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Investing in farmland is one of the most important decisions that farmers face in their lifetimes. Usually, large amounts of debt are required to purchase a substantial tract of land, thereby reducing the farmer's liquidity position and future borrowing capacity. Fixed debt commitments must be met by highly variable future farm income. Variable cash flows are the most critical in the first three to five years after the land purchase. After that time, the financial position has improved as a result of the principal payments and possible appreciation in the value of new and existing land holdings. An incorrect decision in purchasing land may result in prolonged cash flow problems and force partial liquidation or possibly bankruptcy.

Oregon farmers want to know how much can be paid for land considering their objectives relating to the return they desire on their investment and the risk they are willing to accept that debt can be serviced after the proposed farm expansion. Two models were developed in this study. The first is a net present value model to determine

the effect of critical variables on the maximum economically feasible price that can be paid for farmland. The second model developed for this study is a risk analysis model to evaluate the decision maker's ability to meet fixed debt payments and other cash commitments given probability distributions for prices and yields.

The net present value of an acre of land is determined by summing the discounted cash flows after taxes over the planning horizon for the tract to be purchased. Whole firm analysis, or direct comparison between present and proposed expanded operation, is used to determine the exact effects of tax consequences associated with the land purchase. The discount factor used is the desired after-tax rate of return on equity capital. The model considers the case where the planning horizon is shorter in years than the loan repayment period.

The risk model determines gross farm income, which consists of product prices and yields, stochastically using triangular probability distributions. Operating expenses, amortization payments for term debt, net capital purchases associated with depreciable items, living expenses and withdrawals, and all taxes are subtracted from gross receipts to determine yearly cash flow. Items given in the output include the low cash balance at the end of the number of years for which the program was run, the probability of a negative cash balance occurring, and the probability of financial failure.

The models were applied to two case farm studies in Sherman and Marion Counties. Empirical results of these case studies indicate that given current production costs and gross farm receipts, farmland must continue to appreciate at an annual compound rate of 9 percent for the duration of the planning horizon to justify current land prices. Other variables having a sizable impact on the net present value include gross receipts and operating expenses for the newly purchased tract, the purchase price, and the discount factor.

Decision makers who own their farm operations and have low previous debt commitments are the most capable of generating adequate cash flows. Farmers who have large amounts of debt outstanding and who lease portions of their operation may have problems generating a positive cash balance within four years after the purchase. What farmers pay for land is influenced by the amount of risk that they are willing to take.

Evaluating the Financial Risk Involved in Farmland Investment Decisions

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CHAPTER I

INTRODUCTION

The Problem

The land investment decision is one of the most crucial business decisions farmers make in their lifetimes. The decision is particularly important in terms of its impact on the profitability, financing, and risk of the farm business. In most cases, large amounts of debt capital are involved, the firm's liquidity is reduced, and financial reserves are used, therefore limiting the producer's financial management prerogatives.

The infrequency with which most farmers purchase land makes effective decision-making more difficult yet. Investment experience in farmland is thus limited. On the average, a particular tract of farmland will be sold about once every 25 years [60]. Therefore, the sale of a nearby piece of land may put the decision maker in a precarious position. The farmer may not be financially capable of purchasing the land at that point in time. However, a foregone opportunity to purchase the land may be the last chance.

Agricultural producers invest in land for numerous reasons. They may wish to increase their income and net worth. Investments in farmland may be made in order to more fully utilize the firm's management and/or machinery, or as a hedge against inflation by benefiting from increasing land values. Pride of ownership is another reason to invest. Whatever the reason, large capital investment decisions are not easily altered. An error in decision making will result in prolonged cash flow problems, may force partial liquidation of the firm and possibly bankruptcy. These investment decisions are further complicated because fixed repayment responsibilities must be met by highly variable future farm income.

The Situation

The land purchase problem has been complicated by several factors. One is the rapid increase in land values in recent years. Table 1 lists the average value per acre of land and buildings in Oregon. Land prices in Oregon have risen nearly 200 percent in the past fifteen years. Furthermore, the increase was nearly $100 per acre from 1973 to 1978.

Another factor influencing long-term capital asset investment is the small and variable profit margins in agriculture. Net farm income for Oregon after inventory adjustments is listed in Table 2 in nominal dollars. Farmers captured $411.1 million of profit in 1974 while making less than one-third of that three years later (1977). Profits rebounded to over $300 million in 1978. Regardless of the level of farm income, the fixed commitment to land must still be paid. The relationship between land values and net farm income is depicted graphically in Figure 1. The disparity between them has been growing in recent years.

TABLE 1. Average Value Per Acre of Land and Buildings for Oregon, 1955-78 a/

Year	$ Value	Annual Percentage Change
1955	79	
1956	80	1.27
1957	83	3.75
1958	85	2.41
1959	88	3.53
1960	88	0
1961	90	2.27
1962	94	4.44
1963	102	8.51
1964	108	5.88
1965	115	6.48
1966	121	5.22
1967	128	5.79
1968	134	4.69
1969	143	6.72
1970	150	4.90
1971	166	10.67
1972	185	11.45
1973	204	10.27
1974	233	14.22
1975	249	6.87
1976	264	6.02
1977	278	5.30
1978	303	8.99

a/ Index of Real Estate Values.

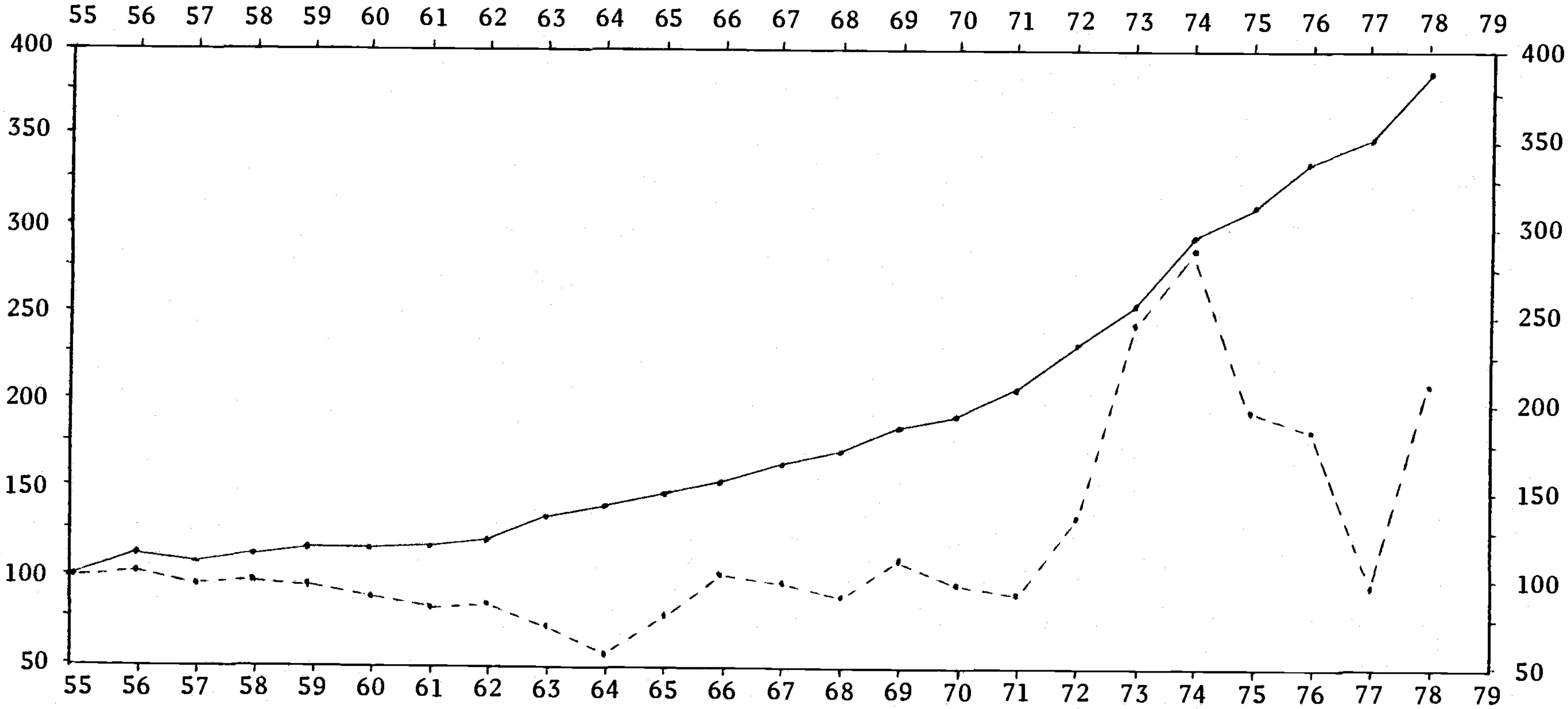
Source: U.S. Department of Agriculture. Farm Real Estate Market Developments. Various issues, Washington, D.C.

TABLE 2. Net Farm Income After Inventory Adjustments in Millions of Dollars for Oregon, 1955-78 a/

Year	$ Value
1955	142.8
1956	157.8
1957	132.5
1958	137.0
1959	134.2
1960	130.2
1961	116.4
1962	118.6
1963	102.7
1964	83.2
1965	109.8
1966	145.2
1967	133.4
1968	123.3
1969	159.2
1970	140.8
1971	131.9
1972	192.7
1973	350.7
1974	411.1
1975	274.9
1976	239.8
1977	135.4
1978	309.8

a/ Index of Net Farm Income.

Source: U.S. Department of Agriculture. State Farm Income Statistics. Supplement to Statistical Bulletin No. 627, Washington, D.C., October 1979.



- - - - Index of Net Farm Income. 1955 = 100. Source: U.S. Department of Agriculture. State Farm Income Statistics. Supplement to Statistical Bulletin No. 627, Washington, D.C., October 1979.

——— Index of Real Estate Values. 1955 = 100. Source: U.S. Department of Agriculture. Farm Real Estate Market Developments. Various issues, Washington, D.C.

Figure 1. Trends in Land Values and Net Farm Income, Oregon, 1955-78.

Terms of financing have also changed dramatically in the past few years. Table 3 and Figure 2 give the average interest rates on new loans as charged by the Spokane Federal Land Bank District. These interest rates steadily increased throughout the 1960's and early 1970's and have appeared to level off somewhat in more recent years. However, as of April 1, 1980, the Spokane Federal Land Bank raised the interest rate on new loans to 10½ percent. These increases in interest rates pose a major concern to borrowers and lenders alike.

Approaches to Analyzing Land Values

Willett and Wirth (1978) suggest that farmers should consider at least four factors before making a land investment: (1) the market price of the land; (2) the economic value of the land to their business in terms of annual returns, liquidation, and equity build-up; (3) various financing constraints (including the financial feasibility of the proposed purchase in terms of cash flow); and (4) risk of financial loss. The market price of the land is based on recent sales of comparable land, while the actual purchase price is not determined until the land has been sold. The latter three are subject to a high degree of uncertainty.

The value of farm real estate may be determined by several factors. Physical characteristics, such as topography, soils, and buildings and improvements can have a major impact on real estate valuations. The location of the tract of land, climate, and regional community factors can make a difference as well. Aesthetic factors such as scenic views

TABLE 3. Spokane Federal Land Bank District
Average Interest Rate on New Loans

Date	Interest Rate[a/]
August 1959	6.00
April 1961	5.50
June 1966	6.00
December 1967	6.75
December 1968	7.00
March 1969	7.50
January 1970	8.50
March 1971	7.75
March 1972	7.25
August 1973	7.50
October 1973	8.00
July 1974	8.50
November 1974	9.00
July 1976	8.75
December 1976	8.50
October 1978	8.75
January 1979	9.25
December 1979	9.75
April 1980	10.50

[a/] The rate listed above is the effective billing rate that borrowers would pay. However, the annual percentage rate (APR) will be somewhat higher due to: 1) a 1% loan fee for membership into the Association, 2) a 3% bank fee, and 3) a 5% stock purchase requirement.

Source: Spokane Federal Land Bank. Personal conversation with staff personnel, April 1980.

Figure 2. Spokane Federal Land Bank District Average Interest Rate on New Loans

Source: Spokane Federal Land Bank. Personal conversation with staff personnel, April 1980.

can also affect land values. Economic factors--namely returns to investment--also have a large impact on determining land values.

Two basic approaches have been used in prior land investment research. Lee and Rask (1976) and Willett and Wirth (1978) used capital budgeting approaches based on cash flow projections using single valued expectations to assess the economic value of land. However, current farm and economic conditions make the assumption of perfect knowledge of product prices and yields very unacceptable. Hardin (1978) used computer simulation to analyze the land purchase decision. This approach does allow the issue of risk to be addressed but poses some problems in that data requirements are quite extensive and difficult for farmers to fulfill.

The risk involved in the land investment decision primarily involves the variability of cash flows that are required to meet the added debt service requirements as well as other cash commitments resulting from the land purchase. Cash flow for the farm firm is invariably difficult to project. Crop yields are subject to weather, insects, and plant diseases, while product prices may be influenced by both domestic and foreign demand, inventory surpluses and shortages, as well as government, farm and food programs, and yields. Future cash flows are also affected by general price inflation and increasing farm production costs, factors which are subject to a high degree of variation.

Variable cash flows are the most critical in the first five years after the land has been purchased. Immediately after a land purchase, the liquidity position of the firm is weakened in terms of cash reserves, and borrowing capacity is probably reduced. After the first five years, the equity in the new land purchases, as well as present land holdings, will have increased through principal payments and possible appreciation. At this point, both new and existing land could be used as a base for additional borrowing, thus relieving the more critical debt burden faced in the early years of the land purchase.

Research Scope

A method of realistically assessing risk with limited but yet adequate data requirements is needed in land investment decision making. This method could help farmers assess their sources of risk when used in an Extension setting.

The programmable hand-held calculator represents a low-cost and efficient method of conveying quantitative information to Extension clientele. The greatest advantage, however, is probably the portability of the calculator in that it can be taken from the university campus directly to the clientele.

The recent development of programmable calculators has greatly improved the effectiveness of Extension economists. However, at this time, no program exists for farmland investment decision making that allows for risk to be properly assessed. The Extension economist is therefore faced with the problem of providing a realistic decision-making tool while staying within the storage and programming space limitations of the calculator.

The specific objectives of this study are the following:

1) To develop a framework for analyzing the returns and financial risk associated with farm investment decisions.

2) To identify the critical variables affecting the outcomes of land purchase decisions for two case farm situations in Oregon.

3) To analyze and interpret what effects these critical variables have on what farmers can pay for land in these situations.

CHAPTER II

NET PRESENT VALUE ANALYSIS

Agricultural decision makers considering farm land investment opportunities are faced with the question, "How much is the land worth to my particular business?" A method is needed to analyze capital investment alternatives that will consider the tax effects of the farmer's present operation[1/] and the expanded operation.[2/] This method will project cash flows over the decision maker's planning horizon and should realistically incorporate the risk and uncertainty[3/] associated with the farm business.

This chapter will present some capital budgeting techniques as they apply to evaluating farm land investment decisions. A brief review of literature will follow, with some recent capital budgeting approaches critiqued, drawing on strengths and weaknesses of each. Finally, an alternative model will be presented for determining farm land values for the individual decision maker.

Theoretical Considerations

Hopkin, Barry, and Baker (1973) state that capital budgeting consists of a sequential number of steps that provide relevant information

1/ Present operation is used to denote the current farm business before the proposed add-on.

2/ Expanded operation is used to denote the current farm business plus the proposed add-on.

3/ The terms risk and uncertainty will be used interchangably throughout this thesis.

for evaluating financial investments. Hopkin, et. al., suggest that the decision maker must identify the investment alternatives, measure the returns associated with each, and select economic decision criteria. Four methods are discussed for evaluating capital investment alternatives: 1) simple rate of return, 2) payback period, 3) present value method, and 4) internal rate of return.

The simple rate of return method is frequently used by agricultural managers and is commonly computed by the formula:

$$R = \frac{Y}{I} \tag{2.1}$$

where: Y = the average annual after-tax earnings, minus depreciation, projected from the new investment,

I = the total capital outlay required for the investment,

R = the average annual rate of return.

This method expresses yearly net receipts as a percentage of the total investment. Individual investments are ranked according to the relative sizes of the annual rate of return and judged as to profitability by comparison with the investor's required rate of return.

The payback period method estimates the length of time necessary to return the original investment. The formula is as follows:

$$P = \frac{I}{E} \tag{2.2}$$

where: I = the total capital outlay for the investment,

E = the additional projected cash flow per period resulting from the investment,

P = the payback period.

Individual investments are ranked according to their relative payback periods, with the shortest being the most desirable. The primary disadvantage to this method is that it does not account for returns to the investment after the investment outlay has been recovered. A major drawback to both the payback period and simple rate of return methods is the failure to consider the time value of money.

The present value method does take into account that one dollar today is worth more than one dollar to be received at a future point in time. This idea is accepted, because we can invest the dollar we have today and have it yield an amount to make it worth more at a later date. The formula for compounding is as follows:

$$FV = A(1+r)^N \tag{2.3}$$

where: FV = future value,

A = amount invested today,

r = interest rate,

N = number of years.

The formula for discounting is as follows:

$$PV = \frac{A}{(1+r)^N} \tag{2.4}$$

where: PV = the value today,

A = amount invested,

r = interest rate,

N = number of years.

Aplin, Casler, and Francis (1977) list four steps in evaluating an investment via the net present value method.

1) determine the discount rate,

2) calculate cash inflows and discount them accordingly,

3) calculate and discount cash outlays, and

4) determine net present value of the outlays from the present value of the cash inflows.

The following formula expresses the net present value method:

$$NPV = \frac{A_1}{1+r} + \frac{A_2}{(1+r)^2} + \cdots + \frac{A_n}{(1+r)^n} + \frac{S}{(1+r)^n} \qquad (2.5)$$

where: NPV = net value of the proposed investment,

A_i = net cash inflows after taxes in years 1, 2, •••, n,

r = discount rate,

n = expected economic life of the investment, and

S = salvage value of the asset in year n.

The size and sign of an investment's present value determine its ranking and acceptability. The decision maker should accept all independent investments that have a positive net present value and reject those independent projects that have a negative net present value. If an investment has a net present value that equals zero, this suggests that if the decision maker negotiates the investment, he will receive a rate of return which is the minimum allowable to make the project profitable.

The internal rate of return (IRR), like the net present value method, incorporates discounted cash flows. Unlike the net present value method, however, the IRR sets the NPV equation equal to zero and solves for the discount rate. In this way, the investor can determine the maximum rate of interest that could be paid and break even. Investments are ranked and accepted or rejected on the basis of their internal-rates-of-return, with the largest being favored. One disadvantage of the IRR method is that it assumes that net cash flows can be reinvested to earn the same rate as internal rate of return of the project under consideration. The net present value method assumes that net cash flows are reinvested at the firm's discount rate. In this regard, the net present value is desirable because it may not be possible to reinvest excess funds that yield the internal rate of return.

