Present Value Formulas for Calculating Maximum Bid Prices for Land with Applications for the TI-59 Hand Held Computer**

by

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They wish to thank Bud Search for preparing Appendix A of this report.

** Michigan State Agricultural Economics, Report No.

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Introduction

Whether or not to purchase farmland can be one of the most difficult investment decisions confronting farm operators. Compared wth other production inputs, land is purchased infrequently, usually in discrete units and involves a longterm financial obligation. The decision to purchase a parcel of farmland is crucial since only about 3 percent of all the farmland in the U.S. is transferred from one owner to another each year (Scott).

Because land is traded infrequently and each parcel has a locational monopoly, an opportunity to purchase a particular tract may come along only once in a lifetime. So determining the maximum bid price one can offer for a parcel of land is critical. If a decision maker's bid price is significantly below the asking price, then he might lose the opportunity to purchase. On the other hand, if it is significantly above the true value, his offered price might put him in a difficult financial position. Therefore, finding accurate ways of estimating land values is important for those wishing to purchase land.

Factors Affecting Land Values

The maximum bid price farmers can pay for land and still "break even" is affected by several factors, the most important being net returns and increases in net returns expected over the planning horizon.

Net returns may increase over time because of inflation, or persistent price increases. People are willing to pay extra for land if they expect continued inflation. The extent of inflationary impacts in the economy will then be reflected by the equilibrium price agreed on by buyers and sellers.

There are, of course, other factors affecting land values. One such factor influencing land prices is job security. A farmer buying land assures himself of longer tenure than he could if he were renting. Another factor is the pride of ownership. Many derive satisfaction from owning farmland and this satisfaction in owning farmland is certainly not confined to rural people (Scott).

Excess machinery and labor within a farm operation can also increase the amount a buyer can afford to pay for land. When technology creates a situation in which a farm operation becomes land deficient in relation to other inputs, the farmer needs to increase the land input. Thus, it may be economically feasible to pay a higher price for land in order to increase the total land input and spread his fixed costs over a larger land area.

Availability and cost of credit also influences the amount a farmer can pay for a parcel of land and still break even. As credit becomes easier to obtain the number of potential buyers for a tract of land increases. As a result, land prices may increase. The cost of credit adds to the cost of land purchase; therefore, if a buyer pays less for credit, he may be able to pay more for the farmland.

Government programs also influence farmland prices. Commodity price support programs insure farm owners a minimum price for their crops. With the price uncertainty reduced, farmers in many cases, respond with increased output and possibly higher returns which are then capitalized into higher land prices.

Objectives

After having reviewed some of the factors which may influence land prices we can construct analytic models which will include some of the factors discussed. The models focus on the relationship between timing and certainty of returns and the present value of land. Present value models which convert future income to present value equivalents were used to find maximum bid prices for land purchasers. These present value formulas will be introduced in increasing complexity--in the end exhausting our ability to deduce understandable formulas. At that point we will introduce a computer model which was constructed by Lee and Rask and adapted for the TI-59 hand held computer by Kooti. Instructions for the implementation of this computer model will also be discussed. It is our object, then, to establish both the theoretical understanding for determining land value as well as providing the computing capacity to make the calculations in applied settings.

Present Value Formulas

The Role of Time

An investment such as farmland generates a stream of income over future time periods. The value of these future returns may be converted to current dollar equivalents through discounting. Once future incomes have been converted to current dollar equivalents and summed, the sum can be compared to the acquisition cost of land expressed in current dollars to determine if the investment is profitable.

The discount rate is composed of two parts: the time preference rate denoted r and the inflation rate denoted i. The rate of return required to induce savers to postpone consumption, assuming constant prices and certain knowledge is the time preference rate, sometimes referred to as the real rate of return. The inflation rate is a rate of return savers must receive in addition to the time preference rate to compensate them for purchasing power losses due to increased prices. Finally a risk premium may be subtracted from expected income to convert it to its certainty equivalence in order to compare it to the certain outlay required to purchase land.[1/]

To begin, however, we consider a world without inflation, certain prices and an n period income stream produced by the investment. This simplified model is referred to as the Basic Capital Budgeting Model (BCB) and provides a point of departure for later models.

The Basic Capital Budgeting Model (BCB)

Consider an investment (in land) that generates a return R for the next n time periods. In addition, assume that the opportunity cost of capital is r and denote the land's acquisition and salvage value as V. The present value of the investment is the present value of income expected from land plus the discounted price received when the land is sold.

Under these assumptions, the present value of land is equal to:

$$(1)\quad V = S + V/(1+r)^n$$

where S is an annuity of R dollars over n periods equal to

$$(2)\quad S = R(1 - (1+r)^{-n})/r$$

Substituting for S in (1) and solving for V we obtain:

1/ In this paper risk and uncertainty will be used interchangeably.

(3) $V = R/r$

which is our BCB model. To illustrate, if constant net returns from land R were \$50 and the opportunity cost or cost of borrowing were 5 percent, the maximum bid price would equal \$50/.05 or \$1,000.

The BCB Model With Inflation

The BCB model assumed no inflation; that is, the discount rate included no premium for savers to offset the reduced purchasing power brought on by inflation. The increasing importance of inflation forces us to rethink our BCB model and allow both returns, land values and discount rates to be influenced by what is assumed to be a constant level of inflation i.

