2,T28,F12.2,T49,F12.2,T66,F12.2,T86,F12.2,T99,F12.2
                 -)
               C RATIO OF GROSS BENEFITS TO GROSS COSTS
0070              BC=TPVGB/TPVGC
0071              IF(TPVGC.GT.0) GO TO 31
0072              BC=0.
0073           31 CONTINUE
               C CALCULATE INTERNAL RATE OF RETURN
0074              XRATIO=0.
0075              XERR=9999
0076              XIRR=DR
0077           40 XTPVGB=0.
0078              XTPVGC=0.
0079              IF(BC.GT.1.) GO TO 41
0080              XIRR=XIRR-.001
0081              IF(XIRR.LT.0.) GO TO 44
0082              GO TO 42
0083           41 XIRR=XIRR+.001
0084           42 DO 43 I=1,JJ
0085              XDF=((1.+XIRR)**I)
0086              XPVGB(I)=GREV(I)/XDF
0087              XTPVGB=XTPVGB+XPVGB(I)
0088              XPVGC(I)=GCOST(I)/XDF
0089              XTPVGC=XTPVGC+XPVGC(I)
0090           43 CONTINUE
0091              RATIO=XTPVGB/XTPVGC
0092              ERROR=ABS(RATIO-1.)
0093              IF(BC.GT.1) GO TO 1010
0094              IF(RATIO.LT.XRATIO) GO TO 1011
0095         1010 IF(ERROR.GT.XERR)GO TO 45
0096         1011 XERR=ERROR
0097              XRATIO=RATIO
```

```
0098                XXRR=XIRR
0099                GO TO 40
0100             44 XXRR=0.
0101             45 ERROR=XERR
0102                XIRR=XXRR*(100.)
0103                RATIO=XRATIO
0104                WRITE(6,69)
0105             69 FORMAT(///T10,'NET PRESENT WORTH',T30,'TOTAL PRESENT VALUE GROSS
                   -BENEFITS',T70,'TOTAL PRESENT VALUE GROSS COST')
0106                WRITE(6,70) TPVCF,TPVGB,TPVGC
0107             70 FORMAT(T7,F15.2,T32,F15.2,T72,F15.2)
0108                WRITE(6,71)
0109             71 FORMAT(//T10,'BENEFIT/COST RATIO',T30,'INTERNAL RATE OF RETURN')
0110                WRITE(6,72) BC,XIRR,RATIO
0111             72 FORMAT(T12,F10.2,T33,F7.2,'(',F5.3,')')
0112                STOP
0113                END
```

```
YEARS OF PROJECT LIFE      =   12
YEAR WHEN ENTRIES CONSTANT=    3
INTEREST RATE              = 0.1025
SALVAGE VALUE              =    833.00
```

	PROJECT COSTS				PROJECT REVENUES		
YEAR	CAPITAL COSTS	OPERATION MAINTENANCE COSTS	PRODUCT COSTS	GROSS BENEFITS	CASH FLOW	PRESENT VALUE CASH FLOW	ACCUMULATED PRESENT VALUE CASH FLOW
1	5000.00	0.0	300.00	0.0	-5300.00	-4807.25	-4807.25
2	7500.00	30.00	500.00	3000.00	-5030.00	-4138.20	-8945.45
3	0.0	60.00	700.00	6000.00	5240.00	3910.17	-5035.28
4	0.0	60.00	700.00	6000.00	5240.00	3546.64	-1488.63
5	0.0	60.00	700.00	6000.00	5240.00	3216.91	1728.28
6	0.0	60.00	700.00	6000.00	5240.00	2917.83	4646.11
7	5000.00	60.00	700.00	6000.00	240.00	121.22	4767.32
8	0.0	60.00	700.00	6000.00	5240.00	2400.51	7167.83
9	0.0	60.00	700.00	6000.00	5240.00	2177.34	9345.16
10	0.0	60.00	700.00	6000.00	5240.00	1974.91	11320.07
11	0.0	60.00	700.00	6000.00	5240.00	1791.30	13111.37
12	0.0	60.00	700.00	6833.00	6073.00	1883.05	14994.42
TOTAL	17500.00	630.00	7800.00	63833.00	37903.00	14994.42	

NET PRESENT WORTH	TOTAL PRESENT VALUE GROSS BENEFITS	TOTAL PRESENT VALUE GROSS COST
14994.42	32734.32	17739.89

BENEFIT/COST RATIO	INTERNAL RATE OF RETURN
1.85	37.75(1.001)

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Hawaii Agricultural Experiment Station, College of Tropical Agriculture, University of Hawaii
William R. Furtick, Dean of the College and Director of the Experiment Station
Noel P. Kefford, Acting Associate Director of the Experiment Station
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