Up to this point, discussion has been confined to capital budgeting techniques with known certainty. Several methods currently exist for incorporating risk in capital investment decisions. Aplin, *et. al.*, (1977) discuss adjusting the discount rate for introducing risk into the net present value method. The approach suggests adding a risk premium to the discount rate, thereby increasing the value of the original discount rate. Increasing the discount rate has the effect of reducing the net present value, *ceteris paribus*. Therefore, increasing the discount factor with an allowance for risk has the effect of reducing the net present value for risky investments relative to investments that are less risky. Hopkin, *et. al.*, (1973), however, correctly point out the major disadvantage of the risk adjusted discount rate. This method implies that risk increases exponentially over time, even when the discount rate is constant. This is contrary to the usual case of agricultural land investments, where the greatest risk is normally incurred in the earlier years rather than in the later years.

Hopkin, et. al., (1973) also discuss the certainty-equivalent method of incorporating risk in capital budgeting. This method allows the discount rate to reflect only the time preference of money and not variations in risk. The formula is as follows:

$$NPV = \frac{F_1(A_1)}{1+r} + \frac{F_2(A_2)}{(1+r)^2} + \cdots + \frac{F_n(A_n)}{(1+r)^n} + \frac{F_n(S)}{(1+r)^n} \qquad (2.6)$$

where: NPV = net present value of the proposed investment,

A_i = net cash inflows after taxes in years 1, 2, $\cdots$, n,

r = discount rate,

n = expected economic life of the investment,

S = salvage value of the asset in year n, and

F_i = risk adjustment factor.

Each risk adjustment factor (F_i) can be specified for each annual net cash flow to indicate the relative degree of risk. The value of each F_i ranges from zero to 1.0 and varies inversely with the net present value equation. As with the discount rate adjustment method, the relative degree of risk involved is measured by differences in the net present value for each investment.

Review of Literature

The traditional income-capitalization formula used for determining the value of farmland is represented by:

$$V = \frac{R}{(1+r)} + \frac{R}{(1+r)^2} + \cdots + \frac{R}{(1+r)^\infty} \tag{2.7}$$

where: V = present value of the property,

R = estimated annual receipts from property,

r = discount rate.

The income-capitalization formula reduces to:

$$V = \frac{R}{r}, \tag{2.8}$$

if three conditions are met: 1) R is constant over time, 2) r is constant over time, and 3) an infinite or very long planning horizon is considered. For example, if annual net receipts of $100 are discounted at 10 percent, the present value would equal $1000 per acre. However, there are several shortcomings of this model:

1) there is no provision for increases in the net returns to land,

2) the appreciation of land values over time is not included,

3) there is no account for possible differences in the purchaser's opportunity cost of capital and the cost of borrowed money,

4) there is no allowance for the terms of financing, and

5) income tax effects are frequently overlooked.

Crowley (1974), expounding on some of the above disadvantages of the income-capitalization formula, discusses some common misuses of the formula. During periods of increasing net receipts, the value of land is understated, and therefore the discounted rate (r) is also understated. Likewise, an expected increase in the value of a property will understate the value obtained from the formula.

Lee and Rask (1976) have developed a model that relaxes some of the above restrictions. A capital budgeting decision model is used to evaluate the maximum price a decision maker could pay for land. Varying assumptions about the future are made in this approach. The variables required are:

- $\overline{P}$ - the average price per acre of recent sales of comparable parcels in the area,
- CC - the after-tax opportunity cost of total capital,
- n - the buyer's planning horizon in years,
- ANI - the expected annual net returns per acre before taxes,
- GNI - the expected annual rate of growth in annual net returns per acre,
- MTR - the buyer's marginal income tax rate (combined federal and state tax rate based on estimated taxable income after the parcel is purchased),
- DP - the proportion of the purchase price paid down,
- IR - the nominal rate of interest charged on the mortgage loan,
- t - the amortization period on the loan,
- INF - the expected annual rate of inflation in land values,
- T* - the tax rate that will apply to capital gains income in year n when the parcel is sold,
- P* - the maximum bid price, given values for the preceding 11 variables.

A sensitivity analysis was performed to determine which variables have the greatest effect on the maximum bid price (P*). The variables related to expected returns have the greatest effect. These three variables are: 1) ANI, the expected annual net cash income per acre before taxes; 2) GNI, the expected annual rate of growth in annual net returns per acre; and 3) INF, the expected annual rate of inflation in land values.

Lee and Rask divide the approach into three basic sections. The first is concerned with income received from the proposed tract of land to be purchased. A projection is made for the expected annual net returns per acre, but unlike the traditional income-capitalization formula, income taxes are considered as well as an allowance for an annual rate of growth in net receipts. The second section is concerned with financing terms of the land purchase. The down payment is deducted, and yearly interest payments are also deducted for tax credit. The third area of the model recognizes that land values may change over time, and a variable is included to reflect this. It is assumed that the land will be sold at the end of the planning horizon, and an estimation for capital gains taxes is considered.

Willett and Wirth (1978) have developed a similar capital budgeting model to determine the maximum bid price. The approach can be easily calculated by hand, unlike the Lee and Rask model. Willett and Wirth divide the model into the same three basic sections as proposed by Lee and Rask. Rather than discounting for each annum, however, Willett and Wirth use an annuity approach for both net receipts and income tax savings. Willett and Wirth's model requires the following data:

1) average annual before-tax gross receipts per rotation year,

2) average annual before-tax costs per rotation acre, except interest on new land debt,

3) marginal income tax rate on ordinary income,

4) number of years in the farmer's planning horizon,

5) annual rate used to discount land rent; this rate equals the farmer's required after-tax real rate of return on land investment plus the annual rate of general price inflation minus the annual rate of change in land rent,

6) average amount of interest paid per year during the land loan repayment period,

7) number of years in the repayment period of the loan used to finance the land acquisition,

8) contractual rate of interest on land loan,

9) annual rate used to discount income tax benefits from deductible interest payments and after-tax value of land at the end of the planning horizon; this rate equals the investor's required after-tax real rate of return plus the annual rate of general price inflation,

10) price per acre received for recent sales of comparable land, i.e., market price,

11) annual rate of change in market price of land,

12) income tax rate on capital gains.

Willett and Wirth list guidelines in determining an appropriate required rate of return. The first is that the rate of return should be at least as high as the after-tax cost of debt capital used to finance the land purchase. The after-tax cost of debt is calculated as follows:

$$ACD = EBI * (1-MTR) \tag{2.9}$$

where: ACD - after tax cost of debt,

EBI - effective before-tax interest rate,

MTR - marginal tax rate.

Equity capital is generally more costly than debt capital because the risk is greater with equity. Because Willett and Wirth specify the rate of return to be greater than debt capital, the figure they derive at can be regarded as a "weighted" cost of capital.

Both approaches discussed above assume a constant marginal tax rate (MTR) throughout the planning horizon. This assumption, however, can lead to inaccurate estimations. Normally, the assumption of a constant MTR will tend to overstate income tax savings, thereby overstating the net present value. In the early years after the land purchase, taxable income will be less, ceteris paribus, than in later years due to the large outstanding debt and the resulting income tax deductions. Because both models credit interest payments for income tax savings on the land loan, the effect of a constant MTR will tend to overstate the tax savings in the early years of the investment. During the later years in the planning horizon, taxable income will increase and therefore the marginal tax rate would increase. The assumption of a constant MTR will hence understate tax savings in the later years. However, because later years are discounted more heavily than early years, the net effect is to overstate income tax savings.

Before discussing some of the effects of interest tax savings, it is first necessary to discuss the nature of amortized loans which are characteristic of agricultural long-term debt. The method of loan amortization requires a "level payment" each year, consisting of both interest and capital. In the early years of the loan, the primary portion of the payment is interest, while the principal portion will be relatively small. These roles reverse over the duration of the repayment period until the loan is totally repaid, and the outstanding balance equals zero. Figure 3 illustrates this process.

Lee and Rask calculate yearly interest payments on an exact basis; however, Willett and Wirth rely on the average amount of interest paid yearly during the loan repayment period. Using an average interest amount will have the effect of understating tax savings for the land debt. Actual interest payments will be higher in the early years than the average payment, thereby understating the actual amount of tax savings. Interest tax savings are overstated in later years, but since later years are discounted at a higher rate, the net effect is to understate net tax savings, and therefore, understate the net present value.

The two models also use a different method of handling the average annual increase in net receipts. Lee and Rask calculate this amount on an exact basis:

$$\sum_{i=1}^{n} \frac{(1 + GNI)^i}{(1 + CC)^i}$$

Willett and Wirth use an approximation which is similar to:

$$\frac{1}{\left[1 + (CC - GNI)\right]^i}$$

When considering the case where the opportunity cost of capital is greater than the annual increase in net receipts, the Willett and Wirth approach will understate the effect of the variable to include increases

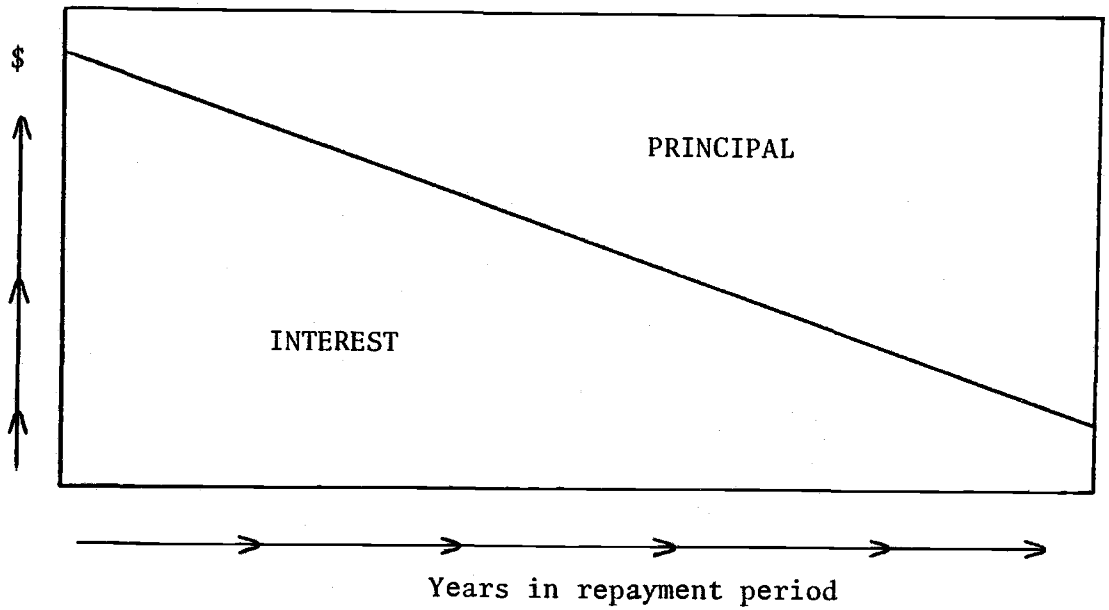


Figure 3. Concept of Amortized Payment.

in net receipts. Willett and Wirth overstate the effect of the case when the annual increase in net receipts is greater than the opportunity cost of capital.

Lee and Rask, and Willett and Wirth both make the limiting assumption that the amortization loan period must be less than or equal to (in number of years) the planning horizon. In some cases, this may be unrealistic. For example, an older farmer may have only fifteen years before retirement. If the land is financed with a twenty-year loan, then the investment decision should be made considering these factors explicitly.

Having made the above comparisons about the two models, it is now possible to discuss the results that each yields. When considering a land purchase using 100 percent equity capital and the annual increase in net receipts equal to zero, the two models yield a result that is identical. The two approaches do not yield the same response when considering a partially debt financed land purchase. Because the Willett and Wirth model understates interest tax savings, Lee and Rask's approach will result in a higher maximum bid price. The comparative result of a land purchase that includes a measure for an increase in annual net receipts depends on the relationship between this variable and the opportunity cost of capital, as discussed earlier.

To illustrate the comparisons between the two models, four numerical examples were contrived. Although the models do not require exactly the same input data, the example problems were adjusted accordingly to accommodate any possible differences. Tables 4 through 7 summarize data requirements for the respective examples.

TABLE 4. Required Data for Comparison of Lee-Rask and Willett-Wirth Models -- Example 1

Data common to both models:	
Market price of land	1,200
Number of years in planning horizon	25
Annual rate of growth in net returns	0
Buyer's marginal tax rate	.32
Annual rate of inflation in land values	.07
Capital gains tax rate	.16
Down payment	1
Interest rate charged on mortgage loan	.09
Amortization period on loan	25
Data unique to Lee and Rask model:	
Net returns before taxes	53
Opportunity cost of capital	.12
Data unique to Willett and Wirth model:	
Before-tax gross receipts	162
Before-tax costs	109
Required after-tax rate of return	.05
Annual general price inflation	.07

TABLE 5. Required Data for Comparison of Lee-Rask and Willett-Wirth Models -- Example 2

Data common to both models:	
Market price of land	1,200
Number of years in planning horizon	25
Annual rate of growth in net returns	.06
Buyer's marginal tax rate	.32
Annual rate of inflation in land values	.07
Capital gains tax rate	.16
Down payment	1
Interest rate charged on mortgage loan	.09
Amortization period on loan	25
Data unique to Lee and Rask model:	
Net returns before taxes	53
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Data unique to Willett and Wirth model:	
Before-tax gross receipts	162
Before-tax costs	109
Required after-tax rate of return	.05
Annual general price inflation	.07

TABLE 6. Required Data for Comparison of Lee-Rask and Willett-Wirth Models -- Example 3

Data common to both models:	
Market price of land	1,200
Number of years in planning horizon	25
Annual rate of growth in net returns	0
Buyer's marginal tax rate	.32
Annual rate of inflation in land values	.07
Capital gains tax rate	.16
Down payment	.20
Interest rate charged on mortgage loan	.09
Amortization period on loan	25
Data unique to Lee and Rask model:	
Net returns before taxes	53
Opporrunity cost of capital	.12
Data unique to Willett and Wirth model:	
Before-tax gross receipts	162
Before-tax costs	109
Required after-tax rate of return	.05
Annual general price inflation	.07

TABLE 7. Required Data for Comparison of Lee-Rask and Willett-Wirth Models -- Example 4

<u>Data common to both models:</u>	
Market price of land	1,200
Number of years in planning horizon	25
Annual rate of growth in net returns	.06
Buyer's marginal tax rate	.32
Annual rate of inflation in land values	.07
Capital gains tax rate	.16
Down payment	.20
Interest rate charged on mortgage loan	.09
Amortization period on loan	25
<u>Data unique to Lee and Rask model:</u>	
Net returns before taxes	53
Opportunity cost of capital	.12
<u>Data unique to Willett and Wirth model:</u>	
Before-tax gross receipts	162
Before tax costs	109
Required after-tax rate of return	.05
Annual general price inflation	.07

The maximum bid price given by example 1 is $610.22 for both models. Example 2 differs from the first in that the increase in net receipts equals .06. In this case, the Lee and Rask model yields a result of $805, while the Willett and Wirth model yields $790. The difference of $15 is due to the method that Willett and Wirth used to handle the increase in net receipts. In this example, Willett and Wirth understate the value of the maximum bid price. Example 3 is the same as example 1 except that 80 percent of the land purchase is financed with debt capital. The maximum bid price is $896 for Lee and Rask and $698 for Willett and Wirth. This difference is due to the method of handling interest tax savings as previously discussed. Example 4 includes the use of debt capital and an amount to increase net receipts. The Lee and Rask model yielded $1,183, while Willett and Wirth's responded with $903. The difference between the two are for the same reasons as with examples 2 and 3. The magnitude, however, is compoundedly increased.

Hardin (1978) stresses the importance of whole firm versus comparative analysis in evaluating the capital investment decisions. In partial analysis, a marginal tax rate is estimated and assumed to be constant. Whole firm analysis, on the other hand, examines the firm before and after the proposed investment. This method allows for precise measures of annual interest payments and income tax savings.
In this respect, whole firm analysis is superior. The primary disadvantage of this method is the relatively larger amounts of data requirements that are necessary to compare the existing and proposed operating units.

The three models by Lee and Rask (1976), Willett and Wirth (1978), and Hardin (1978) provide an excellent framework from which to build a capital investment analysis model. The proposed model should consider all tax effects of the proposed investment and be capable of handling the case when the planning horizon is shorter, in years, than the loan repayment period.

The Model

The major purpose of the proposed model is to calculate one value, the net present value for one acre of farm land. The model will be programmed on a Hewlett-Packard 41C programmable calculator and can easily be adapted to problems faced in an Extension setting. Direct comparison of the present farm business and the proposed expanded operation are made in order to determine the effect of the investment on the present farm operation.

Not unlike the models presented by Lee and Rask (1976), and Willett and Wirth (1978), the approach taken here will include three basic sections. They are the inclusion of net receipts after income taxes, tax savings resulting from interest on the outstanding debt, and the market value of the land at the end of the planning horizon. More specifically, the proposed approach is to account for net receipts per acre of the add-on purchase, with an allowance appropriated for an annual change (in net receipts). Income taxes will be calculated on an exact basis, rather than using a constant MTR approximation. Yearly interest payments are calculated and deducted for tax purposes. Allowances for appreciation in land values are considered to determine the market value of the proposed add-on at the end of the planning horizon.

The formula for the net present value model is:

$$NPV = -DP + \sum_{i=1}^{N} \frac{NCF_i}{(1+DF)^i} + \frac{(MKL_N * AR) - OLB_N}{(1+DF)^N} \quad (2.10)$$

and each:

$$NCF_i = (AR)(AGR-AOE-ADE-AOC)(1+INR)^i - CHT_i - APN_i \quad (2.11)$$

where:

NPV - net present value of one acre of the proposed add-on,

DP - down payment for add-on in dollars,

N - number of years in the planning horizon,

NCF_i - net cash flow for each year in the planning horizon,

DF - relevant discount factor,

MKL_N - market value per acre of the proposed add-on at the end of the planning horizon,

AR - number of acres in the add-on,

OLB_N - outstanding loan balance of the debt for the add-on at the end of the planning horizon,

AGR - average annual gross receipts per acre for the add-on,

AOE - average annual operating expenses per acre for the add-on,

ADE - average annual reserve for depreciation per acre for the add-on, AOC - average annual opportunity costs for labor and capital per acre for the add-on,

INR - average annual expected increase (or decrease) in net farm receipts,

CHT_i - total change in taxes for each year in the planning horizon--equal to total tax for proposed expanded business minus total tax for the current business,

APN_i - amortization payment of the debt for the add-on (includes interest and principal).

The down payment of the add-on purchase is subtracted because it represents a direct cash outlay. This amount is not discounted as it occurs at the beginning of the planning horizon, or in capital budgeting language, in year zero.

The market value of the land at the end of the planning horizon is added to the net present value and discounted by N years. It is calculated by:

$$MKL_N = MKT(1+ILV)^N \tag{2.12}$$

where:

MKT - market value in dollars per acre of the add-on tract when the land is purchased,

ILV - average annual expected increase (or decrease) in land values.

An average annual change in farmland values (ILV) is included to recognize that land values may change over time. Land values in the United States have historically increased.

In order to obtain the net value of the purchased land at the end of the planning horizon, the outstanding balance of the loan (OLB_N) is subtracted from the total market value and discounted by N years. For cases where the number of years in the planning horizon (N) is greater than or equal to the number of years in the loan repayment period (L), the outstanding balance will be equal to zero.