Inflation may be introduced into the BCB model by assuming that expected net returns to land and the discount rate increase by the same inflation rate. If the net returns to land increase by the rate of inflation, then the net income to land in the first period becomes $R(1+i)$ where i is the inflation rate, and in the n-th period becomes $R(1+i)^n$. Meanwhile, the discount rate which also is increased by the inflation rate equals $(1+r)(1+i)$ in the first period and in the n-th period equals $(1+r)^n (1+i)^n$. Thus, the value of an asset V with inflation rate i can be written as:

$$(4) \quad V = \frac{R(1+i)}{(1+i)(1+r)} + \dots + \frac{R(1+i)^n}{(1+i)^n(1+r)^n} + \frac{V(1+i)^n}{(1+i)^n(1+r)^n}$$

But in (4) the impact of inflation on the discount rate is exactly offset by the impact of inflation on returns. After cancelling the inflation terms in (4) we are left with the BCB in (3) with one difference: the income stream R increases over time by the compound rate i. So in the initial period, period zero, the present value of land V_o is:

(5) $V_o = R/r$

But t periods later land price is:

(6) $V_t = R(1+i)^t/r$

A Generalized Inflation Model

The BCB model with inflation assumed equal and constant inflationary impacts on both income and the discount rate. There is evidence that inflationary pressures are not always so uniform in their impact (Lins and Duncan). To consider such a model, continue to let the inflation increase the discount rate by i + ir so that the discount rate r* equals i+r+ir. Then let income R increase at a compound rate g. This model can be written as:

(7) $V_o = R(1+g)/(1+r^*) + \ldots + R(1+g)/(1+r^*) + V(1+g)/(1+r^*)^n$

The income portion of the right hand side of (7) represents a geometric series whose sum G can be written as:[2/]

(8) $G = R[1-(1+g)^n(1+r^*)^{-n}]\ (1+g)/(r^*-g)$

Then substituting (8) into (7) and solving for V_o we obtain:

(9) $V_o = R(1+g)/(r^*-g)$

The interesting feature of this model is that inflation is not neutral even in the initial period unless, of course, g equals i.[3/] Also of interest

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2/ The solution to a geometric sum can be easily illustrated. Let
$G = R(1+g)/(1+r^*) + \ldots + R(1+g)^n/(1+r^*)^n$
Then multiply both sides above by (1+r*)/(1+g) to obtain:
$(1+r^*)G/(1+g) = R + \ldots + R(1+g)^n/(1+r^*)^n$
Finally, subtract from the second expression the first and solve for G.

3/ In such an event equation (9) can be written as
$V_o = R(1+i)/(r+i+ir-i) = R/r$

is the rate of increase in V, over time, equal to the compound rate g, so that in the t-th period land price V_t is:

$$(10)\ V_t = R(1+g)^t/(r^*-i)$$

One aspect of equation (10) is particularly revealing: the sensitivity of V_t to differences in g and i. Starting with g and i equal, a one percent increase in g, for example, increases V_t by 25 percent. On the other hand, if i and g are equal and i increases by one percent, V_t decreases by 17 percent (see Table 1). That such wide variations in land prices have actually occurred is demonstrated in Table 1.

Basic Capital Budgeting Model With Taxes

We now address a still different concern of investors: taxes. We will begin by introducing taxes into the BCB model and then combine them with inflation. The important concept to be understood about the introduction of taxes into the BCB model is that it affects both the discount rate and income. Income, of course, must be adjusted to an after-tax basis because it is being compared to an after-tax outlay of funds for land's purchase. Income, however, is adjusted to a present value by discounting it with a rate reflecting the opportunity cost rate of return in the next best investment opportunity or the cost of borrowing. But taxes are involved in alternative investments and also affect the actual interest cost incurred by borrowing.

To include such features into the model we write V equal to the present value of an income stream adjusted for taxes. Letting t_p be the personal income tax rate we write:

Table 1. The Effects of Inflation and Increases in Net Return to Land on the Percentage Change in Land Values Assuming a Time Preference Rate of Five Percent.[a/]

Expected Rate of Inflation	Percentage Increase Expected In Cash Rents 0	1	2	3	4
	Percent				
0	0	25	65	140	333
1	-17	0	24	63	136
2	-29	-17	0	24	63
3	-38	-28	-16	0	24
4	-44	-37	-28	-16	0

a/ If g equals the rate of increase in income, R equals last periods returns, r equals the time preference rate, and i equals inflation, then the value of land $V^* = R(1 + g) - (i + r + ir - g)$. Dividing V^* by R/r after subtracting 1 produces the numbers in Table 1.

Source: Robison, Lindon J. "Income from Land and Land Values: Is There a Connection"? Michigan Farm Economics, No. 439, June 1980.

Table 2

Percentage Change in Land Values, Cash Rents, and the Consumer Price Index, 1968-1980

Year	Annual Actual Change in Land Values (Percent)	Annual Change in Cash Rents (Percent)	Annual Change in the CPI (Percent)
1968	14.2	-9.9	4.2
1969	.3	3.6	5.4
1970	.3	-6.1	5.9
1971	1.0	12.3	4.3
1972	16.6	-1.8	3.3
1973	7.8	14.7	6.2
1974	16.7	15.2	11.0
1975	3.0	8.7	9.1
1976	22.4	9.4	5.8
1977	34.6	20.3	6.5
1978	3.5	1.3	7.7
1979	7.8	5.3	11.3
1980	13.2	16.0	13.1
Average Annual Change	10.2	6.5	7.2

Source: Espel, T., The Theoretical Basis for Estimating Land Value: A Market Equilibrium Approach, p. 85.

$$(11)\quad V = \frac{R(1-t_p)}{[1+r(1-t_p)]} + \ldots + \frac{R(1-t_p)}{[1+r(1-t_p)]^n} + \frac{V}{[1+r(1-t_p)]^n}$$

Since inflation is absent from the model and V does not inflate (deflate) we need not concern ourselves, for the moment, with capital gains taxes. Equation (11) can be easily solved if we let $R(1-t_p)$ be $\hat{R}$ and $r(1-t_p)$ be $\hat{r}$. Expressed as a relationship between V, $\hat{R}$, and $\hat{r}$, equation (11) turns out to be nothing more than the BCB model which can be written as:

$$(12)\quad V = \hat{R}/\hat{r}$$

$$= R(1-t_p)/r(1-t_p)$$

which after cancelling produces again the BCB model results of equation (3). The implication of this model is that taxes have no impact on the maximum bid price for land. But a conclusion quite different from this results is obtained once inflation is introduced. Such a model has been deduced by Baker which we now explore.

Taxes, Generalized Inflation, and the BCB model

Letting inflation be the generalized type described in equation (7) and continuing to let the personal income tax rate be reflected by t_p we are prepared to deduce the analytic model. But before doing so, however, two simplifications in our solution procedures are required. First, if income is inflating the progressive personal income tax rate t_p would also increase. With indexation, however, it remains constant. We incorporate the indexation feature into this model by letting t_p be constant over the entire planning period.

The second simplification involves capital gains. We assume in this model that the land purchaser intends to hold the land for n periods at which time he expects to sell his land for an inflated price $V_o(1+g)^n$ and pay a capital gains tax. The difference between the inflated price and the original purchase price V_o is the amount subject to a capital gains tax of $.4t_p$. To solve the model with this capital gains tax provision produces results of uninteresting complexity—a solution best reserved for the computer. We approximate the solution instead by adopting a logical alternative. The price received by the first owner depends on the income expected from the land by the second buyer and the sale price received by the second buyer depends on the income expected from the land by the third buyer etc. So our alternative to solving the model with capital gains and capital gains tax included is to solve it with an infinitely long income stream.4/

Our infinitely long income stream from land can be written as:5/

$$(13)\quad V_o = \frac{R(1+g)(1-t_p)}{1+r^*(1-t_p)} + \ldots + \frac{R(1+g)^n(1-t_p)}{[1+r^*(1-t_p)]^n}$$

where r* is i+r+ir as before and n is allowed to approach an infinitely large number. The geometric sum of the right hand side of (13) can be expressed as:

$$(14)\quad V_o = \left[\frac{R(1-t_p)(1+g)}{r^*(1-t_p)-g}\right]\left[1 - \frac{(1+g)^n}{(1+r^*(1-t_r))^n}\right]$$

4/ As Baker has demonstrated the solution isn't exact since capital gains tax is not included explicitly. The solution improves in accuracy the longer the first buyer holds the land before selling to buyer two.

5/ The model converges just in case $g < r^*(1-t_p)$.

Then taking the limit of (14) by letting n become very large we obtain the results in the equation below:

$$(15)\quad \lim_{n\to\infty} V_o = \frac{R(1-t_p)(1+g)}{r^*(1-t_p)-g}$$

The rather surprising result from this model is that V_o is no longer invariant with respect to changes in the personal income tax rate t_p. In fact, for increases in t_p, V_o increases.[6/] The conclusion is that the higher the tax rate, the larger the maximum bid price other things being equal opportunity costs which are reduced by taxes more than offset the reduction in after tax income. In addition, inflation produces capital gains which are sheltered from taxes until the investment is sold--and then is taxed at a lower rate. The higher the tax rate, the more important is the tax shelter for investors. Moreover, they earn a return on the capital gains. It should also be apparent that the larger the inflation rate g, the larger will be the capital gains sheltered, distinguishing even more the differences in the maximum bid price resulting from income tax rate differences.

Inflation, Taxes, and Risk

Our final extension of the ȒCB model is to include risk. Thus far we have assumed perfect knowledge about the future. Net income to land in each period has been assumed known with certainty. However, the value of the future net income which determines land prices is rarely known with certainty. Because the net return to land is a function of the price

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6/ This result is demonstrated by taking the derivitive of V_o with respect to t_p. This can be expressed as:

$$\frac{d(\lim_{n\to\infty} V_o)}{dt_p} = \frac{R(1+g)g}{[r^*(1-t_p)-g]^2} > 0$$

Unambiguous results are not obtained, however, when capital gains are included as Baker has shown, but for most reasonable values, the results above hold.

of the agricultural output, the level of output, and the cost of agricultural input, all of which are uncertain.