The net cash flow for each year (NCF_i) is discounted annually by the discount factor (DF). The relevant discount factor (also referred to as the discount rate and the required rate of return) is determined by considering the real opportunity cost of capital. Because of the nature of the capital structure of the farm firm, return to equity capital will be considered rather than using a weighted cost of capital approach. In general, decision makers can more easily identify with returns to their equity capital rather than a return to a weighted cost approach that considers both debt and equity capital. Expected general inflationary trends must be added to the real return to equity capital figure in order to obtain a discount factor rate of return. As a general rule, the discount factor should be greater than the interest rate paid on the land debt (Aplin, *et. al.*, 1977). Otherwise, the decision maker will be paying a higher rate for debt capital than they will receive as return on their equity investment.

Each yearly net cash flow is computed by subtracting costs from total revenue for the proposed add-on, then multiplying this figure times an allowance for annual increases to net farm receipts, and then subtracting the amortized payment for the land debt and also subtracting the resulting change in total taxes (total tax for expanded business minus total tax for present business). The following discussion will begin with the receipts and costs for the add-on.

Gross receipts per acre are obtained using real and trended prices and yields. The prices and yields are assumed to be for an average year, given the historical time series. Operating expenses for the add-on are obtained through enterprise budgets and deducted from gross receipts. Interest expenses for the land debt are excluded from operating expenses and are taken into account with the amortization payment. An average depreciation figure per acre is obtained, again from enterprise cost studies, and is subtracted. The depreciation, although it is not a direct cash expense, represents an average yearly amount that the decision maker would incur by the additional machinery purchases that would be necessary to operate the expanded operation. The third amount to be subtracted from gross receipts is a variable defined as additional opportunity costs (AOC). This variable is composed of two parts--wages to operator labor and interest on equity capital. Compensation is made to the operator labor that is incurred on the add-on, viewing it in the opportunity cost sense, and to any equity capital the farmer employs on the new tract of land such as that required to finance additional machinery requirements.

Gross receipts less operating costs, added depreciation, and an opportunity cost figure yields net receipts per acre for the proposed add-on. Multiplying by the number of acres for the add-on yields total net receipts for the new tract. Total net receipts is then multiplied by an allowance for an average annual change in net receipts (INR).

This annual allowance recognizes that net farm income may change over time.

The next step in determining yearly net cash flows for the add-on is to subtract the amortized payment from the adjusted net receipts. The payment (APN), consisting of both principlal and interest for the new debt, is a direct cash payment resulting from the land purchase. The amortization payment is calculated as follows:

$$APN = \left(\frac{INT}{1 - \frac{1}{(1+INT)^{L}}} \right) BLB \tag{2.13}$$

where: INT - the rate of interest charged on the amortized loan,

BLB - beginning loan balance for the new debt,

L - number of years in the repayment period.

The beginning balance is calculated by:

$$BLB = (PP * AR) - DP \tag{2.14}$$

where: PP - purchase price per acre for the add-on.

The yearly net cash flow is then obtained by subtracting the change in total taxes, which results from total taxes for the proposed expanded operation minus total taxes for the current farm business. The change in taxes (CHT) is calculated in the following manner:

$$(GRP - OEP - DEP)(1 + INR)^{i} - IED_{i} - EX = TIP_{i} \tag{2.15}$$

$$SETP_{i} + FTP_{i} + STP_{i} = TTP_{i} \tag{2.16}$$

$$(GRE - OEE - DEE)(1 + INR)^{i} - IED_{i} - IND_{i} - EX = TIE_{i} \quad (2.17)$$

$$SETE_{i} + FTE_{i} + STE_{i} = TTE_{i} \quad (2.18)$$

$$TTE_{i} - TTP_{i} = CHT_{i} \quad (2.19)$$

where:

GRP - average annual gross receipts for the present operation,

OEP - average annual operating expenses for the present operation,

DEP - average annual depreciation for the present operation,

IED_i - annual interest payment on existing debt,

TIP_i - taxable income for the present operation,

$SETP_i$ - self-employment tax for the present operation,

FTP_i - federal tax for the present operation,

STP_i - state tax for the present operation,

GRE - average annual gross receipts for the expanded operation,

OEE - average annual operating expenses for the expanded operation,

DEE - average annual depreciation for the expanded operation,

IND - annual interest payment on new debt,

EX - personal exemptions,

TIE_i - taxable income for the expanded operation,

$SETE_i$ - self-employment tax for the expanded operation,

FTE_i - federal tax for the expanded operation,

STE_i - state tax for the expanded operation,

TTE_i - total tax for the expanded operation,

TTP_i - total tax for the present operation,

CHT_i - change in total taxes in year i.

where:

$$GRE = GRP + (AGR * AR) \quad (2.20)$$

$$OEE = OEP + (AOE * AR) \quad (2.21)$$

$$DEE = DEP + (ADE * AR) \quad (2.22)$$

$$EX = ND * 1{,}000 \quad (2.23)$$

$$SETP_i = f(TIP_i) \quad (2.24)$$

$$FTP_i = f(TIP_i) \quad (2.25)$$

$$STP_i = f(TIP_i, FTP_i) \quad (2.26)$$

$$SETE_i = f(TIE_i) \quad (2.27)$$

$$FTE_i = f(TIE_i) \quad (2.28)$$

$$STE_i = f(TIE_i, FTE_i) \quad (2.29)$$

where:

ND - number of dependents claimed.

Interest payments each annum are calculated for both existing debt and the new debt and are treated as a direct tax deduction. The interest payment for the new loan, however, is only deducted for the expanded business.

The model assumes that the add-on tract will be sold at the end of the planning horizon. At this time, capital gains taxes will be considered for the expanded operation only. Capital gains taxable income is added to taxable income (TIE) in year N and is calculated in the following manner:

$$CGTI = (MLV_N - PP) * AR * .4 \tag{2.30}$$

where:

CGTI - capital gains taxable income in year N.

Although it is not a requirement for the decision maker to sell the land at the end of the planning horizon, including this measure will indicate its impact on the net present value if the farmer did choose to liquidate the investment. Given the income averaging possibilities today, this treatment of capital gains will probably overstate the tax, therefore yielding a conservative estimate of the net present value.

Given the method for calculating the change in total taxes, the decision maker faces a larger tax payment if expanded operation taxes are greater than taxes for the present business. However, immediately after a land purchase, large amounts of outstanding debt result in large interest expenses, thereby decreasing taxable income for the expanded business. Conceivably, the interest expense for the new debt could be greater than the additional net receipts in the early years of the planning horizon, thus yielding a change in taxes with a negative sign. Because this amount is subtracted from net receipts for the add-on, the above scenario would result in a net tax savings to the investor which would increase the net cash flow for that year. It is important to note that since early years in the planning horizon are not discounted as heavily as are later years, a possible tax savings would have a relatively larger impact on the net present value. Regardless of the initial sign of the total change in taxes, this amount will steadily grow larger over time.

Benefits accruing from investment tax credit are not considered in the proposed model. Therefore, in cases where depreciable items are included in the analysis, the net present value will be understated.

CHAPTER III

RISK ANALYSIS

Analyzing a capital investment alternative is not complete by considering the net present value of the proposed investment alone. A net present value of greater than zero, a desirable characteristic as described in the previous chapter, will not ensure that the decision maker can meet the long-term debt payments associated with the land purchase. For this reason, agricultural decision makers must address the question, "What are my repayment capabilities?"

Long-term fixed commitments must be met by variable farm income that is subject to a high degree of risk and uncertainty. Current agricultural and economic conditions make the assumption of perfect knowledge of product prices and yields highly artificial. A method of projecting cash flows over time is needed that incorporates the risk associated with agricultural production.

This chapter will contain four basic sections. The first will contain a brief review of literature to be followed by some theoretical considerations for the triangular probability distribution. A general description of a proposed alternative model will follow, and the chapter will conclude with a basic data development section.

Review of Literature

Jones (1972) utilized simulation techniques as a plan of action for corporations faced with risky decisions. The primary purpose was to determine what the effect of alternative actions would be. Jones refers to this method as a "look before you leap" philosophy.

Hertz (1979) also used computer simulation to quantify risk in capital investment decisions. Three basic steps are prescribed. First, each significant factor affecting costs and returns is identified. The range of values for each factor is estimated as well as the likelihood of occurrence of each value. Second, one value is selected at random from each factor and combined with a value for all of the factors. This process is continually repeated to determine the probability of occurrence for each possible rate of return. The average expectation is the average of the values of all outcomes weighted by the chances of each occurring.

Sprow (1967) states three desirable characteristics that a probability distribution should possess. The first is that the function contain parameters that the decision maker is familiar with and be completely defined by the estimates. The second states that the function should be capable of being skewed by the economic estimates. Finally, the distribution should be amenable to mathematical analysis. Sprow used the triangular distribution to evaluate research expenditures with Monte Carlo simulation methods.

Cassidy, Rodgers, and McCarthy (1970) also used Monte Carlo techniques to assess farm planning and various alternative investments. The triangular distribution was specified with subjective probabilities. The approach includes incorporating subjective weightings on stochastic events. Parameters entering into the simulation are chosen by Monte Carlo selection and combined according to the functional relationships of the model. The combination of these values for each simulation run determines an outcome, with a cumulative distribution constructed from a number of such outcomes. In this way, the output describes the range of possible results with the probability of their occurrence.

Richardson and Mapp (1976) used a probabilistic cash flow approach to analyze both agricultural and non-agricultural investments under conditions of risk and uncertainty. Critical variables are identified and probability distributions developed for each that were thought to be stochastic. The next step is to link probability distributions for stochastic variables to known or fixed variables that influence the proposed investment. The next step specifies accounting relationships, such as costs and returns, associated with the investment. Stochastic values for critical variables are drawn and repeated until probability distributions of annual net returns are generated.

Willett and Wirth (1978), in conjunction with their net present value analysis, calculate the maximum financially feasible price that can be paid for land with respect to cash flow. This price is determined by the equity available and the amount of debt the farm's cash flow will allow. Cash receipts and costs are budgeted, including average annual payments for existing long-term debt, average funds required to replace depreciable assets, and average annual family living expenses. Gross farm receipts, comprised of product prices and yields, are assumed to be known with certainty, however. Nevertheless, this model provides a starting point for analyzing the decision maker's cash flow repayment abilities.

Nelson (1978) used the triangular probability distribution to assess the risk associated with product prices and yields in meeting cash flow obligations related to new debt obligations for the land purchase. The result, rather than being a single value estimate, is the probability that during any one of the years adequate cash will not be generated through the normal operation of the business to meet all of the cash requirements including the land loan repayment. Nelson correctly points out that this analysis does not consider the probabilities involved with the "high" and "low" events of the distribution or the consequences if cash flow requirements are not met.

Hardin (1978) developed a stochastic capital investment model that calculates net present value, annual net worth, net cash flow, and the probability of firm financial failure. The model incorporates stochastic variation in prices and yields. Whole farm analysis is used rather than marginal analysis. This approach allows for a detailed comparison between the current operating unit and proposed new unit. The primary disadvantage to this approach is the large amounts of data necessary. Hardin suggests three possible alternatives to meet annual cash flow deficits. The first is to use accumulated cash from previous years. Another alternative is to refinance the long-term land loan. The third is to borrow against intermediate assets, providing the intermediate equity ratio is above a specified minimum. If cash flow deficits can be met by any of the above methods, the decision maker can continue in business. Otherwise, the farmer is insolvent or bankrupt.

The three approaches by Willett and Wirth (1978), Nelson (1978), and Hardin (1978) provide an excellent framework from which to build a stochastic model that determines the cash flow repayment capabilities of farm firms considering the proposed investment. The model should consider all tax effects and be capable of utilizing stochastic variation in product prices and yields, the main determinant of annual net returns.

Theoretical Considerations for the Triangular Probability Distribution

Monte Carlo simulation techniques offer an alternative approach for evaluating capital investment decisions under conditions of uncertainty. Using this approach, objective and/or subjective probability distributions are specified for the stochastic variables influencing the feasibility of the investment. Random values are then drawn for these variables to calculate the desired result. The process is repeated many times, and a probability distribution of the result is thus generated. The result associated with risk can be reduced to a single value. For example, there may be an 80 percent chance that the investment will be a successful one or that cash flow requirements will be met. This use of simulation is superior to traditional single-value estimates of returns.

A frequently used method of incorporating risk is to specify mean expected values and the variance about that mean for key variables. Hess and Quigley (1962) present the mathematical formulas necessary to generate a normal probability density function. Most farmers are not familiar with the above concepts, however; therefore, most distributions of this type are based on historical or objective probabilities. Even so, Officer and Anderson (1968) suggest that the decision maker will have at least some prior knowledge of the problem at hand. For this reason, the argument is made for subjective probabilities.

The triangular probability distribution can be completely specified by assigning only three values: 1) lowest possible value, 2) highest possible value, and 3) the most likely or modal occurrence of the variable. These parameters are more easily understood and interpreted by decision makers than mean and variance. The triangular distribution can be skewed by specifying a most likely value that is closer to either the minimum or maximum value.

Mathematically, the probability density function of the triangular distribution, illustrated in Figure 4, is given by:

$$f(x) = \frac{2(x-a)}{(c-a)\ (b-a)} \quad , \quad a \leq x \leq b \qquad (3.1)$$

$$f(x) = \frac{2(x-c)}{(c-a)\ (b-c)} \quad , \quad b \leq x \leq c \qquad (3.2)$$

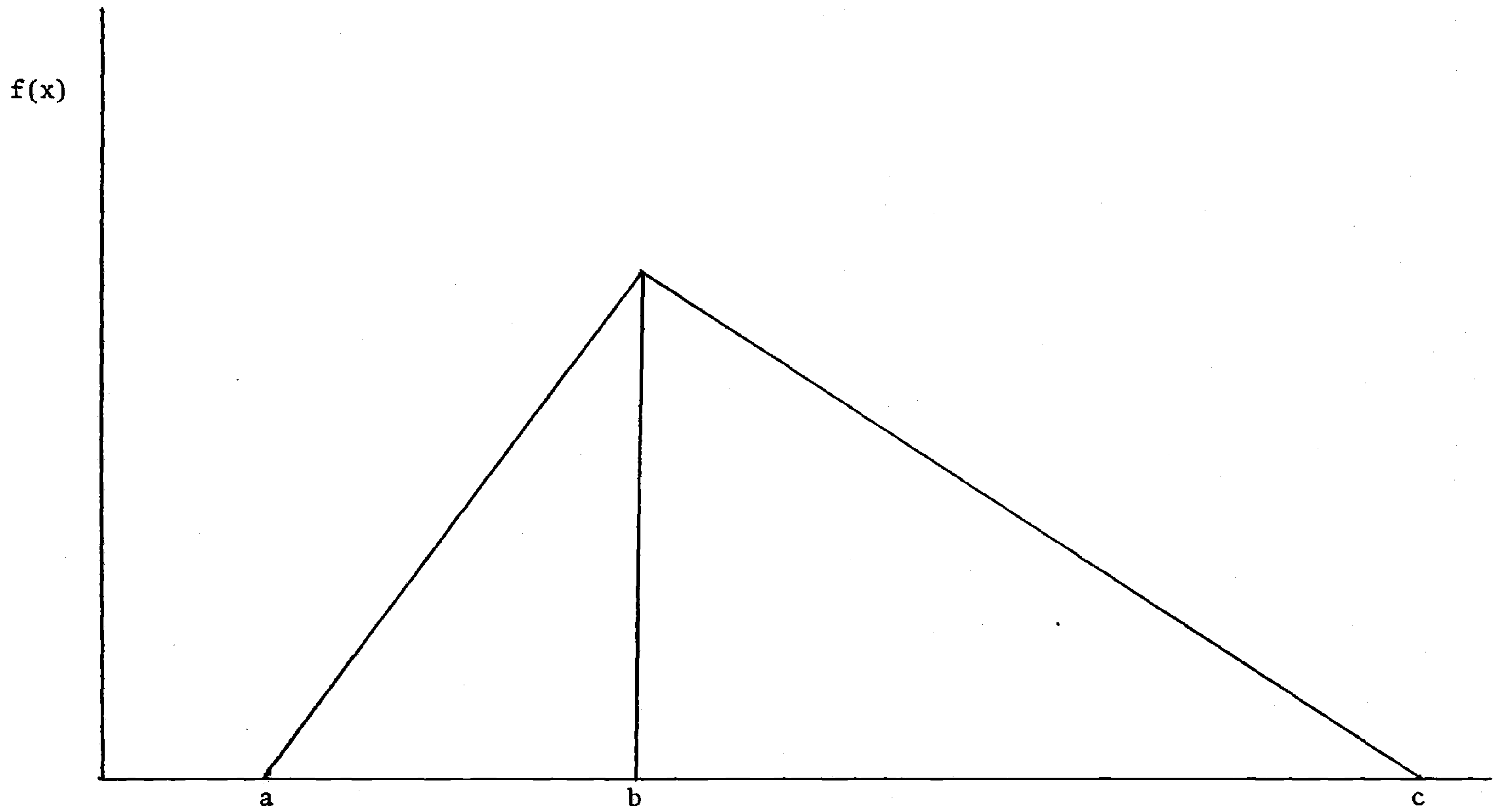

Figure 4. Triangular probability density function

where:

x = the value of the particular variable,

a = the minimum value of x,

b = the "most likely" value of x,

c = the maximum value of x.

The cumulative distribution function F(x) is given by the integration:

$$F(x) = \int f(x) \cdot dx \tag{3.3}$$

such that F(a) = 0, and F(c) = 1. The following equations result:

$$F(x) = \frac{(x-a)^2}{(c-a)\ (b-a)}, \quad a \leq x \leq b \tag{3.4}$$

$$F(x) = 1 - \frac{(x-c)^2}{(c-a)\ (c-b)}, \quad b \leq x \leq c \tag{3.5}$$

Solving in terms of x, equations 3.6 and 3.7 result:

$$x = \left[F(x)\ (c-a)\ (b-a)\right]^{\frac{1}{2}}, \quad a \leq x \leq b \tag{3.6}$$

$$x = \left[(1 - F(x))\ (c-a)\ (c-b)\right]^{\frac{1}{2}}, \quad b \leq x \leq c \tag{3.7}$$

Given this form, the value of the stochastic variable can be determined by a random selection of a value for F(x) between zero and one. The value of x is then obtained by solving equation 3.6 or 3.7. Figure 5 illustrates the cumulative probability function for a triangular distribution.