The guiding principle, we believe, for including risk into the model is what we refer to as the "homogeneity of measurements" rule. That is, the income stream which is discounted and summed to obtain the maximum bid price for land must reflect the same kind of measure used to identify the land's acquisition prices. If the price of land is an after-tax price, then the income stream must be measured in after-tax discounted dollars. If the price V reflects a certain outlay of dollars, then the income stream must be converted to its certainty equivalent value. This requires no adjustment in the discount rate because r and i were both assumed certain. If the returns R, however, is what returns are expected to be on average, then a risk averse decision maker would be willing to pay some risk premium π to obtain R with certainty. The average or expected minus the risk premium π is called a certainty-equivalent income of R, CE(R).[7/] The certainty equivalent income then is the income which if received with certainty produces the same level of satisfaction as would the rights to the uncertain income R.

Pratt obtained an explicit measure of π as:

(16) $\pi \approx \lambda\sigma^2/2$

where σ^2 is the variance of the returns and λ is one-half of the preferred trade-off between expected income and variance or risk.[8/]

7/ A risk averse decision maker is defined as one whose marginal utility of income is diminishing, or one whose utility function is concave (see Pratt).

8/ To show this we first recognize that π is the difference between expected returns R and certainty equivalent income CE(R). We can replace π with $\bar{R}$-CE(R) in (16) to obtain the expression:

$$CE(R) = R - \lambda\sigma^2/2$$

Then taking the total derivitive with respect to R and σ^2 while holding the certainty equivalent constant, we find the optimal trade-off between expected income and variance (risk) σ^2. The result is: $dR/d\sigma^2 = \lambda/2$

To solve our analytic model we replace R, now considered the average income in (13) and solve.

$$(17)\quad V_o = \frac{(\bar{R}-\lambda\sigma^2/2)(1+g)(1-t_p)}{1+r^*(1-t_p)} + \ldots + \frac{(\bar{R}-\lambda\sigma^2/2)(1+g)^n(1-t_p)}{[1+r^*(1-t_p)]^n}$$

The simplifying assumptions of (17) are employed, namely that the land is never sold. This assumption allows us to approximate land's value with an infinitely long income stream. We also assume that the inflation rates i and g are known with certainty. Equation (17), after replacing $(R-\lambda\sigma^2/_2)$ with its certainty equivalent CE(r), can be solved in the same manner as equation (13). The result is:

$$(18)\quad V_o = \frac{CE(R)(1-t_p)(1+g)}{r^*(1-t_p)-g}$$

Financial Considerations in the BCB Model

We have now proceeded as far as our analytic methods allow us while still producing relatively simple models. But, so far financial considerations have not been included.

Land purchases are usually financed with borrowed money. A down payment from 10 to 50 percent of the purchase price is usually required with the remaining amount paid over a number of years. Financial arrangements, such as interest rates, down payments, and the length of the loan amortization period, should be considered in evaluating agricultural land values, along with the other factors which have been considered.

The Lee and Rask Model

To overcome the limitations of simple analytic models, Lee and Rask constructed a computer model to calculate the maximum bid price for land.

They included as this paper has, net income in the first period, the rate of increase in income, the discount rate, the length of the investment period and the income tax rate. In addition, their model considers the impact of financial arrangements on the maximum bid price which our models have not. They include such variables in their model as:

(a) the proportion of the purchase price paid initially (the down payment);

(b) the mortgage interest rate; and

(c) the amortization period for the loan

A curious feature of the Lee and Rask model, however, is their treatment of capital gains. In our models, land's value cannot increase independent of it's increase in land's value. But in the Lee and Rask model it can. The user can specify any rate of increase in land values desired. But in order to bound capital gains, the initial land value or value of comparable tracts must be inputed by the user.

We caution the users of this program that land values cannot theoretically change at rates different from rates of expected changes in lands earnings. While there are short run aberrations, the longer run has shown quite a direct relationship between land value and earnings from land. So unless there are overriding factors such as outside pressure for land, the rate of increase in income should equal the rate of in land's value.

Hand Held Computers

The Lee and Rask model, despite its many advantages is somewhat inaccessible. It is available on many large computer systems but many decision makers simply do not have access to them. So there is a need, to increase its availability and reduce its application cost. Recent developments in computer technology have led to the development of the hand-held computer which has provided a powerful computing capacity that can solve problems that formerly could be solved only by large computers. The Lee and Rask model is an example. These programmable calculators are currently available at reasonable prices which seem to be decreasing as technology advances promising to reduce the application costs.

The hand-held programmable calculator, like any computer, can carry out the following:

(1) Read in both data and instructions.
(2) Store the data and instructions in a memory.
(3) Perform calculations in manner prescribed by the instructions.
(4) Read out the results.
(5) Control all aspects involved in getting an answer.

The advantages of these hand-held programmable calculators to a large number of decision makers and professionals are clear-cut. Its use helps speed up business decisions and eliminates manual calculations.

Many of the principles of programming are common to large computers and programmable calculators of all manufacturers. However, each manufacturer's equipment requires the user to follow some specific rules and conventions that are unique to that particular line. Since the Texas Instruments-59 programmable calculator was used to solve for land values in this paper, some of its features will be discussed briefly.