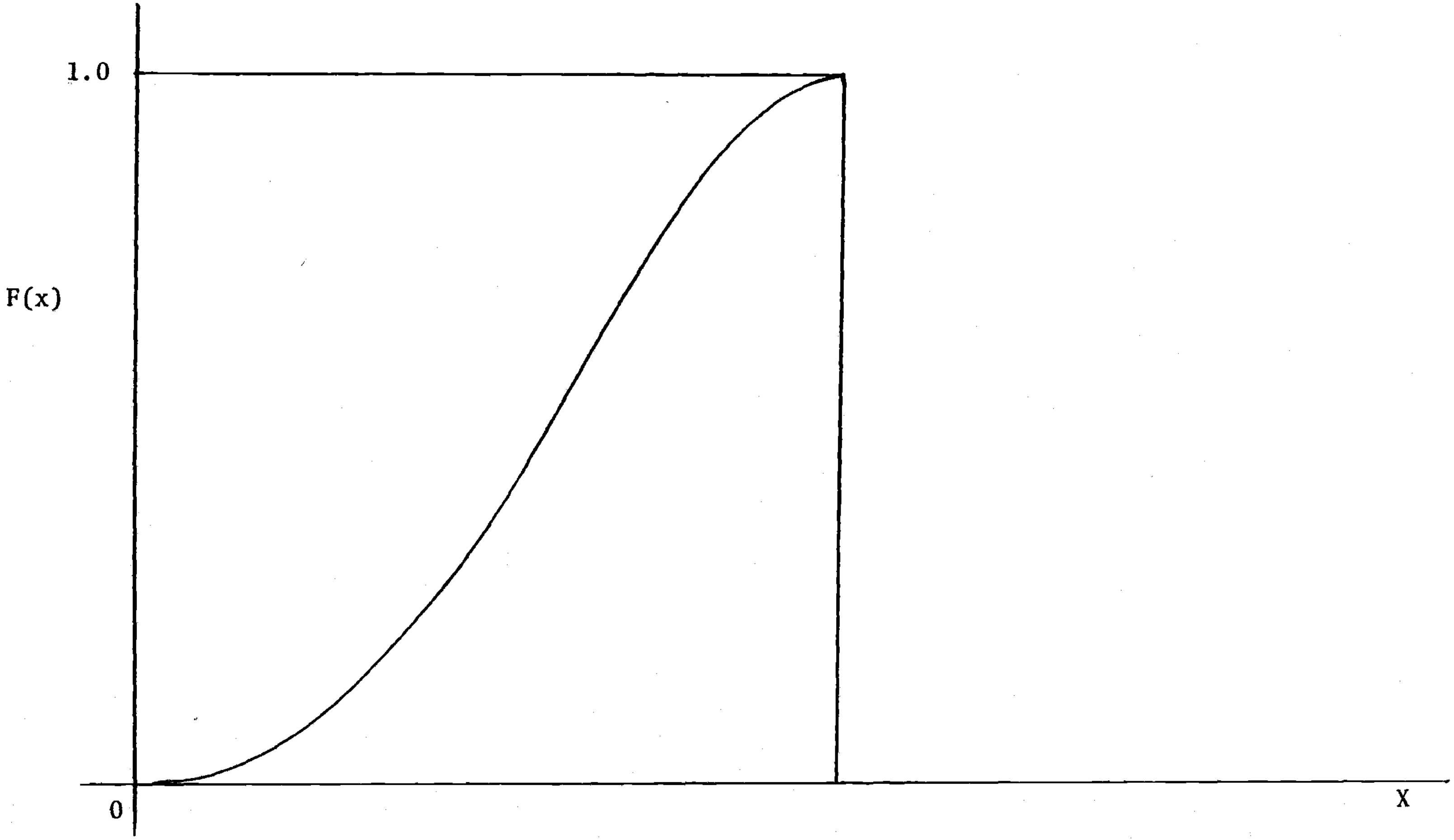

Figure 5. Cumulative probability function for a triangular distribution

The Model

The major purpose of the proposed model is to calculate cash flow requirements associated with the expanded business after the land purchase. Product prices and yields will be stochastic in nature. The probability that fixed cash commitments are not met will be calculated as well as a measure to determine the probability of firm survival. Like the net present value model discussed in Chapter II, the risk analysis model is programmed on a Hewlett-Packard 41C programmable calculator.

While the net present value model is run for the number of years in the planning horizon, it is not necessary to run the risk model for that length of time. Normally, three to five years is sufficient because it is the early years of the land purchase that repayment abilities associated with cash flow are the most critical. After the first few years, the financial position of the decision maker will improve, due to principal payments and possible appreciation in the value of land holdings.

The program will include 100 to 200 runs for each year.[4/] This will provide an adequate number of samples in obtaining the data

[4/] As mentioned in the review of literature, one disadvantage to triangular distributions is that the low and high values have a zero probability of occurring. This limitation, however, can be overcome. In this model, the first three times through the loop will draw all most likely, low and high values respectively. Even though there may exist a very small probability of these extreme events occurring, it is nevertheless necessary to consider these possibilities, particularly the low values which would decrease gross receipts and in turn decrease cash flow.

necessary to evaluate cash flow probabilities. The model is capable of paying interest on yearly cash deficits and receiving interest on yearly cash surpluses.

The formula for the risk evaluation model is:

$$TI_i = (\Sigma p_j x_j * ACR_j) + OCI - FCE - \Sigma VEC_j x_j - IPA_i = DPN - EX \quad (3.8)$$

$$YCF_i = (\Sigma p_j x_j * ACR_j) + OCI - FCE - \Sigma VEC_j x_j - APL - NCP - SET_i - FT_i - ST_i - LEW \quad (3.9)$$

$$EB = \sum_{i=1}^{I} YCF_i + BB \quad (3.10)$$

where:

TI_i - taxable income in year i,

$\Sigma p_j x_j$ - sum of price times yield for crop j,

ACR_j - acreage of crop j,

OCI - other cash income,

FCE - total fixed cash expense,

$\Sigma VEC_j x_j$ - expenses that vary with product output for each crop j,

IPA_i - yearly interest payments for all outstanding loans,

DPN - average annual depreciation,

NCP - net capital purchases, i.e., an estimate of annual capital needed to replace depreciable assets,

EX - exempt income,

APL	-	amortized payments, due on intermediate and long-term debt,
YCF_i	-	yearly net cash flow in year i,
SET_i	-	self-employment tax,
FT_i	-	federal tax,
ST_i	-	state tax,
LEW	-	annual living expenses and withdrawals,
EB	-	ending cash balance at the end of the number of years for which the program was run,
BB	-	beginning cash balance.

where:

$$EX = ND * 1,000 \tag{3.11}$$

$$SET = f(TI) \tag{3.12}$$

$$FT = f(TI) \tag{3.13}$$

$$ST = f(TI, FT) \tag{3.14}$$

where:

ND - number of dependents claimed.

The variable, other cash income (OCI), is included to allow for cash inflows that are not directly related to agricultural crop production. Examples of this include income from livestock production and non-farm income.

Total fixed cash expense (FCE) includes all cash operating expenses and cash ownership costs minus expenses that vary with agricultural production (e.g., harvesting costs). The variable VEC_j is an expense that varies directly with agricultural output. Harvesting costs are a common type of this expense.

As with the net present value model, yearly interest payments (IPA) will be deducted in determining taxable income. Average annual depreciation (DPN), although not a direct cash expense, is also a tax deductable item.

Annual net capital purchases (NCP) is included as a depreciation reserve concept. This amount represents the requirement necessary for replacement and to increase machinery purchases associated with the land purchase.

In calculating the yearly cash flow, only receipts and direct cash outflows are included. Gross receipts from agricultural production are added to other cash income. Both fixed and variable cash expenses are subsequently subtracted. Annual net capital purchases and all taxes are also subtracted. Amortized payments, consisting of both principal and interest payments, are a direct cash payment and therefore subtracted. Finally, annual living expenses are deducted to obtain the yearly cash flow figure.

Output associated with the model consists of five basic items. The first three are concerned with cash flow balances. The first output item is the average ending cash balance at the end of the number of years for which the program was run. The second item of output is the lowest cash balance obtained in any one of the repeated runs. This amount corresponds to the set of low values that were chosen.

The third output item is the highest cash balance, which corresponds to the set of high values for each price and yield distribution.

The final two items of output are associated with firm survival. The probability of a negative cash flow in the last year the program is run is given in the output. For example, if the program is run for four years, and in that fourth year the ending cash balance is negative in five of the 100 samples, the probability of a negative cash balance is .05. Lastly, the probability of bankruptcy is calculated. This is determined when the negative cash balance, in absolute value, is greater than the specified maximum exposure limit for any given year in the analysis. This limit is determined by the equation:

$$MAX = TAS - (2 * LIB) \tag{3.15}$$

where:

MAX - maximum exposure limit,

TAS - total assets of expanded farm business,

LIB - total liabilities of expanded farm business.

The maximum exposure limit, or credit reserve, is used as an approximation of what is deemed to be a critical financial position, not necessarily bankruptcy. When negative cash balances exceed the given limit, this implies that the debt-equity ratio has fallen below one (1).

One noticeable difference between the net present value model and the risk model is that net receipts are trended (either upward or downward) in the former and not in the latter. Product prices and yields, which comprise gross receipts, are deflated and detrended in the risk model to represent 1979 figures considering "real dollars." Possible inflationary trends in production costs are not considered. However, inflationary price changes are not as critical in a four-year time period as they are for 20 years.

Data Development

Gross receipts associated with agricultural prices and yields will be determined stochastically. Corresponding input data will be assumed to be triangularly distributed. The first step in developing the probability distributions was to collect price and yield series for the commodities included in each study area in Oregon. Historical prices were deflated using the Gross National Product (GNP) implicit price deflator. Both prices and yields were detrended using linear regression. The model builds average values for price and yields from the trend and intercept coefficients. The equation used is:

$$\hat{Y} = a + bT \tag{3.16}$$

where:

$\hat{Y}$ - average value for prices and yields,

a - the intercept coefficients,

b - the slope coefficient,

T - time in years.

Although the input data for the probability distributions are based on historical data, the values associated with the high, low, and most likely values in the triangular distribution will be subjective. When considering a relatively short period of time (3 to 5 years), historical data does not always give an accurate indication of product price and yield expectations. For this reason, Farm Management Extension specialists were consulted to elicit their expectations based on their expertise. In short, the probability distributions used in the model are subjective but consideration is given to historical data.

In cases where two or more crops are produced by the case firm under study, prices and yields may be correlated. Correlations are determined using historical data. The following equation is used:

$$\text{Price (A)} = a + b\,[\text{Price (B)}] + r \qquad (3.17)$$

where:

Price (A) - price of the "base" crop,

a - the intercept coefficient,

b - the slope coefficient,

Price (B) - the price of the crop used as the dependent variable,

r - the residual.

Yields are correlated using the same procedure.

The procedure operates in the following manner. A "base" crop is selected, and the triangular distribution is developed for that crop as if no correlation existed. The price or yield of each subsequent crop is determined to be a function of the base crop, using equation 3.17. The randomness associated with each "dependent" crop is determined by the residual in equation 3.17. It is the residual that will be given the values high, low, and most likely in the triangular distribution. As a result, the triangular distributions used in this model are a combination of subjective parameter estimates and correlations among prices or yields based on historical data.

Given historical data, it is possible to determine an *a priori* shape of the triangular distributions associated with product prices and yields. The distribution for yields will usually be skewed to the left. A "bumper" crop will normally not be a great deal higher than the most likely, while a crop failure will be considerably less. In this case, the most likely value lies to the right of the arithmetic mean. Figure 6 illustrates the shape of the triangular distribution for product yields. Product prices are generally the converse case of yields. Prices may fall somewhat but usually not drastically. On the other hand, the possibility exists for very high prices in a given year. Figure 7 illustrates the case of product prices, in which the most likely value lies to the left of the arithmetic mean.

Organization of Remaining Chapters

Chapter IV contains an analysis of a proposed land investment to two different dry-land wheat farms in Sherman County. The chapter

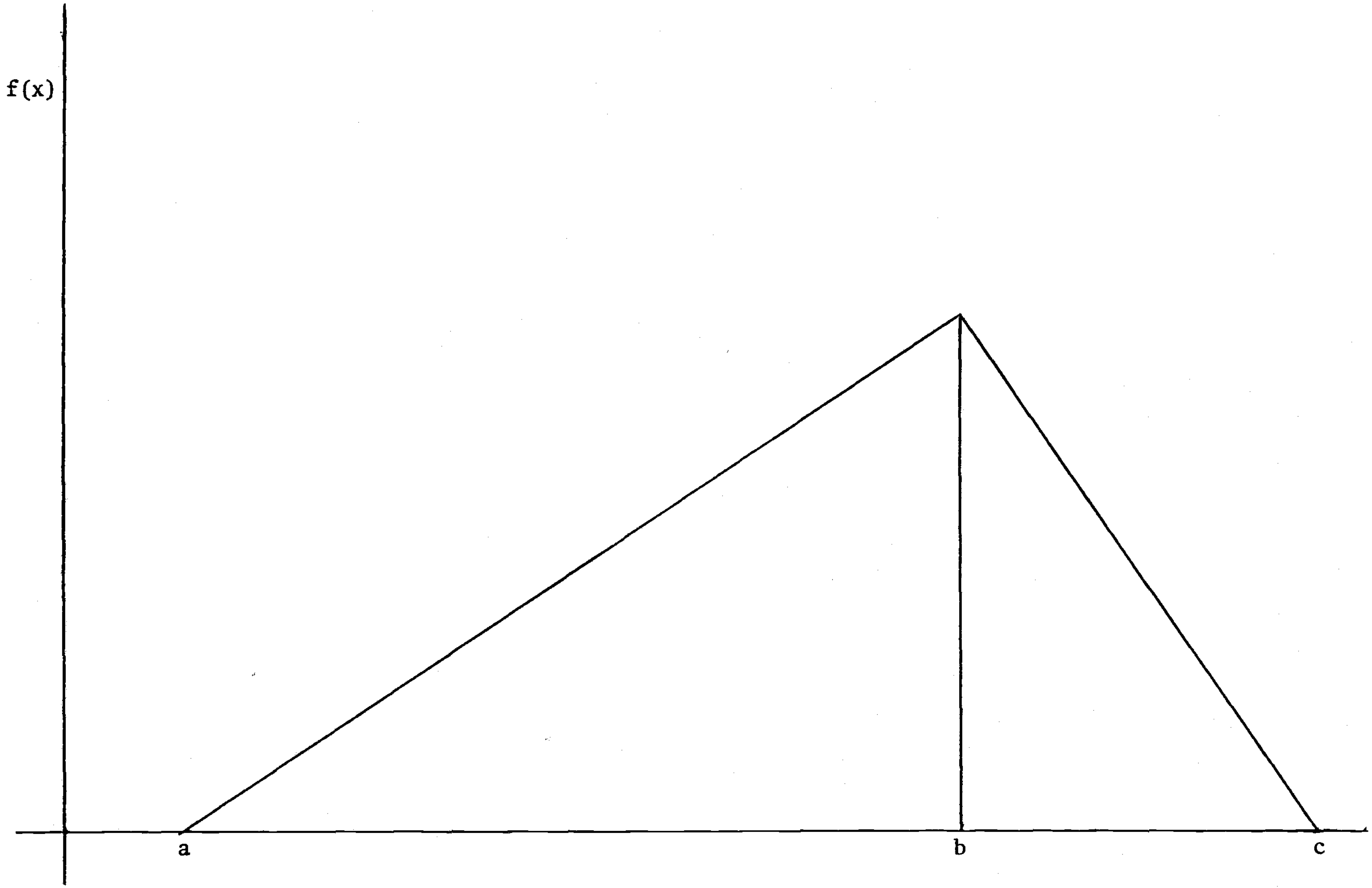

Figure 6. Expected shape of the triangular distribution for agricultural product yields.

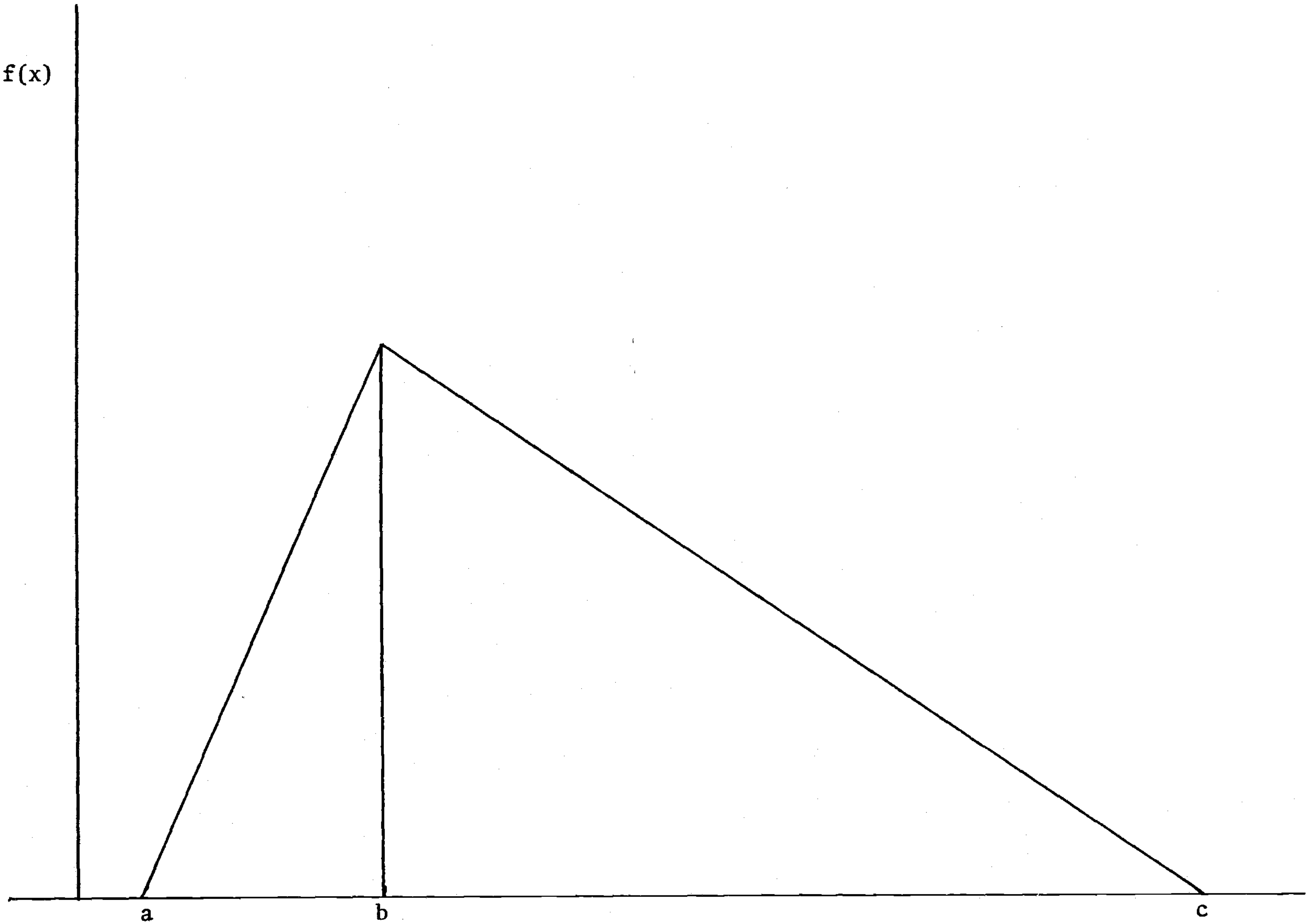

Figure 7. Expected shape of the triangular distribution for agricultural product prices.

begins with a data development section, includes a discussion of initial results and their implications, and concludes with a section on sensitivity analysis and the identification of key variables. Chapter V examines a case farm in Marion County and contains the same structural format as Chapter IV. Chapter VI summarizes the contents of this study and presents some ideas for future research.