The TI-59 is one of the recent programmable calculators made by Texas Instruments and capable of handling problems that formerly could be solved only by large computers. The most striking feature of the TI-59 is the use of removable solid-state modules for the storage and execution of library programs.

Program steps are entered into the memory of the calculator by pressing keys on the keyboard. The program will be stored in the memory and can be used repeatedly with different data. If a given program is to be used only once, it can be erased from the program memory when the power is turned off. However, if needed again, the same program can be saved by recording it on a magnetic card. Then, when it is needed, the card containing the program can be read into the calculator memory and the program reused.

The program to determine the maximum bid price and cash flow using the Lee and Rask model was programmed by Kooti for the TI-59 and is listed in Appendix B. This program estimates the maximum bid price for land, annual loan payment, unpaid balance remaining on loan in any year, net cash flow in any period, market value of the land and equity, given the variables listed earlier under the Lee and Rask model. The input form for the model is listed in appendix A.

To test the sensitivity of the program, a sample problem was first solved with input data equal to:

(1) Income growth rate g of 8 percent.
(2) Before-tax opportunity cost of capital, i + r + ir or r* of 11 percent.
(3) Certainty equivalent income R equal to $50/acre.
(4) Marginal tax rate of 25 percent
(5) Expected rate of inflation on land values of 10 percent.
(6) The market value of comparable land is $1,000/acre.
(7) The capital gain income tax rate of 10 percent (40 percent of 25 percent).
(8) Down payment of 25 percent.
(9) Interest rate on mortgage loan of 10 percent per annum.
(10) Planning horizon, 20 years.
(11) Amortization period on the loan, 20 years.

The above values are stored in accordance with the input format given in appendix A. The resulting maximum bid price by pressing key A equals $2,105. The solution for the base case is the point of departure to examine the sensitivity of the maximum bid price to changes in the input variables.

The sensitivity to the maximum bid price was tested by altering the input variables one at a time from the base solution. Each variable was examined over a range. In every case the values for all variables, other than the one being tested, were fixed as specified in the original case.

The results of the sensitivity analysis from the base case are summarized below:

(1) An increase in the mortgage loan interest rate from 10 to 14 percent reduces the maximum bid price for land from $2,105 to $1,772.

(2) Increasing the percent of loan paid as a down payment from 25 percent to 50 percent decreases the maximum bid price for land from $2,105 to $2,073.

(3) An increase in the before-tax opportunity cost of capital from 11 percent to 15 percent reduces the maximum bid price from $2,105 to $1,577.

(4) An increase in average price of comparable tract of land from $1,000 to $1,500 increases the maximum bid price from $2,105 to $2,767.

(5) Increase in the expected rate of inflation from 10 percent to 15 percent increases the maximum bid price from $2,105 to $4,001.

(6) If the expected net income to land increases from $50 to $100, the maximum bid price increases from $2,105 to $2,886.

(7) Income growth rate of 10 percent instead of 8 percent increases the maximum bid price from $2,105 to $2,275.

(8) An increase in the income tax rate from 25 to 50 percent and capital gain tax rate from 10 to 20 percent increases the maximum bid price from $2,105 to $2,773. This result occurs because reduction in the expected annual net income per acre, due to income taxes, is more than offset by the tax deductible interest payments and the decrease in after-tax opportunity cost of capital.

(9) An increase in loan amortization and planning horizon from 20 to 30 years increases the maximum bid price from $2,105 to $2,712.

The Cash Flow Statement

The program is not only capable of determining the maximum bid price but can determine the annual loan payment, the unpaid balance remaining on the loan in any one year, the net cash flow in each period, the market price of land in each period and the equity. The procedures used to produce the cash flow statement are listed in appendix A.

How To Calculate Income

Central to our efforts to calculate a maximum bid price for land was the determination of the net return attributable to land. We conclude this paper by discussing two methods for calculating the returns attributable to land. These two approaches are: (1) the landlord method, and (2) the residual method.

The landlord method involves an estimation of the income stream (R) to farmland based on the net rental payments received by the landlord for the use of his farmland. Where land is cash rented and the rental fee is known, as well as the costs associated with land ownership (such as taxes), the net income stream to the landlord is also the return on land and is relatively certain.

The residual approach is best illustrated with an example. Consider Table 2 which illustrates net income for a typical corn grain farm which yields an average of 85 bushels an acre. The income from the land is the income earned from the sale of the corn grain or its equivalent value if the grain is used on the farm. From this gross income, we subtract all the operating expenses associated with growing the corn, including seeds, fertilizer, fuel for machines, labor, interest charged on short-term debt, herbicides, insecticides, and taxes. The difference between the gross income and farm operating expenses equals net income—the income expected from the land purchase. This income may then be adjusted to its certainty equivalence by the decision maker.

TABLE 2: Enterprise Budget for One Acre of Medium-Yield Corn Grain

GROSS INCOME (100 bu. X $2.00)		$200.00
EXPENSES:		
Labor (6.1 hrs. X $5.00)	$ 30.50	
Repairs and Maintenance	9.80	
Seeds	11.33	
Fertilizer	38.25	
Insecticides and Herbicides	12.40	
Fuel	6.00	
Utilities	2.30	
Harvesting, Trucking	6.20	
Corn Drying	14.00	
Other Expenses (including interest on operating debt)	$ 7.53	
	$138.31	
NET INCOME (Gross Income - Expenses)		$ 61.69

Source: Robison, Lindon J. and John R. Brake.

Summary and Conclusions

Calculating the maximum bid price one can offer for land is important for applied decision makers. Making such a calculation may be complicated because of the many factors affecting the returns attributable to land. These may include inflation, taxes, uncertainty, and financial arrangements.

In this paper, present value models of increasing complexity were introduced to demonstrate how maximum bid prices are calculated. Finally, hand held programable computers were introduced to solve the model which included all the considerations discussed in this paper. The program and an input and output format were described in the paper and listed in Appendices A and B. Those wishing to check their models were provided a solved example.

What the paper has provided, then, is a practical aid for those who make land investment decisions. But it is important to understand that it is only an aid. A successful decision maker will continue to find no substitute for good judgment.

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Appendix A

Instructions for Using the Lee and Rask Program on the TI-59

Appendix A. Instructions for using the Lee and Rask Program on the TI-59.

Objective: To determine: (1) The maximum amount one can afford to pay for one acre of land, (2) Annual loan payment, (3) Unpaid balance remaining on loan at year j; (4) Netcash flow at period j, (5) Market price of land at period j, (6) Equity at year j; j=1 . . . . m, where m is the amortization period of the loan.

STEP	INPUT DESCRIPTION	INPUT VALUE	PRESS
1.	Turn calculator off, and back on, to clear program and memory.		
2.	Partition memory (Note 639.39 should appear on the screen. If not, return to step 1.)		(4) (2nd) (op) (17)
3.	Clear Display		(CLR)
4.	Insert side 1 of the card containing the program (A:1). If the calculator has read the card successfully, a "1" will appear and remain stationary. If a flashing "0" appears, repeat step 3 and 4.		
5.	Clear Display		(CLR)
6.	Insert side 2 of the card. If the calculator reads side 2 successfully, a "2" will		

Appendix A. (continued)

STEP	INPUT DESCRIPTION	INPUT VALUE	PRESS
	appear and remain stationary. If a "0" appear, repeat steps 5 and 6.		
7.	Clear Display		(CLR)
8.	Insert side 3 of the card containing the program. If the calculator has read the card successfully, a "3" will appear and remain stationary. If a "0" appears, repeat steps 7 and 8.		
9.	Clear Display		(CLR)
10.	Insert side 4 of cards contining the program. If the calculator has read the card successfully, a "4" should appear and remain stationary. If "0" flashes on the display after the card has been read, steps 9 and 10 should be repeated.		
11.	Clear Display		(CLR)
12.	Growth rate of annual net income to land, % annum	______	(STO) 10
13.	Before tax opporunity cost of capital, % annum	______	(STO) 11
14.	Annual Net Income to land; $ per acre.	______	(STO) 12
15.	Marginal tax rate on annual income, %.	______	(STO) 13
16.	Expected rate of inflation	______	(STO) 14

Appendix A. (continued)

STEP	INPUT DESCRIPTION	INPUT VALUE	PRESS
17.	Price of comarable tract, $ per acre.	________	(STO) 15
18.	Capital gain tax rate, %	________	(STO) 16
19.	Down payment, %	________	(STO) 17
20.	Interest rate, % annum.	________	(STO) 18
21.	Planning horizon, years.	________	(STO) 19
22.	Amortization period, years.	________	(STO) 20

OUTPUT

STEP	OUTPUT DESCRIPTION	PRESS	VALUE	RESULTS
1.	The maximum bid price $/ac.	A	____	____
	INPUT DESCRIPTION			
2.	Enter the price $/acre that will be used in the cash flow analysis.	(STO) 21	____	
	OUTPUT DESCRIPTION			
3.	Annual loan payment (principal and interest).	B	____	

CASH FLOW ANALYSIS

Note: To prepare an annual cash flow chart, enter the year you want to examine in (STO) 22. Then press (C) to get the unpaid balance at the end of that year. Press (D) and you will see the taxable income. Press (E) for income tax paid and (2nd) A for the net cash flow that year. Press (2nd) B for the inflated investment (market price) and press (2nd)C for the equity (cost less principal paid plus inflation) use the chart as shown in the next page to record your data.

Appendix A. (continued)

CASH FLOW CHART

Year	Unpaid Balance	Taxable Income.	Income Tax.	Net Cash Flow	Market Price	Equity

Appendix B

A Listing of the Lee and Rask Maximum Bid Price and Cash Flow Program

Appendix B. A Listing of the Lee and Rask Maximum Bid Price and Cash Flow Program