CHAPTER IV

SHERMAN COUNTY ANALYSIS

Two case farm situations will be analyzed with regard to a proposed land purchase in this chapter. The first will be a situation where the operator owns and operates a 2,000-acre fallow wheat farm in Sherman County. In the second case, the operator is assumed to own 500 acres, and 1,500 acres are rented on a two-thirds to one-third tenant agreement. Both farms will be considering an add-on purchase of 400 acres, a 20 percent increase in the size of the current operation.

Data Development

Input data are divided into subsections in this chapter. All data are for the year 1979.

General Description and Background Information

A land value of $300 per acre is generally representative of recent sales and appraisals in Sherman County [9]. The asking price for the example purchase is assumed to be slightly higher at $310 per acre. The add-on purchase of 400 acres yields a total purchase price of $124,000. The down payment is 20 percent of the purchase price with the remaining 80 percent to be financed with amortized payment at 9.5 percent interest over 30 years. The decision maker's planning horizon is assumed to be 20 years. The discount factor, or required rate of return on equity capital after taxes, is 10 percent.

From 1973 to 1979, farmland prices in Sherman County increased at an annual average compound rate of 12.25 percent. However, recent reports [55] indicate that this upward trend may be leveling off somewhat. For this reason, the expected rate of appreciation in land values is assumed to be 9 percent for this case study.

As discussed in Chapter II, an allowance is made for an annual increase in net farm receipts in the net present value model. This is a difficult projection to make, because production costs have increased steadily in recent years while gross receipts from wheat farm operations have been somewhat variable. The average annual increase in net receipts will be assumed to be 1 percent.

Prices and Yields

Gross receipts for each case farm will equal price times yield times the number of acres in production. Sherman County wheat price and yield data for 1962-79 were collected. Prices were deflated using the Gross National Product implicit price deflator, and both prices and yields were trended with a time variable. Based on this analysis, $3.88 was found to be the expected average price of wheat. This amount is after adjusting for trends and is in 1979 dollars. The average yield is 31.4 bushels per acre after adjusting for trends. Both price and yields are projected for the next 20 years.

Gross receipts for the present business are equal to gross receipts per planted acre times the number of planted acres when considering the full ownership case. Because 1,000 acres are planted, this amount equals \$122,126. Added gross receipts per acre of the add-on is equal to one-half of \$122.13, or \$61.07.

Gross receipts for the present business are calculated in a different manner for the partial ownership case. Since the decision maker owns 500 acres, gross receipts will be \$30,532 from this portion of the farm. The tenant relationship entitles the decision maker to two-thirds of the receipts from the land that is rented. Therefore, gross receipts from the 1,500 acres that are rented are \$61,063. Total gross receipts are consequently \$91,595. Added gross receipts per acre of the add-on is identical to the full ownership case because the decision maker is entitled to all of the crop that is grown on this tract.

Agricultural product prices and yields are determined stochastically in the risk model. Subjective probabilities were estimated for the triangular probability distribution based on the data for 1962-79 and on information from Extension Farm Management specialists. The low price for wheat was estimated to be \$3.25, the high \$4.85, and the most likely value \$3.55.[5/] For yields, the low is 21 bushels per acre, the high 41, and the most likely value 32.33.

5/ The following relationship was assumed to hold between these three values and the average:

$$\text{Mean} = \frac{\text{Low + Most Likely + High}}{3} = \frac{3.25 + 3.55 + 4.85}{3} = 3.88$$

Production Costs

Enterprise cost budgets were developed to estimate production costs. These costs are listed in Table 8.

The following differences are to be noted between the full ownership case and the partial ownership case. The landlord is assumed to pay for all of the land taxes and conservation practices for the land that is being rented. In addition, the landlord pays for one-third of both fertilizer and crop insurance. As a result, the interest on operating capital is somewhat smaller than for the full ownership case.

Alternative Long-term Loans for Previous Debt Commitments

Hypothetical debt situations were constructed to represent varying debt positions. Both the net present value and risk models consider the implications of previous long-term debt commitments. The four loans used for both Sherman County case farms are summarized in Table 9. The hypothetical debt situations involve various combinations of the loans.

Other Cash Flow Requirements

The machinery debt is assumed to be one-half of the machinery investment. Net capital purchases are then calculated by subtracting the principal payment on the machinery debt from the total depreciation for the expanded business. This amount is equal to $6,000 for both case farms. The total depreciation for the expanded business equals the depreciation per planted acre times the number of planted acres, or $17,304 in both cases.

TABLE 8. Estimated Costs per Planted Acre (Including Fallow Costs) per Plant Acre for a Sherman County 2,000-Acre Dryland Wheat Farm

Item	Ownership case	Tenant case
Cash Operating Costs		
Fertilizer	5.10	3.40
Wheat seed	6.16	6.16
Herbicide and application	5.84	5.84
Diesel fuel	4.72	4.72
Gasoline	2.12	2.12
Lubricants	.95	.95
Machinery repair	7.37	7.37
Crop insurance	3.66	2.44
Conservation practices	.75	0
Hired labor	2.23	2.23
Miscellaneous	3.90	3.90
Operating capital interest	3.61	2.09
Cash Ownership Costs		
Taxes on land	5.04	0
Taxes on machinery	.37	.37
Machinery insurance	.92	.92
Other Ownership Costs		
Interest on machinery[a/]	9.49	9.49
Machinery depreciation	14.42	14.42
Operator Labor		
Operator labor	9.08	9.08

a/ Assumes that one-half of machinery owned is debt financed.

Source: Cook, Gordon H., Holst, David L., and MacNab, Sandy. "Estimated Wheat Production and Marketing Costs on a 2,000-Acre Dryland Farm, Oregon Columbia Plateau, 1979-1980." Special Report 528, Oregon State University Extension Service, November 1979.

TABLE 9. Alternative Debt Situations Associated with Both Sherman County Case Farms

Loan Number	Year	Purchase price	Number of acres purchased	Interest rate	Length of loan	Amortized payment	1979 outstanding balance
1	1973	150	300	.075	25	3,229.58	32,163.68
2	1977	260	400	.085	30	7,741.81	81,803.45
3	1977	260	500	.085	30	9,677.26	102,254.31
4	1973	150	500	.075	25	5,382.64	53,606.14

The maximum exposure limit equals total assets minus two times total liabilities. Machinery assets equal \$155,000 for both case farms. Land assets equal \$720,000 for the full ownership case and \$270,000 for the partial ownership case. Each corresponding maximum exposure is hence dependent on the hypothetical debt burden that is imposed.

In all cases, it is assumed that the decision maker is married filing a joint tax return claiming four dependents. Annual family living expenses are assumed to be \$16,000.

Net Present Value Results

Results will be first discussed for the full ownership case farm and then for the partial ownership case. In both cases, initial results will be presented followed by a sensitivity analysis and the identification of key variables.

Although the model gives a response in the form of the net present value, this information alone is of limited use to the decision maker. A positive net present value indicates a favorable investment while a negative one does not. Decision makers want to know the maximum price that can be paid for farmland. For this reason, an estimation technique is used to determine the purchase price corresponding to a net present value of zero for each of the sensitivity analysis trials.[6/] In most cases, the estimation will be within \$5 of the

6/ For determining the purchase price resulting from a net present value result, the following equation was used:

$$PP = a + b(NPV) + c(NPV)^2$$

The coefficients a, b, and c were estimated using a system of three equations. Three data points from the relationship between net present value and purchase price were used to solve the system of equations.

actual purchase price, but in some of the extreme sensitivity trials listed in Tables 12 and 15, the estimated purchase price may be in error by as much as $20.

Initial Results for Full Ownership Case

Given the input data in Table 10, the net present value was found to be $-.39, or very nearly equal to zero. In other words, under these assumptions the decision maker can bid $310 per acre for the add-on, which is $10 higher than the market price, and still earn the required 10 percent after-tax rate of return on equity capital.

The initial case is used as a starting point for determining the response of the net present value and the corresponding purchase price to the assumed input data. A sensitivity analysis was performed on the input variables. Initially, each variable, excluding the hypothetical debt situations, was changed to plus twenty percent and then minus twenty percent. These results are summarized in Table 11. However, further sensitivity analysis was conducted and is summarized in Table 12. The range over which these selected variables were examined reflects either the entire possible range (e.g., zero to 100 percent for the down payment) or a reasonably comprehensive range (e.g., zero to 15 percent for increase in land values). In all cases, values for all variables other than the one varied were fixed as specified in the initial case. All iterations assume a down payment of 20 percent.

TABLE 10. Input Data for Analysis of Net Present Value Sherman County Full Ownership Case

PP	Purchase price	310	$/A
MKT	Market price of land	300	$/A
ILV	Increase in land values	.09	Decimal
DP	Down payment	24,800	$
INT	Interest rate	.095	Decimal
L	Length of repayment period	30	Years
AR	Number of acres purchased	400	No.
N	Length of planning horizon	20	Years
DF	Discount factor[a/]	.10	Decimal
GRP	Gross receipts for present operation	122,126	$
OEP	Operating expenses for present operation [b/]	62,230	$
DEP	Depreciation for present operation	14,420	$
AGR	Gross receipts for add-on	61.07	$/A
AOE	Operating expenses for add-on [c/]	31.12	$/A
ADE	Depreciation for add-on	7.21	$/A
AOC	Opportunity cost for add-on [d/]	9.29	$/A
INR	Increase in net receipts	.01	Decimal
ND	Number of dependents claimed	4	No.
OPA	Outstanding principal for loan A	32,163.68	$
IRA	Interest rate for loan A	.075	Decimal
APA	Amortized payment for loan A	3,229.58	$
OPB	Outstanding principal for loan B	0	$
IRB	Interest rate for loan B	0	Decimal
APB	Amortized payment for loan B	0	$

TABLE 10 (continued)
Footnotes

a/ Required rate of return on equity capital after taxes.

b/ Calculated by adding cash operating costs, cash ownership costs, and interest on machinery, and multiplying this amount times the number of planted acres for the present operation.

c/ Calculated by adding cash operating costs, cash ownership costs, and interest on machinery, and dividing this amount by 2 (because only one-half of the add-on tract is planted yearly).

d/ Table 8 assumes that one-half of machinery owned is debt financed. The remaining one-half is assumed to be financed with equity capital. AOC is calculated by adding interest on equity capital (which is identical to interest on machinery) with operator labor, and dividing this amount by 2 (because only one-half of the add-on tract is planted yearly).

TABLE 11. Net Present Value Results for Sherman County
Full Ownership - Initial Sensitivity

		Net Present Value		Breakeven Purchase Price	
		% change in variable		% change in variable	
Variable		+20%	-20%	+20%	-20%
ILV	Increase in land values	65.49	-48.52	417	228
DF	Discount factor	-37.04	56.07	248	402
INR	Increase in net receipts	-.63	-.18	308	309
DP	Down payment	-5.82	5.02	300	318
N	Length of planning horizon	-8.55	7.42	295	322
L	Length of repayment period	3.62	-7.92	315	296
INT	Interest rate	-16.37	14.10	282	333
MKT	Market price of land	33.60	-34.37	365	252
AR	Number of acres purchased	-1.18	.80	307	311
PP	Purchase price	-37.94	36.82	372	248
AGR	Gross receipts for add-on	50.26	-54.12	392	219
AOE	Operating expenses for add-on	-27.36	25.79	264	352
ADE	Depreciation for add-on	-6.56	5.75	298	319
AOC	Opportunity cost for add-on	-17.45	16.67	280	337
GRP	Gross receipts for present operation	-4.64	6.97	302	321
OEP	Operating expenses for present operation	3.07	-2.86	314	305
DEP	Depreciation for present operation	.29	-1.02	310	308
AGR GRP	Gross receipts for add-on Gross receipts for present operation	34.33	-62.01	366	206
AOE OEP	Operating expenses for add-on Operating expenses for present operation	-29.83	19.83	260	342
ADE DEP	Depreciation for add-on Depreciation for present operation	-6.11	4.90	299	317

TABLE 12. Net Present Value Results for Sherman County Full Ownership - Selected Sensitivity

Variable				Net Present Value	Breakeven Purchase Price
DP	Down payment	=	0	26.43	353
			100%	-112.94	119
INR	Increase in net receipts	=	0	.32	310
			.05	-12.26	289
ILV	Increase in land values	=	0	-144.38	66
			.045	-98.54	144
			.12	122.18	509
			.15	325.96	828
INT	Interest rate	=	.06	24.95	351
			.14	-40.27	242
N	Length of planning horizon	=	5	11.70	329
			10	14.19	333
			30	-21.16	274
			35	-31.01	258
L	Length of repayment period	=	20	-16.76	282
			40	5.23	318
DF	Discount factor	=	.05	202.10	636
			.15	-69.03	194
ND	Number of dependents claimed	=	8	.42	310
			0	-1.13	307

Sensitivity Analysis and Identification of Key Variables for Full Ownership Case

Expected annual appreciation in land values (ILV) appears to be quite important in the net present value analysis. If land values increase at 15 percent, the decision maker can justify paying over $800 per acre and still receive his required rate of return on equity capital. On the other hand, if land values do not appreciate throughout the planning horizon, less than $70 can be paid for the add-on tract. The market price of land (MKT), used as the base for land appreciation, also appears to be an important variable. Increasing or decreasing this variable by 20 percent will change the purchase price by more than $50 per acre.

The discount factor (DF), or required after-tax rate of return on equity capital, is quite important as it is decreased. When the discount factor is reduced to five percent, the corresponding purchase price more than doubles. Conversely, as the discount factor is increased to 15 percent, the purchase price drops below $200 per acre, still a sizable amount. The number of acres (AR) in the proposed add-on is a relatively unimportant factor as it pertains to net present value.

The terms of financing the proposed investment appear to be fairly important. The longer the loan repayment period (L), the higher the corresponding purchase price. This results because as the repayment period is lengthened, the decision maker is able to make smaller annual payments. Smaller cash outlays in the earlier years of the planning horizon will increase net present value. The interest rate (INT) can have a large impact in the analysis. As the interest rate is increased to 14 percent, the purchase price drops by nearly $70 per acre. The down payment (DP) is relatively unimportant as it changes 20 percent either way. However, if the down payment is assumed to be 100 percent, the purchase price falls below $125 per acre. This is because a 100 percent down payment represents a cash outlay in year zero which is not discounted, rather than using an amortized schedule that repays the loan over time.

The variable, increase in net receipts (INR), gives some interesting results. Contrary to the expected outcome, increasing INR will decrease the net present value (for this case farm). The reason for this can be attributed to the following. This variable, INR, is used in the model two times; once for increasing the net receipts associated with the add-on, and for the taxable income of the present and expanded business. For this case farm, the effects of the change in annual income taxes (CHT) and capital gains tax (CGT) is greater than the effect that INR has on increasing the net receipts for the add-on tract. This is due to the progressive nature of the income tax rate structure. Although the negative relationship is noted, its impact of INR is not very significant.

The effect of the length of the planning horizon (N) on the net present value analysis is difficult to predict _a priori_. This relationship is dependent on the size of net receipts, increase in net receipts, the discount factor, and increase in land values. As N is increased from 5 to 10 years, the net present value increases slightly, but steadily decreases from that point as it is increased further.

The two variables associated with gross receipts, operating expenses, and depreciation, for the present land and the add-on normally change simultaneously. In other words, if gross receipts for the present business increases by 20 percent, gross receipts for the add-on will probably do the same. However, each variable was tested separately, and then the appropriate pairs were changed simultaneously and tested together. The variable, added gross receipts (AGR) is quite important. A 20 percent change in AGR in turn will affect the purchase price by more than $80 per acre. Added operating expenses (AOE) is not quite as important as a twenty percent change in this variable will affect the purchase price by just over $40 per acre. Added depreciation (ADE) has a relatively small impact on the net present value. Gross receipts, operating expenses, and depreciation associated with the present operation all have a relatively minor impact, as shown in Table 11. This is because these variables are used only in calculating the change in taxes (CHT).

When AGR and GRP are both increased by 20 percent, the purchase price increases by $50 per acre. However, when both AGR and GRP are decreased by 20 percent, the corresponding purchase price falls more than $100 per acre. The two variables associated with operating expenses are also relatively important. Their impact has the greatest magnitude when both variables are increased, or when net present value is decreased. Both variables associated with depreciation are of relatively small importance.

The variable, added opportunity cost (AOC), included as a measure for compensation to the decision maker's capital and labor, has a sizable impact on net present value. As AOC changes by 20 percent, the purchase price changes approximately $30.

The number of dependents claimed by the decision maker for tax purposes is of minor consequence.

The hypothetical debt condition included loan #1 in the original case. Varying this previous existing long-term commitment from one extreme to the other changed the purchase price by less than $2 per acre. When existing debt burdens are added to the net present analysis, the effect is noted in the change in taxes (CHT) between the present and expanded businesses. Because prior debt commitments are included in both the present and expanded operations, the effect tends to cancel one another when calculating CHT.

Figure 8 illustrates the sensitivity analysis for the variables, increase in land values (ILV), market price of land (MKT), purchase price (PP), and discount factor (DF). Figure 9 depicts graphically the sensitivity analysis for variables associated with costs and receipts.