1. is Line No. 2. is Key Code 3. is Key

1	2	3	1	2	3	1	2	3
000	91	R/S	039	43	RCL	078	19	19
001	76	LBL	040	19	19	079	54	)
002	11	A	041	54	)	080	55	÷
003	43	RCL	042	65	×	081	53	(
004	20	20	043	43	RCL	082	53	(
005	42	STO	044	15	15	083	01	1
006	00	00	045	65	×	084	85	+
007	43	RCL	046	53	(	085	43	RCL
008	11	11	047	01	1	086	01	01
009	65	×	048	75	-	087	54	)
010	53	(	049	43	RCL	088	45	Y^x
011	01	1	050	16	16	089	43	RCL
012	75	-	051	54	)	090	19	19
013	43	RCL	052	95	=	091	54	)
014	13	13	053	42	STO	092	54	)
015	54	)	054	02	02	093	54	)
016	95	=	055	43	RCL	094	65	×
017	42	STO	056	12	12	095	53	(
018	01	01	057	65	×	096	53	(
019	53	(	058	53	(	097	01	1
020	53	(	059	01	1	098	85	+
021	01	1	060	75	-	099	43	RCL
022	85	+	061	43	RCL	100	10	10
023	43	RCL	062	13	13	101	54	)
024	14	14	063	54	)	102	55	÷
025	54	)	064	65	×	103	53	(
026	45	Y^x	065	53	(	104	43	RCL
027	43	RCL	066	01	1	105	01	01
028	19	19	067	75	-	106	75	-
029	54	)	068	53	(	107	43	RCL
030	55	÷	069	53	(	108	10	10
031	53	(	070	53	(	109	54	)
032	53	(	071	01	1	110	54	)
033	01	1	072	85	+	111	95	=
034	85	+	073	43	RCL	112	42	STO
035	43	RCL	074	10	10	113	03	03
036	01	01	075	54	)	114	43	RCL
037	54	)	076	45	Y^x	115	17	17
038	45	Y^x	077	43	RCL	116	85	+

Appendix B. (continued)

1	2	3	1	2	3	1	2	3
117	53	(	156	54	)	195	95	=
118	53	(	157	54	)	196	42	STO
119	01	1	158	54	)	197	04	04
120	75	-	159	65	×	198	53	(
121	43	RCL	160	53	(	199	01	1
122	17	17	161	53	(	200	75	-
123	54	)	162	43	RCL	201	43	RCL
124	65	×	163	18	18	202	17	17
125	53	(	164	65	×	203	54	)
126	53	(	165	53	(	204	65	×
127	53	(	166	53	(	205	43	RCL
128	53	(	167	01	1	206	13	13
129	01	1	168	85	+	207	65	×
130	85	+	169	43	RCL	208	43	RCL
131	43	RCL	170	18	18	209	18	18
132	01	01	171	54	)	210	65	×
133	54	)	172	45	YX	211	53	(
134	45	YX	173	43	RCL	212	53	(
135	43	RCL	174	20	20	213	43	RCL
136	20	20	175	54	)	214	18	18
137	54	)	176	54	)	215	65	×
138	75	-	177	55	÷	216	53	(
139	01	1	178	53	(	217	01	1
140	54	)	179	53	(	218	85	+
141	55	÷	180	53	(	219	43	RCL
142	53	(	181	01	1	220	18	18
143	43	RCL	182	85	+	221	54	)
144	01	01	183	43	RCL	222	45	YX
145	65	×	184	18	18	223	43	RCL
146	53	(	185	54	)	224	20	20
147	53	(	186	45	YX	225	54	)
148	01	1	187	43	RCL	226	55	÷
149	85	+	188	20	20	227	53	(
150	43	RCL	189	54	)	228	53	(
151	01	01	190	75	-	229	53	(
152	54	)	191	01	1	230	01	1
153	45	YX	192	54	)	231	85	+
154	43	RCL	193	54	)	232	43	RCL
155	20	20	194	54	)	233	18	18

Appendix B. (continued)

1	2	3	1	2	3	1	2	3
234	54	)	273	53	(	312	65	×
235	45	Y^x	274	01	1	313	53	(
236	43	RCL	275	85	+	314	01	1
237	20	20	276	43	RCL	315	85	+
238	54	)	277	01	01	316	43	RCL
239	75	-	278	54	)	317	18	18
240	01	1	279	45	Y^x	318	54	)
241	54	)	280	43	RCL	319	45	Y^x
242	54	)	281	00	00	320	53	(
243	95	=	282	54	)	321	43	RCL
244	42	STO	283	54	)	322	20	20
245	05	05	284	65	×	323	75	-
246	43	RCL	285	53	(	324	43	RCL
247	16	16	286	53	(	325	00	00
248	55	÷	287	53	(	326	85	+
249	53	(	288	53	(	327	01	1
250	53	(	289	01	1	328	54	)
251	01	1	290	85	+	329	54	)
252	85	+	291	43	RCL	330	54	)
253	43	RCL	292	18	18	331	95	=
254	01	01	293	54	)	332	44	SUM
255	54	)	294	45	Y^x	333	07	07
256	45	Y^x	295	53	(	334	97	DSZ
257	43	RCL	296	43	RCL	335	00	00
258	19	19	297	20	20	336	10	E'
259	54	)	298	75	-	337	53	(
260	95	=	299	43	RCL	338	43	RCL
261	42	STO	300	00	00	339	02	02
262	06	06	301	85	+	340	85	+
263	25	CLR	302	01	1	341	43	RCL
264	00	0	303	54	)	342	03	03
265	42	STO	304	54	)	343	54	)
266	07	07	305	75	-	344	55	÷
267	76	LBL	306	01	1	345	53	(
268	10	E'	307	54	)	346	43	RCL
269	53	(	308	55	÷	347	04	04
270	01	1	309	53	(	348	75	-
271	55	÷	310	43	RCL	349	53	(
272	53	(	311	18	18	350	43	RCL