Initial Results for Partial Ownership Case

Required input data for the net present value analysis for the partial ownership case is listed in Table 13. The resulting net present value was $6.81, indicating that given the same conditions as for the full ownership case, a slightly higher rate of return would be earned. Conversely, just over $320 per acre could be paid for the land and still earn 10 percent on equity capital after taxes. The net

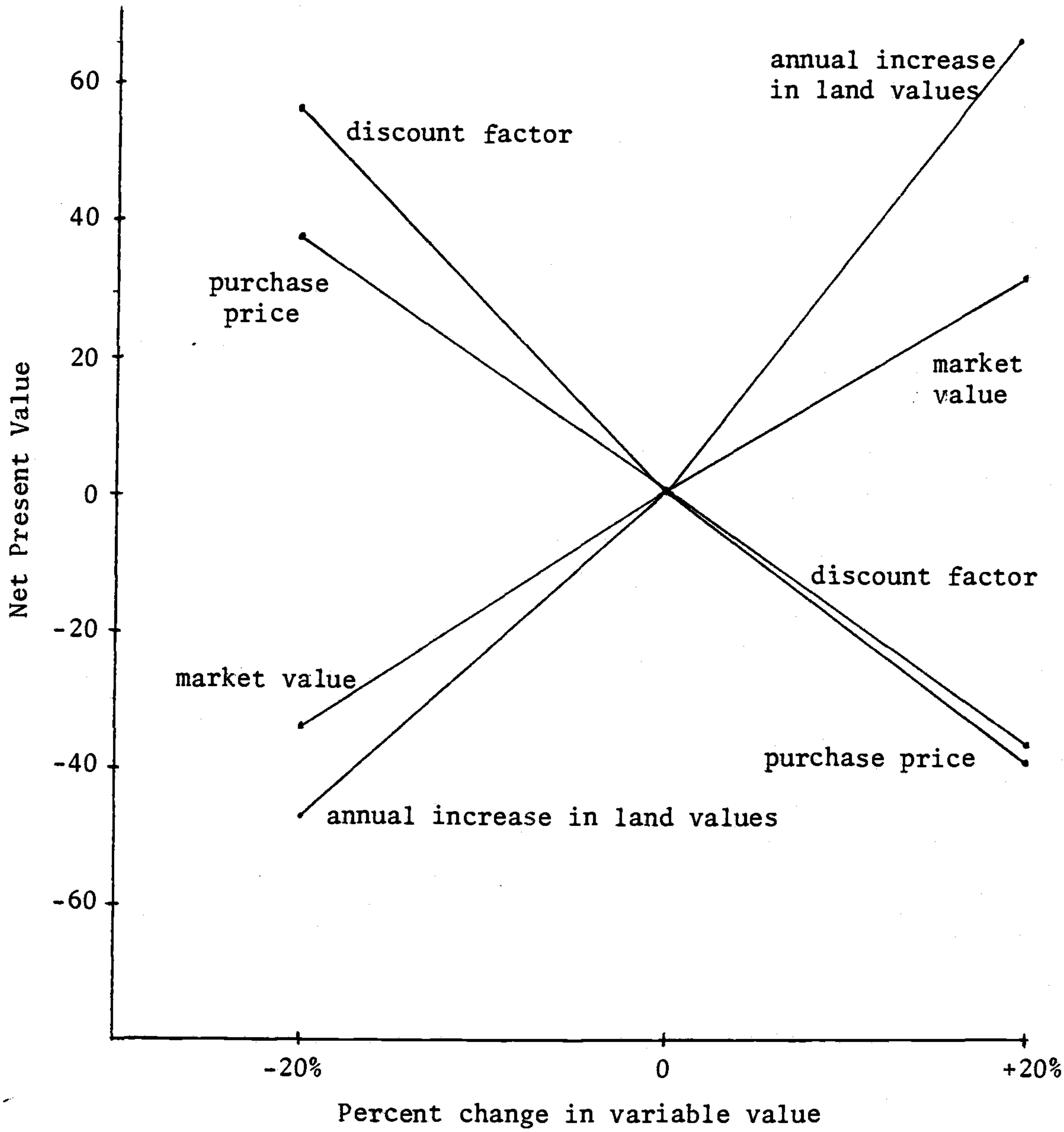

Figure 8. Sensitivity Analysis of Net Present Value Associated with Selected Variables for Sherman County Full Ownership Case

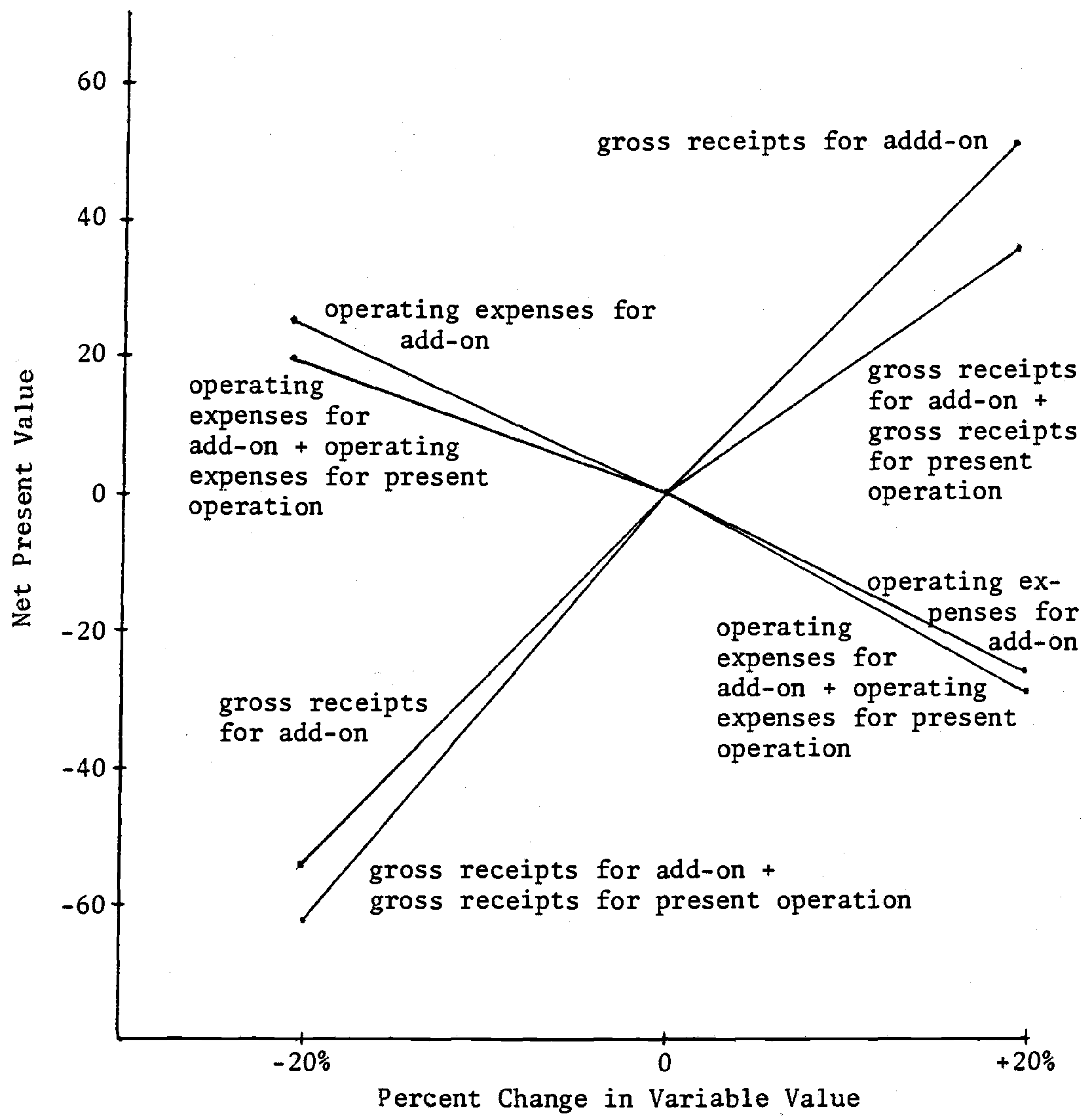

Figure 9. Sensitivity Analysis of Net Present Value Associated with Costs and Receipts for Sherman County Full Ownership Case

TABLE 13. Input Data for Analysis of Net Present Value Sherman County Partial Ownership Case

PP	Purchase price	310	$/A
MKT	Market price of land	300	$/A
ILV	Increase in land values	.09	Decimal
DP	Down payment	24,800	$
INT	Interest rate	.095	Decimal
L	Length of repayment period	30	Years
AR	Number of acres purchased	400	No.
N	Length of planning horizon	20	Years
DF	Discount factor	.10	Decimal
GRP	Gross receipts for present operation	91,595	$
OEP	Operating expenses for present operation	54.558	$
DEP	Depreciation for present operation	14,420	$
AGR	Gross receipts for add-on	61.07	$/A
AOE	Operating expenses for add-on	31.12	$/A
ADE	Depreciation for add-on	7.21	$/A
AOC	Opportunity cost for add-on	9.29	$/A
INR	Increase in net receipts	.01	Decimal
ND	Number of dependents claimed	4	No.
OPA	Outstanding principal for loan A	32,163.68	$
IRA	Interest rate for loan A	.075	Decimal
APA	Amortized payment for loan A	3,229.58	$
OPB	Outstanding principal for loan B	0	$
IRB	Interest rate for loan B	0	Decimal
APB	Amortized payment for loan B	0	$

present value is higher for the partial ownership case because the resulting change in taxes is smaller.

In order to compare whether the results for the partial ownership case were more sensitive to changes in the variable values than they were for the full ownership case, the net present value was set equal to zero (or nearly zero), which is where the full ownership case was before beginning the sensitivity analysis. This was accomplished by iteratively adjusting the increase in land values (ILV) until net present value equaled zero. The final adjustment left ILV equal to .088.

Sensitivity Analysis and Identification of Key Variables for Partial Ownership Case

Results of the sensitivity analysis performed for the partial ownership case are listed in Tables 14 and 15. Because the majority of the results are similar to the full ownership case, discussion will center on the major differences between the two case farms.

Over a very small range, the variable increase in net receipts (INR) has a positive relationship with the net present value. When INR is increased from zero to .05, net present value increases. When increased to .10, however, net present value declines markedly.

Gross receipts and operating expenses are more sensitive to change for the partial ownership case. When AGR and GRP are increased together by 20 percent, purchase price is increased by nearly $70 per acre. When both are decreased, purchase price falls to $175 per acre. The purchase price varies $40 to $60 per acre are as AOE and OEP are changed.

TABLE 14. Net Present Value Results for Sherman County Partial Ownership - Initial Sensitivity

	Variable	Net Present Value		Breakeven Purchase Price	
		% change in variable		% change in variable	
		+20%	-20%	+20%	-20%
ILV	Increase in land values	61.45	-45.84	400	243
DF	Discount factor	-36.47	55.90	257	391
INR	Increase in net receipts	.35	-.52	310	309
DP	Down payment	-4.18	4.05	304	316
N	Length of planning horizon	-8.97	8.39	297	322
L	Length of repayment period	2.87	-5.63	314	302
INT	Interest rate	-21.64	20.54	278	340
MKT	Market price of land	32.54	-32.85	357	262
AR	Number of acres purchased	-1.41	1.86	308	313
PP	Purchase price	-42.62	42.70	372	248
AGR	Gross receipts for add-on	69.22	-68.47	411	211
AOE	Operating expenses for add-on	-34.77	35.06	259	361
ADE	Depreciation for add-on	-8.12	8.00	298	322
AOC	Opportunity cost for add-on	-17.13	16.99	285	335
GRP	Gross receipts for present operation	-6.18	9.81	301	325
OEP	Operating expenses for present operation	3.00	-4.00	314	304
DEP	Depreciation for present operation	.19	-.88	310	309
AGR GRP	Gross receipts for add-on Gross receipts for present operation	47.33	-93.87	379	174
AOE OEP	Operating expenses for add-on Operating expenses for present operation	-37.22	27.27	256	350
ADE DEP	Depreciation for add-on Depreciation for present operation	-7.90	7.41	298	321

TABLE 15. Net Present Value Results for Sherman County Partial Ownership - Selected Sensitivity

Variable				Net Present Value	Breakeven Purchase Price
DP	Down payment	=	0	20.55	340
			100%	-81.13	193
INR	Increase in net receipts	=	0	-2.54	306
			.05	-.07	310
			.10	-27.85	269
ILV	Increase in land values	=	0	-140.28	108
			.045	-92.15	177
			.12	129.38	499
			.15	333.16	804
INT	Interest rate	=	.06	37.16	364
			.14	-52.76	233
N	Length of planning horizon	=	5	15.10	332
			10	17.32	335
			30	-22.10	278
			35	-32.22	263
L	Length of repayment period	=	20	-12.17	292
			40	4.06	316
DF	Discount factor	=	.05	200.42	605
			.15	-68.33	211
ND	Number of dependents claimed	=	8	1.19	312
			0	-1.25	308

As with the full ownership case, increase in land values (ILV) has the greatest effect on the net present value analysis. The terms of financing, again, are fairly important, with the interest rate being slightly more important for the partial ownership case. The discount factor is also very important when changed to levels such as .05 or .15.

Figures 10 and 11 illustrate the sensitivity analysis for selected variables that have a relatively large impact on the net present value.

Risk Results

As with the net present value analysis, results will be first discussed for the full ownership case and then for the partial ownership case. Initial results will be presented in each case and followed by a sensitivity analysis and identification of key variables. The sensitivity analysis involved changing the variables, other cash income (OCI), living expenses and withdrawals (LEW), and the hypothetical debt situation, which in turn changes the maximum exposure limit. Changing OCI and LEW is to reflect what realistically may occur immediately after a land purchase. For example, decision makers who have the opportunities to generate off-farm income or curb their standard of living will have less difficulty in meeting fixed cash commitments.

For each result obtained, two trials are generated. This is to assure consistency in the results that are stochastically determined. Each trial contains 100 runs. Because the first three to five years

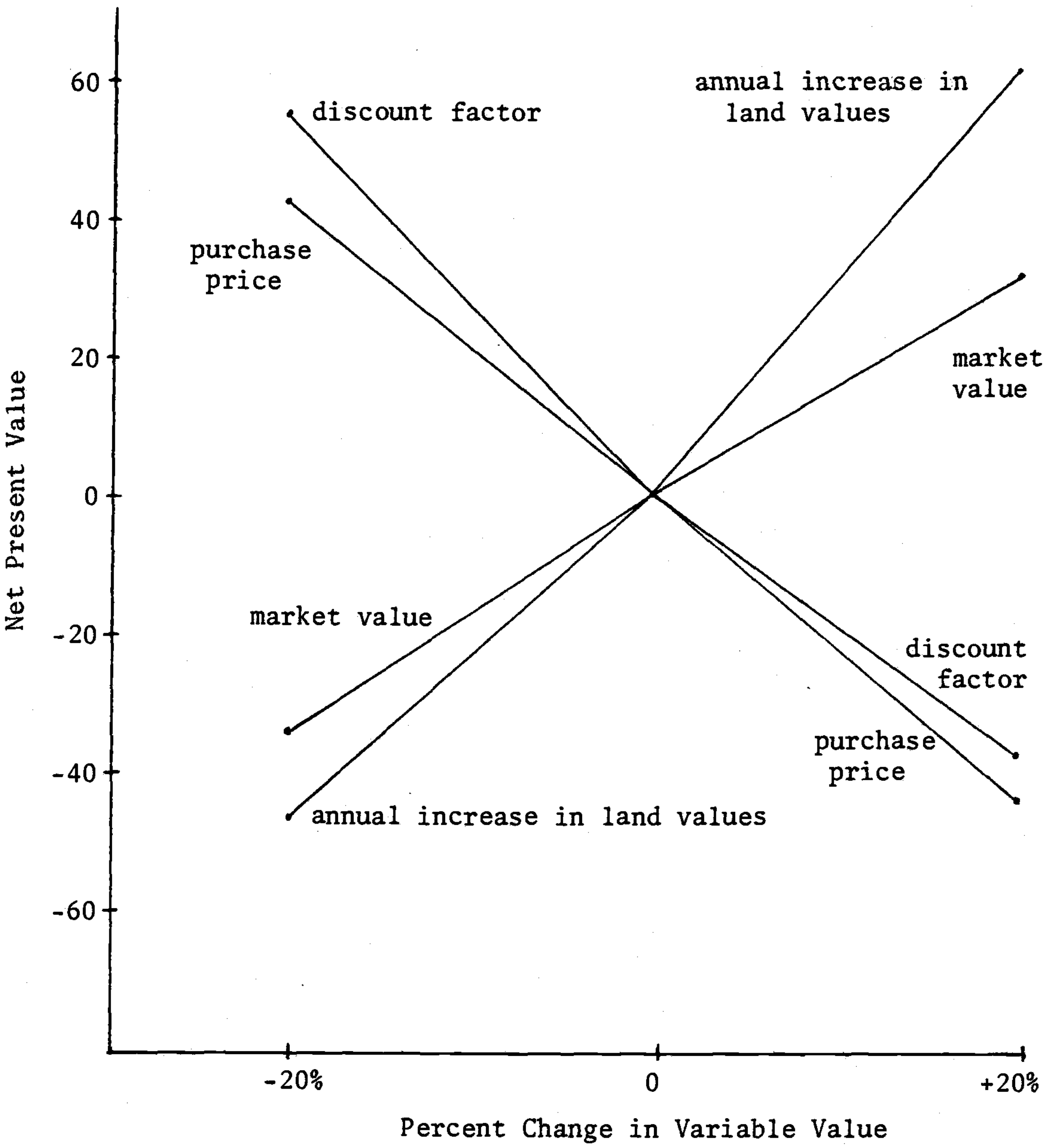

Figure 10. Sensitivity Analysis of Net Present Value Associated with Selected Variables for Sherman County Partial Ownership Case

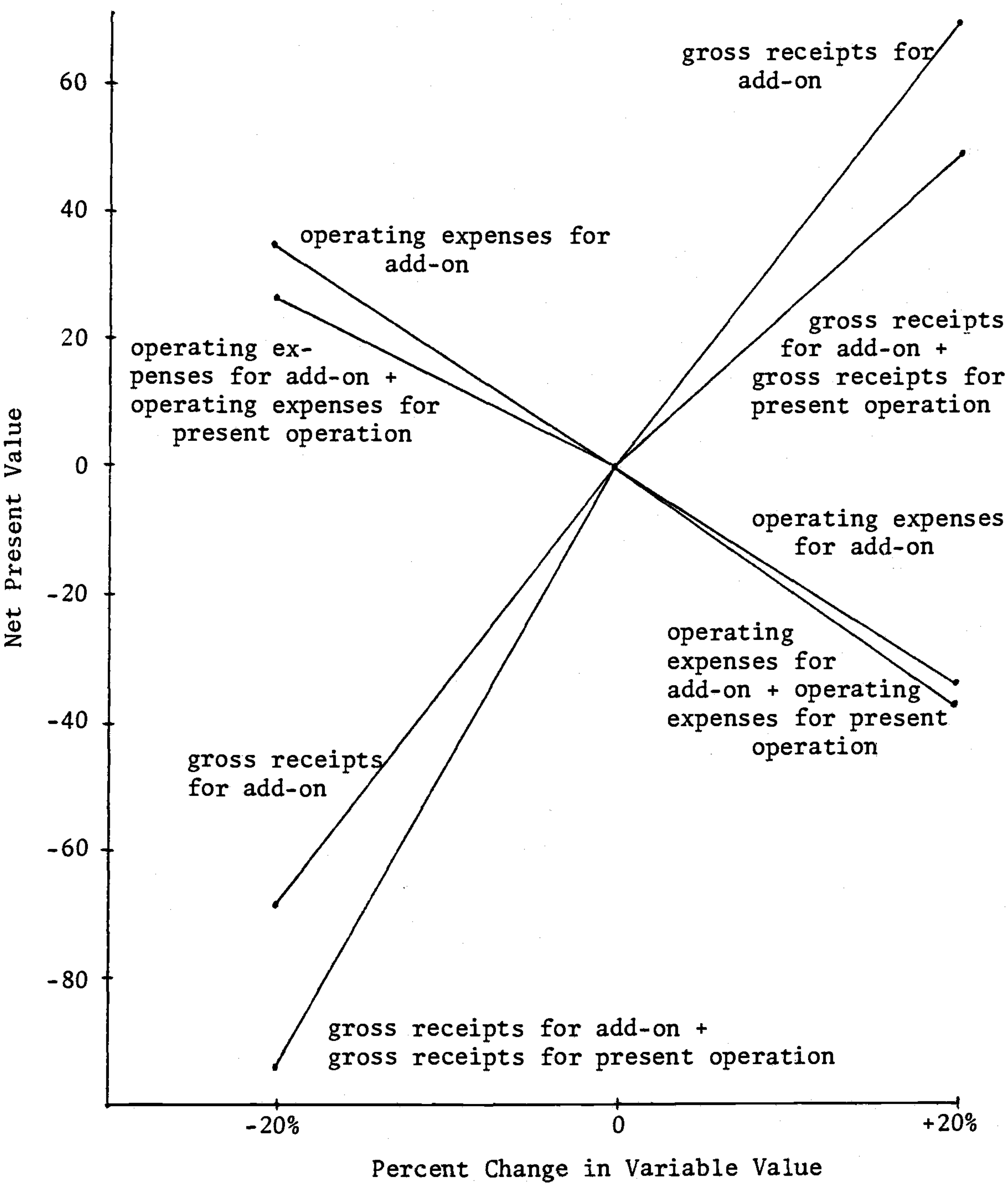

Figure 11. Sensitivity Analysis of Net Present Value Associated with Costs and Receipts for Sherman County Partial Ownership Case

following a land purchase are the most critical in terms of cash flow, each trial is run for four years. Based on the results for four years, one could expect cumulative cash balances to become more favorable over time because cash flows are summed and carried forward from year to year.

The results are viewed in terms of giving the case farm enough debt to make interpretation of the results interesting in terms of risk, yet not so much as to place the decision maker in a position to face almost certain bankruptcy.

Risk Analysis Results for Full Ownership Case

Table 16 summarizes required input data for risk analysis in the full ownership case. Loan #3 listed in Table 9 is assumed to be additional, long-term debt, beyond the machinery debt and the new debt associated with the new land purchase.

Results are listed in Table 17. Averaging the two trials will give us a 30 percent chance of a negative cash balance in the fourth year of the simulation run. If prices and yields are the most pessimistic for all four years, the decision maker will lose nearly $200,000. However, asset holdings associated with 2,400 acres of farmland valued at $300 per acre give the decision maker a high enough maximum exposure to avoid bankruptcy.

Also listed in Table 17 is the possibility of other cash income (OCI) being increased to $10,000 per year, and living expenses and withdrawals (LEW) being reduced to $14,000 per year. This situation

TABLE 16. Input Data for Risk Analysis for Sherman County Full Ownership Case

Number of runs			100	
Number of years			4	
		Lowest	Most likely	Highest
Wheat	- price	3.25	3.55	4.85
	- yield	21	32.33	41
	Acreage of Wheat		1200	
	Other cash income		0	
	Variable expense		.15	
	Total fixed cash expense		57,432	
		Outstanding principal	Interest rate	P & I payment
	Loan A	77.469.39	.1225	21,000
	Loan B	99,200	.095	10,086.71
	Loan C	102,254.31	.085	9,677.26
Interest rate paid on cash deficits			.1225	
Interest rate received on cash surpluses			.10	
Beginning cash balance (first year)			2,500	
Net capital purchases			6,000	
Living expenses and withdrawals			16,000	
Credit reserve (maximum exposure)			317,100	
Number of dependents			4	
Depreciation			17,304	

TABLE 17. Risk Results for Sherman County Full Ownership Case - Debt Load Includes Loan #3

	Trial No. 1	Trial No. 2
Average ending balance	13,141	6,219
Low balance	-197,943	-197,943
High balance	161,510	161,510
Probability of a negative cash balance	.24	.36
Probability of bankruptcy	0	0

Other cash income = 10,000
Living expenses and withdrawals = 14,000

	Trial No. 1	Trial No. 2
Average ending balance	43,078	40,977.34
Low balance	-140,381	-140,381
High balance	180,410	180,410
Probability of a negative cash balance	.03	.04
Probability of bankruptcy	0	0

brightens the cash flow outlook considerably. The average ending cash balance is $40,000 with only a 3 to 4 percent chance of a negative cash balance at the end of the fourth year.

Table 18 lists input data for an increased debt burden, which includes loans #3 and #4. Results are given by Table 19. Initial results are not favorable. There exists a better than 50 percent chance of a negative cash balance in year four. There is also a small chance of bankruptcy due to low prices and yields.

In an effort to brighten the financial picture, OCI was increased to $10,000, and LEW reduced to $14,000. These changes were enough to generate a positive cash balance and reduce the probability of a fourth year negative cash flow to six or eight percent.

Several things need to be considered when interpreting the results. First, "bankruptcy" as presented here has a specific meaning. This measure is used as a proxy for determining what could be regarded as a very unfavorable financial position, but not necessarily bankruptcy in the legal sense. Secondly, adding more debt burden will decrease yearly cash flow, but not by the amount of the amortized payment. The interest portion associated with the amortized payment results in some tax savings benefits. Other cash income (OCI) will increase yearly cash flow, but by less than the amount of OCI because this represents taxable income. Changing the value of living expenses and withdrawals (LEW) contributes directly to cash flow because it is not affected by taxes.

TABLE 18. Input Data for Risk Analysis for Sherman County Full Ownership Case with Added Debt

Number of runs	100
Number of years	4

		Lowest	Most likely	Highest
Wheat	- price	3.25	3.55	4.85
	- yield	21	32.33	41

Acreage of Wheat	1200
Other cash income	0
Variable expense	.15
Total fixed cash expense	57,432

	Outstanding principal	Interest rate	P & I payment
Loan A	77,469.39	.1225	21,000
Loan B	99,200	.095	10,086.71
Loan C	102,254.31	.085	9,677.26
Loan D	53,606.14	.075	5,382.64

Interest rate paid on cash deficits	.1225
Interest rate received on cash surpluses	.10
Beginning cash balance (first year)	2,500
Net capital purchases	6,000
Living expenses and withdrawals	16,000
Credit reserve (maximum exposure)	209,940
Number of dependents	4
Depreciation	17,304

Table 19. Risk Results for Sherman County Full Ownership Case - Debt Load Includes Loans #3 and #4

	Trial No. 1	Trial No. 2
Average ending balance	-6,819	-10,821
Low balance	-223,763	-223,763
High balance	151,042	151,042
Probability of a negative cash balance	.56	.68
Probability of bankruptcy	.01	.01

Other cash income = 10,000

Living expenses and withdrawals = 14,000

	Trial No. 1	Trial No. 2
Average ending balance	25,628	27,931
Low balance	-166,201	-166,201
High balance	170,027	170,027
Probability of a negative cash balance	.08	.06
Probability of bankruptcy	0	0

Risk Analysis Results for Partial Ownership Case

The partial ownership case represents a situation with a relatively small amount of total assets. With this in mind, the decision maker is approaching a maximum exposure of zero as a new tract of land, and consequently a new debt burden, is considered. There is little prior debt for the partial owner.

Input data are listed in Table 20. Loan #1 is added as an additional debt burden. Results of this analysis are given by Table 21. Initial results are very unfavorable. Almost certain bankruptcy is assured. The average cash balance at the end of the fourth year is at least a minus $16,000.

Imposing the same conditions that were given in the full ownership case, it was assumed that OCI were increased to $10,000 and LEW reduced to $14,000. These changes aid the decision maker's prospects greatly. Average ending cash balance is approximately $20,000, but the chance of firm failure is not reduced altogether. An eighteen percent chance of bankruptcy is predicted in one trial, and a five percent chance by the other. Although these conditions improve the financial outlook, there is still a substantial amount of risk to be considered.

Special Net Present Value Analysis:
Situation of Excess Machinery for Full Ownership Case

An initial look at the net present value results of the above examples may be misleading. Decision makers do not always purchase

TABLE 20. Input Data for Risk Analysis for Sherman County Partial Ownership Case

Number of runs			100	
Number of years			4	

		Lowest	Most likely	Highest
Wheat	- price	3.25	3.55	4.85
	- yield	21	32.33	41

Acreage of Wheat	950
Other cash income	0
Variable expense	.19
Total fixed cash expense	45.156

	Outstanding principal	Interest rate	P & I payment
Loan A	77,469.39	.1225	21,000
Loan B	99,200	.095	10,086.71
Loan C	32,163.68	.075	3,229.58

Interest rate paid on cash deficits	.1225
Interest rate received on cash surpluses	.10
Beginning cash balance (first year)	500
Net capital purchases	6,000
Living expenses and withdrawals	16,000
Credit reserve (maximum exposure)	7,335
Number of dependents	4
Depreciation	17,304

TABLE 21. Risk Results for Sherman County Partial Ownership Case - Debt Load Includes Loan #1

	Trial No. 1	Trial No. 2
Average ending balance	-16,702	-20,109
Low balance	-193,137	-193,137
High balance	125,056	125,056
Probability of a negative cash balance	.78	.81
Probability of bankruptcy	.72	.72

- -

Other cash income = 10,000

Living expenses and withdrawals = 14,000

	Trial No. 1	Trial No. 2
Average ending balance	16,907	23,437.98
Low balance	-135,574	-135,574
High balance	145,100	145,100
Probability of a negative cash balance	.18	.08
Probability of a bankruptcy	.18	.05

both machinery and land at the same time when expanding farm size. Due to financial constraints associated with cash flow requirements, the machinery and land are often purchased at different periods of time. Therefore, the decision maker who purchases the machinery before the land will experience excess machinery capacity and will probably be operating at a higher cost of production for that period of time than the farmer who does not have excess machinery capacity.

One common reason for purchasing farmland is to take advantage of any excess machinery capacity that may exist. In this example, the decision maker is assumed to currently own enough machinery to operate a 2,400 acre farm but currently owns and operates only 2,000 acres. All variables in the net present value model associated with machinery depreciation and interest on machinery debt must be changed to accommodate this situation.

The depreciation variable for the present business (DEP) is increased to $17,304 while added depreciation (ADE) is set equal to zero. Operating expenses for the present operation (OEP) are increased to reflect the interest on machinery debt and added operating expenses (AOE) are decreased for the same reason. The variable opportunity cost for the add-on (AOC) is reduced because, in this case, no opportunity cost for equity capital used for machinery purposes exists. Input data are summarized in Table 22.

The resulting net present value for this example is $104.17, which corresponds to a purchase price of approximately $450 per acre. This indicates that a decision maker who does have excess machinery capacity can pay a higher price per acre for farmland and still

TABLE 22. Input Data for Analysis of Net Present Value Sherman County Full Ownership Case with Excess Machinery Capacity

PP	Purchase price	310	$/A
MKT	Market price of land	300	$/A
ILV	Increase in land values	.09	Decimal
DP	Down payment	24,800	$
INT	Interest rate	.095	Decimal
L	Length of repayment period	30	Years
AR	Number of acres purchased	400	No.
N	Length of planning horizon	20	Years
DF	Discount factor	.10	Decimal
GRP	Gross receipts for present operation	122,126	$
OEP	Operating expenses for present operation	64,396	$
DEP	Depreciation for present operation	17,304	$
AGR	Gross receipts for add-on	61.07	$/A
AOE	Operating expenses for add-on	24.73	$/A
ADE	Depreciation for add-on	0	$/A
AOC	Opportunity cost for add-on	4.54	$/A
INR	Increase in net receipts	.01	Decimal
ND	Number of dependents claimed	4	No.
OPA	Outstanding principal for loan A	32,163.68	$
IRA	Interest rate for loan A	.075	Decimal
APA	Amortized payment for loan A	3,229.58	$
OPB	Outstanding principal for loan B	0	$
IRB	Interest rate for loan B	0	Decimal
APB	Amortized payment for loan B	0	$

receive the required rate of return on the investment. The risk implications of this analysis do not change markedly from the original case with regard to changing the operating expenses, depreciation, and opportunity cost variables associated with machinery ownership. However, paying a substantially higher price for the add-on would have the same effect on the risk analysis as increasing the hypothetical debt burden.

Conclusions

Results of a proposed farmland investment in Sherman County are somewhat mixed. Favorable results from the net present value model do not necessarily coincide with favorable results from the risk model. The results presented in this chapter verify just that. The partial ownership case had a higher net present value than the full ownership case, given comparable input data, due to a resulting smaller change in taxes (CHT). However, the partial ownership case encountered more complications in meeting cash flow requirements. In addition to the full ownership case being able to generate cash flows superior to the partial ownership case, the full ownership case is better able to handle the situation where negative cash flows are generated because of the significantly higher maximum exposure limit. For this reason, the partial ownership case with a small maximum exposure limit that generates a number of negative cash flows is highly susceptible to financial failure.

In order for a decision maker in Sherman County to pay $310 per acre for farmland and still earn an after-tax rate of return of 10 percent, land values must appreciate at an annual compound rate of nine percent over the next 20 years. Given current projections, this is questionable [55]. If land values have indeed begun to "level off," 1979 would appear to be an unfavorable time to purchase land in terms of return on investment.

Regardless of the rate of return received by the decision maker, fixed commitments associated with outstanding debt must be met. Given the results presented in this chapter, it appears that the partial ownership case farm will have problems in generating cash flow to meet these fixed debt commitments. Producers buying farmland who are most capable of generating adequate cash flow are those operating a full ownership case farm who can draw on receipts from previously owned land holdings and who can use their net worth as a credit reserve for financial cash flow shortfall.

CHAPTER V

MARION COUNTY ANALYSIS

In this chapter, one case farm will be analyzed with regard to a proposed land investment. The farm will include a decision maker owning and operating a 320-acre farm in Marion County that raises bush beans, sweet corn, and wheat. The proposed add-on land purchase is 80 acres, a 25 percent increase in the size of the current operation.

Data Development

Input data are divided into subsections in this chapter. All data are for the year 1979.

General Description and Background Information

Farmland is valued at $3,000 per acre. This price is generally representative of recent sales and appraisals in Marion County [30]. The asking price, or assumed purchase price, is $3,100 per acre. The total purchase price of the 80 acres is $248,000, with a $49,600 down payment (20 percent). The 80 percent of the purchase price that is debt financed is amortized over 30 years at 9.5 percent interest. The discount factor is assumed to be 10 percent, and the planning horizon is 20 years.

Farmland prices in Marion County increased at an annual average compound rate of 20 percent from 1973 to 1979 [30]. These are record rates of appreciation, however. The expected rate of appreciation in land values is assumed to be 9 percent over the planning horizon for this case study.

Projecting an annual increase in net receipts is no easier for Marion County than for Sherman County. The picture is complicated by the fact that three crops are being considered rather than one. Vegetable crop growers have experienced one or two years of sizable profits, but production costs continue to escalate. The average annual increase in net receipts will be assumed to be 3 percent.

Prices and Yields

It is assumed that each of the three crops constitutes one-third of the total planted acreage for the case farm, whether it be the present or expanded operation. Marion County wheat and sweet corn price and yield data for 1962-79 were collected. Bush bean data were only available for the years 1969-79 because of the change of technology from pole beans to bush beans. Like Sherman County, prices were deflated using the Gross National Product implicit price deflator and both prices and yields were detrended with a time variable. The mean price of bush beans is $150, and the average yield is 4.3 tons per acre. Sweet corn has a mean price of $60 and a mean yield of 7.7 tons per acre. The average price of wheat was found to be $3.75, while the average annual yield is 74 bushels per acre.

Gross receipts for the present business was found to be $147,680. Added gross receipts per acre of the add-on is equal to $461.50.

This amount is a weighted average of the three crops under consideration.

Subjective probabilities were estimated for each of the three crops based on the data and personal conversations with Extension Farm Management Specialists. Table 23 summarizes the values for the subjective probabilities.

Prices and yields were tested for correlation. Sweet corn was chosen as the "base crop" and correlated with bush beans and wheat using county data for the years 1969-79. The correlation coefficient was .07 between wheat and sweet corn yields, and between bean and corn yields was .32. Correlation between yields was considered to be of minor significance and is not considered in the risk analysis.

Correlation was found to exist among crop prices. The correlation coefficient was .63 between wheat and sweet corn and .89 between beans and corn. The intercept of each equation was adjusted to conform with the subjective probability values that were estimated.

$$P_W = .39 + .052\ P_C + r \tag{5.1}$$

where: P_W = price of wheat,

P_C = price of corn,

r = residual.

$$P_B = 34.5 + 1.94\ P_C + r \tag{5.2}$$

where: P_B = price of beans.

TABLE 23. Triangular Probabilities for Marion County Case Farm

Crop		Low	Most Likely	High
Bush Beans	price/ton[a/]	$123	$147	$180
	yield/acre	4 ton	4.35 ton	4.55 ton
Sweet Corn	price/ton	$46	$58	$76
	yield/acre	6.35 ton	8.1 ton	8.65 ton
Wheat	price/bushel[a/]	$3.12	$3.41	$4.72
	yield/acre	60 bu.	77 bu.	85 bu.

[a/] Although these prices were estimated to be the subjective probabilities, the correlation equation is used to estimate the prices for bush beans and wheat. The values for bush bean and wheat prices are randomly determined by the residuals that are given by the triangular distribution. The values of the residuals for bush bean and wheat prices were chosen to conform with the subjective probabilities that were estimated and summarized above.

The risk simulator will choose the price of corn randomly. Both bean and wheat prices are subsequently determined by the random corn price. The stochastic element for bean and wheat prices is provided by the residual for each. The low wheat price residual is $-.62, the high $1.34, and the most likely value $0. For bean prices, the low is $-23, the high $23, and the most likely value $0.

Production Costs

Enterprise cost budgets were developed to estimate production costs. The cost budgets were taken from 1976 studies and updated using the indices of prices paid by farmers for the appropriate categories. Bush beans and sweet corn production costs are listed in Table 24. Irrigation costs are included for these two crops. Production costs for dry-land wheat are given by Table 25.

Alternative Long-term Loans for Previous Debt Commitments

Three hypothetical loans were constructed for the Marion County case farm. The loans are used to reflect varying levels of previous long-term debt commitments. Table 26 lists the alternative loans associated with Marion County. Hypothetical debt situations imposed involve various combinations of the loans.

Other Cash Flow Requirements

The machinery debt is assumed to be one-half of the machinery investment. Net cash required for capital purchases is $4,500 per

TABLE 24. Estimated Costs per Planted Acre for Marion County Crops: Bush Beans and Sweet Corn

Item	Bush Beans	Sweet Corn
Cash Operating Costs		
Fertilizer and spreader	$68.01	$96.71
Seed	78.08	16.47
Chemicals and application	83.06	12.97
Other direct expenses	46.92	65.28
Machinery operating	19.57	22.46
Irrigation pumping	29.40	17.64
Irrigation repairs	15.86	9.52
Irrigation labor	37.24	20.95
Operating capital interest	18.90	12.83
Cash Ownership Costs		
Taxes on land	12.65	12.65
Overhead	16.51	12.10
Machinery, taxes and insurance	4.98	4.67
Other Ownership Costs		
Interest on machinery[a]	24.91	23.35
Machinery depreciation	44.84	42.03
Operator Labor		
Operator labor	23.02	21.00

a/ Assumes that one-half of machinery owned is debt-financed.

Sources: Holst, David L., A. Gene Nelson and Carl W. O'Connor. "The Economics of Producing and Marketing Soybeans in Oregon." Circular of Information 679, Agricultural Experiment Station, Oregon State University, October 1979.

U.S. Department of Agriculture. Agricultural Prices. Crop Reporting Board, ESCS, Washington, D.C., 1976-1979.

TABLE 25. Estimated Costs per Planted Acre for Marion County Dryland Wheat Farm

Item	Cost
Cash Operating Costs	
Fertilizer and spreader	$47.63
Seed	12.20
Herbicide	24.38
Insect and rodent control	.55
Lime	9.69
Machinery operating expense	21.76
Hired labor	3.46
Operating capital interest	6.72
Cash Ownership Costs	
Taxes on land	12.65
Overhead	13.34
Machinery taxes and insurance	1.47
Other Ownership Costs	
Interest on machinery[a/]	7.36
Machinery depreciation	13.24
Operator Labor	
Operator labor	9.51

a/ Assumes that one-half of machinery owned is debt-financed.