Appendix B. (continued)

1	2	3	1	2	3	1	2	3
351	05	05	390	54	)	429	53	(
352	65	×	391	55	÷	430	01	1
353	43	RCL	392	53	(	431	85	+
354	07	07	393	53	(	432	43	RCL
355	54	)	394	53	(	433	18	18
356	75	-	395	01	1	434	54	)
357	43	RCL	396	85	+	435	45	Y^X
358	06	06	397	43	RCL	436	43	RCL
359	54	)	398	18	18	437	20	20
360	95	=	399	54	)	438	54	)
361	42	STO	400	45	Y^X	439	55	÷
362	08	08	401	43	RCL	440	53	(
363	91	R/S	402	20	20	441	53	(
364	76	LBL	403	54	)	442	53	(
365	12	B	404	75	-	443	01	1
366	53	(	405	01	1	444	85	+
367	01	1	406	54	)	445	43	RCL
368	75	-	407	54	)	446	18	18
369	43	RCL	408	95	=	447	54	)
370	17	17	409	42	STO	448	45	Y^X
371	54	)	410	26	26	449	43	RCL
372	65	×	411	91	R/S	450	20	20
373	43	RCL	412	76	LBL	451	54	)
374	21	21	413	13	C	452	75	-
375	65	×	414	53	(	453	01	1
376	53	(	415	01	1	454	54	)
377	43	RCL	416	75	-	455	54	)
378	18	18	417	43	RCL	456	65	×
379	65	×	418	17	17	457	53	(
380	53	(	419	54	)	458	53	(
381	53	(	420	65	×	459	53	(
382	01	1	421	43	RCL	460	53	(
383	85	+	422	21	21	461	01	1
384	43	RCL	423	65	×	462	85	+
385	18	18	424	53	(	463	43	RCL
386	54	)	425	43	RCL	464	18	18
387	45	Y^X	426	18	18	465	54	)
388	43	RCL	427	65	×	466	45	Y^X
389	20	20	428	53	(	467	53	(

Appendix B. (continued)

1	2	3	1	2	3	1	2	3
468	43	RCL	507	53	(	546	76	LBL
469	20	20	508	43	RCL	547	16	A'
470	75	-	509	12	12	548	43	RCL
471	43	RCL	510	65	×	549	12	12
472	22	22	511	53	(	550	65	×
473	54	)	512	53	(	551	53	(
474	54	)	513	01	1	552	53	(
475	75	-	514	85	+	553	01	1
476	01	1	515	43	RCL	554	85	+
477	54	)	516	10	10	555	43	RCL
478	55	÷	517	54	)	556	10	10
479	53	(	518	45	Y^x	557	54	)
480	43	RCL	519	43	RCL	558	45	Y^x
481	18	18	520	22	22	559	43	RCL
482	65	×	521	54	)	560	22	22
483	53	(	522	54	)	561	54	)
484	53	(	523	75	-	562	75	-
485	01	1	524	53	(	563	43	RCL
486	85	+	525	43	RCL	564	26	26
487	43	RCL	526	18	18	565	75	-
488	18	18	527	65	×	566	43	RCL
489	54	)	528	43	RCL	567	29	29
490	45	Y^x	529	27	27	568	95	=
491	53	(	530	54	)	569	42	STO
492	43	RCL	531	95	=	570	30	30
493	20	20	532	42	STO	571	91	R/S
494	75	-	533	28	28	572	76	LBL
495	43	RCL	534	91	R/S	573	17	B'
496	22	22	535	76	LBL	574	43	RCL
497	54	)	536	15	E	575	15	15
498	54	)	537	43	RCL	576	65	×
499	54	)	538	28	28	577	53	(
500	54	)	539	65	×	578	53	(
501	95	=	540	43	RCL	579	01	1
502	42	STO	541	13	13	580	85	+
503	27	27	542	95	=	581	43	RCL
504	91	R/S	543	42	STO	582	14	14
505	76	LBL	544	29	29	583	54	)
506	14	D	545	91	R/S	584	45	Y^x

Appendix B. (continued)

1	2	3
585	43	RCL
586	22	22
587	54	)
588	95	=
589	42	STO
590	31	31
591	91	R/S
592	76	LBL
593	18	C'
594	43	RCL
595	31	31
596	75	-
597	43	RCL
598	27	27
599	95	=
600	42	STO
601	32	32
602	91	R/S
603	76	LBL
604	19	D'
605	53	(
606	43	RCL
607	21	21
608	65	×
609	53	(
610	53	(
611	01	1
612	85	+
613	43	RCL
614	14	14
615	54	)
616	45	Y^x
617	43	RCL
618	20	20
619	54	)
620	75	-
621	43	RCL
622	21	21
623	54	)
624	65	×
625	53	(
626	01	1
627	75	-
628	43	RCL
629	16	16
630	54	)
631	95	=
632	42	STO
633	33	33
634	91	R/S