Sources: Hickerson, Hugh J. "Winter Wheat - Mid-Willamette Valley." Enterprise Cost Study, Oregon State University Extension Service, March 1976.

U.S. Department of Agriculture. Agricultural Prices. Crop Reporting Board, ESCS, Washington, D.C., 1976-1979.

TABLE 26. Alternative Long-term Debt Situations Associated with the Marion County Case Farm

Loan Number	Year	Purchase Price	Number of Acres Purchased	Interest Rate	Length of Loan	Amortized Payment	1979 Outstanding Balance
5	1973	1,000	80	.075	25	5,741.48	57,179.90
6	1975	1,500	80	.09	30	9,344.29	92,779.19
7	1977	2,000	80	.085	30	11,910.47	125,851.47

year. The total depreciation for the proposed expanded operation equals $13,348.

Land assets equal $1,200,000 for the case farm. Machinery assets are assumed to be $120,000. The maximum exposure limit is dependent on the hypothetical debt burden that is imposed.

The decision maker is assumed to be married filing a joint return claiming four dependents. Annual family living expenses equal $16,000 per year, unless otherwise noted.

Net Present Value Initial Results

Input data for the net present value analysis are listed in Table 27. The resulting net present value was found to $-.01, or almost equal to zero. The decision maker can pay $3,100 per acre for the 80 acre tract and still earn the required 10 percent after-tax rate of return on equity capital. However, land values over the next 20 years must appreciate at an annual compound rate of 9 percent for this rate of return to be earned.

Sensitivity Analysis and Identification of Key Variables

Initial sensitivity results are listed in Table 28, and selected sensitivity results are given by Table 29. Expected annual appreciation in land values (ILV) is a very important variable in the net present value analysis. Increasing ILV by 20 percent will increase the breakeven purchase price over $1,000 per acre. If ILV is equal to zero throughout the planning horizon, only slightly more than $860

TABLE 27. Input Data for Analysis of Net Present Value Marion County Case Farm

PP	Purchase price	3100	$/A
MKT	Market price of land	3000	$/A
ILV	Increase in land values	.09	Decimal
DP	Down payment	49,600	$
INT	Interest rate	.095	Decimal
L	Length of repayment period	30	Years
AR	Number of acres purchased	80	No.
N	Length of planning horizon	20	Years
DF	Discount factor	.10	Decimal
GRP	Gross receipts for present operation	147.680	$
OEP	Operating expenses for present operation	100,790	$
DEP	Depreciation for present operation	10,678	$
AGR	Gross receipts for add-on	461.50	$/A
AOE	Operating expenses for add-on	314.97	$/A
ADE	Depreciation for add-on	33.37	$/A
AOC	Opportunity cost for add-on	36.38	$/A
INR	Increase in net receipts	.03	Decimal
ND	Number of dependents claimed	4	No.
OPA	Outstanding principal for loan A	92,779.19	$
IRA	Interest rate for loan A	.09	Decimal
APA	Amortized payment for loan A	9,344.29	$
OPB	Outstanding principal for loan B	0	$
IRB	Interest rate for loan B	0	Decimal
APB	Amortized payment for loan B	0	$

TABLE 28. Net Present Value Results for Marion County Case Farm - Initial Sensitivity

		Net Present Value		Breakeven Purchase Price	
		% change in variable		% change in variable	
Variable		+20%	-20%	+20%	-20%
ILV	Increase in land values	694.44	-504.66	4,133	2,340
DF	Discount factor	-379.99	584.65	2,529	3,971
INR	Increase in net receipts	12.74	-14.33	3,119	3,079
DP	Down payment	-44.36	44.38	3,034	3,166
N	Length of planning horizon	-59.42	50.85	3,011	3,176
L	Length of repayment period	36.37	-68.99	3,154	2,997
INT	Interest rate	-202.43	186.45	2,796	3,379
MKT	Market price of land	351.01	-351.02	3,624	2,572
AR	Number of acres purchased	-4.10	5.93	3,094	3,109
PP	Purchase price	-415.17	411.79	2,475	3,714
AGR	Gross receipts for add-on	533.78	-574.24	3,895	2,235
AOE	Operating expenses for add-on	-386.62	369.42	2,519	3,651
ADE	Depreciation for add-on	-39.93	39.92	3,040	3,160
AOC	Opportunity cost for add-on	-78.37	78.36	2,982	3,217
GRP	Gross receipts for present operation	118.84	-216.76	3,278	2,775
OEP	Operating expenses for present operation	-120.21	90.60	2,920	3,236
DEP	Depreciation for present operation	-4.43	7.36	3,093	3,111
AGR GRP	Gross receipts for add-on Gross receipts for present operation	476.37	-1,183.72	3,810	1,306
AOE OEP	Operating expenses for add-on Operating expenses for present operation	-697.72	366.33	2,048	3,647
ADE DEP	Depreciation for add-on Depreciation for present operation	-45.43	46.61	3,032	3,170

TABLE 29. Net Present Value Results for Marion County Case Farm - Selected Sensitivity

	Variable			Net Present Value	Breakeven Purchase Price
DP	Down payment	=	0	218.29	3,426
			100%	-927.34	1,698
INR	Increase in net receipts	=	0	-71.90	2,992
			.05	34.06	3,151
			.10	21.32	3,132
ILV	Increase in land values	=	0	-1,472.55	862
			.045	-1,024.13	1,550
			.12	1,169.99	4,833
			.15	3,207.79	7,754
INT	Interest rate	=	.06	328.42	3,590
			.14	-506.11	2,338
N	Length of planning horizon	=	5	103.08	3,254
			10	106.81	3,260
			30	-162.21	2,857
			35	-248.19	2,727
L	Length of repayment period	=	20	-150.83	2,874
			40	50.93	3,176
DF	Discount factor	=	.05	2,095.13	6,174
			.15	-712.15	2,026
ND	Number of dependents claimed	=	8	-18.21	3,073
			0	18.92	3,128

per acre could be paid and still earn the required rate of return. The market price of land (MKT) appears to be quite important. Increasing or decreasing this variable by 20 percent will affect the purchase price by more than $500 per acre.

The discount factor (DF), or required after-tax rate of return on equity capital, is also influential in the analysis. If the decision maker is willing to accept a 5 percent return on investment, over $6,000 per acre can be paid for the farmland. On the other hand, if a 15 percent after-tax rate of return on equity capital is required, the decision maker can pay just over $2,000 per acre. The number of acres of the proposed add-on (AR) appears to be a relatively unimportant factor in the net present value analysis.

The terms of financing have a rather large impact on the analysis. As the loan repayment period (L) is lengthened, the net present value increases, but not markedly. The interest rate (INT) has a large effect on net present value as it is increased to 14 percent. Decreasing the interest rate to 6 percent increases the breakeven purchase price by nearly $500 per acre. The down payment (DP) appears to be relatively unimportant unless it is changed to extreme values. A down payment of 100 percent reduces the breakeven purchase price by nearly one-half.

Changing the assumed increase in net receipts (INR), gives some mixed results. As INR is increased from zero to .05, the purchase price increases by approximately $150 per acre. However, as INR is increased to .10, the purchase price decreases somewhat. The direction of the effect that INR has on net present value is dependent on whether the tax effects (CHT) dominate the net receipts associated with the add-on. For this case farm, the net receipts section dominates when INR is at low values, and CHT dominates as INR is increased to higher levels.

The length of the planning horizon (N) has a negative effect on net present value, i.e., as N is increased, net present value decreases. As N is increased to 35 years, the breakeven purchase price falls by nearly $400 per acre. The relationship between N and net present value depends on the size of net receipts, increase in net receipts, the discount factor, and increase in land values.

Variables associated with receipts and costs were changed in the sensitivity analysis in the same manner as they were for the Sherman County case farms. In each case, the variables were tested independently and then in pairs as was appropriate. Added gross receipts (AGR) is very important. When AGR is changed 20 percent in either direction, the breakeven purchase price is affected by $800 per acre. Added operating expenses (AOE) has a relatively large impact on the breakeven purchase price. Changing this variable by 20 percent will affect the purchase price by more than $500 per acre in either direction. Added depreciation (ADE) does not appear to be an important variable in the analysis. Gross receipts for the present operation (GRP) is fairly important, particularly when it is decreased rather than increased by 20 percent. Operating expenses and depreciation associated with the present operation have a relatively minor impact on the net present value.

When AGR and GRP are each increased by 20 percent, the breakeven purchase price increases by $700 per acre. However, when both are decreased by 20 percent, the purchase price falls to $1,300 per acre, less than one-half of the original purchase price of $3,100. The two variables associated with operating expenses, AOE and OEP, decrease the purchase price by over $1,000 per acre when increased by 20 percent and increase the purchase price by $550 per acre when decreased by 20 percent. Both variables associated with depreciation are relatively unimportant, as purchase price changes by $70 per acre as the two variables are either increased or decreased.

The variable added opportunity cost (AOC), when changed by 20 percent, will change the purchase price by just over $100 per acre in either direction.

The number of dependents claimed by the decision maker for tax purposes is not of great importance.

Sensitivity results resulting from changes in debt loads are listed in Table 30. When no prior debt is assumed to exist, the breakeven purchase price increases by $50 per acre. As the debt load is increased to include loans #6 and #7, the purchase price falls by approximately $30 per acre. The effect of previous long-term debt load is measured in the change in taxes (CHT) and is not of significant importance.

Figures 12 and 13 depict graphically the sensitivity analysis for variables that have a substantial effect on the net present value.

TABLE 30. Net Present Value Results for Marion County Case Farm - Sensitivity with Alternative Debt Situations

Includes Loans	Net Present Value	Breakeven Purchase Price
#6	0	3,100
#5 and #6	-6.10	3,091
#6 and #7	-18.88	3,072
#5 and #7	-8.35	3,087
#5	14.63	3,122
#7	-4.12	3,094
No Loans	36.22	3,154

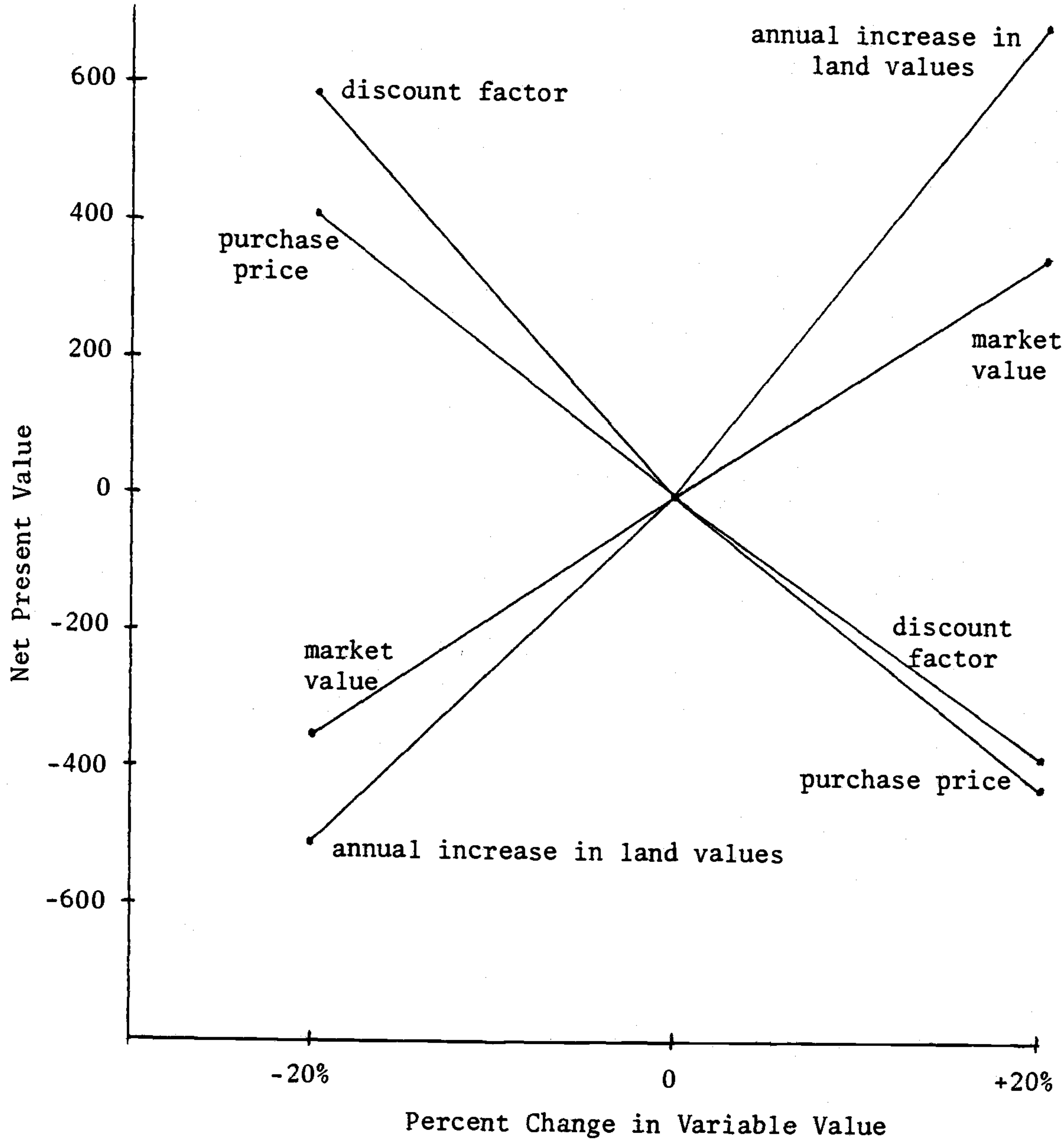

Figure 12. Sensitivity Analysis of Net Present Value Associated with Selected Variables for Marion County Case

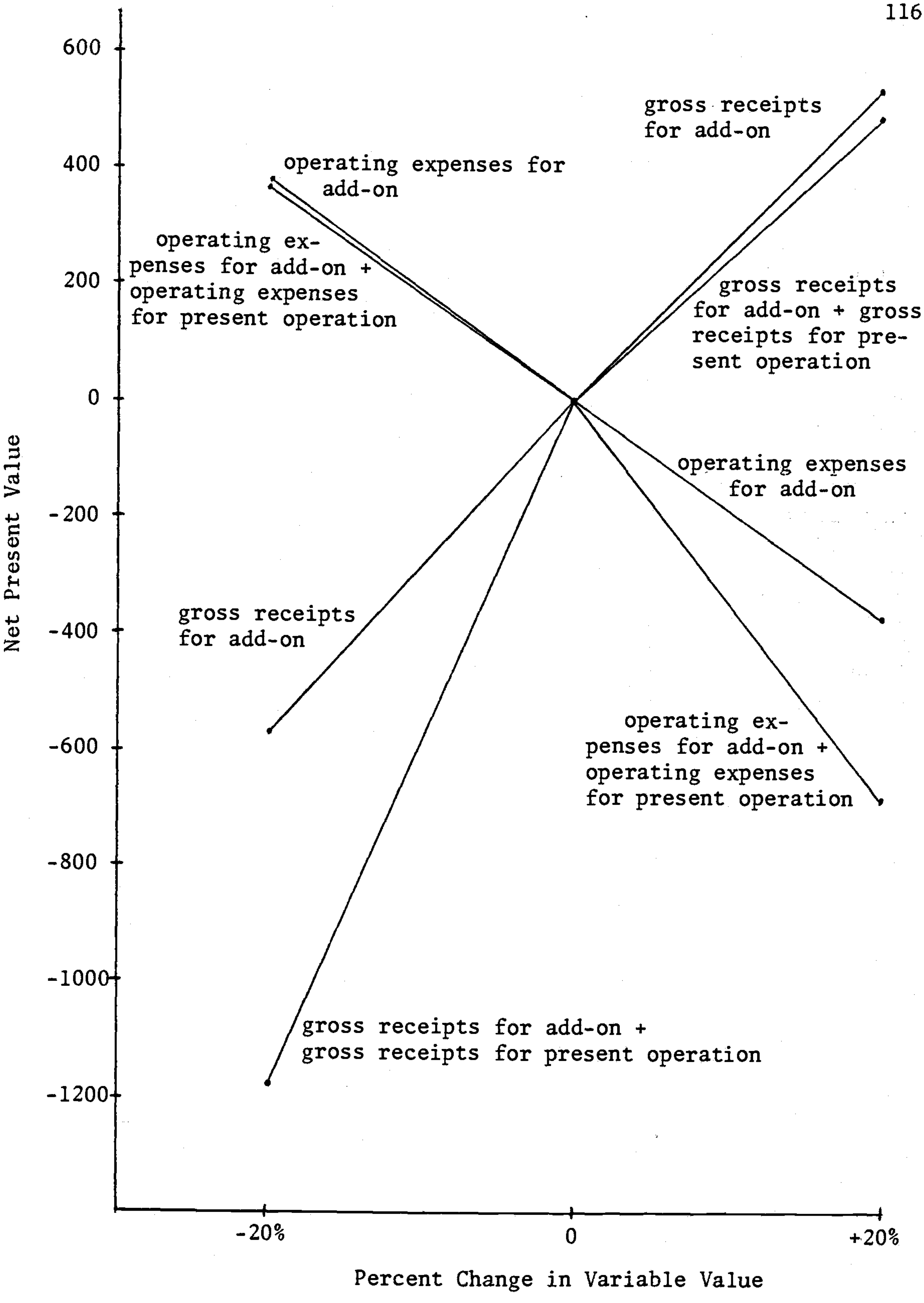

Figure 13. Sensitivity Analysis of Net Present Value Associated with Costs and Receipts for Marion County Case

Risk Analysis Results

Table 31 summarizes required input data for the Marion County case farm with no previous long-term debt load. Outstanding debt includes the machinery debt and new debt associated with the add-on purchase. Results are listed in Table 32. The average ending balance at the end of the fourth year is approximately a minus $7,000. The probability of a negative cash balance in the fourth year is greater than 50 percent, but because of the large maximum exposure limit, there is no probability of bankruptcy.

Also shown in Table 32 is the scenario for increasing other cash income (OCI) to $10,000 and decreasing living expenses and withdrawals to $14,000. Results show a considerably more favorable picture with only a 6 to 7 percent chance of a negative cash balance. The average ending cash balance is just under $30,000 at the end of the fourth year.

Table 33 indicates input data that includes loan #6. Initial results paint a poor financial picture. A negative cash balance at the end of the fourth year is almost certain, as shown in Table 34. Again, no probability for bankruptcy exists due to large asset holdings.

Also given by Table 34 is the situation where other cash income (OCI) equals $15,000, and living expenses and withdrawals (LEW) is equal to $13,000. A positive cash flow is generated at the end of four years, but the chance for a negative cash balance still exists.

TABLE 31. Input Data for Risk Analysis for Marion County Case Farm - No Prior Debt Load

Number of runs	100
Number of years	4

		Lowest	Most likely	Highest
Wheat	- price (resid.)	-.62	0	1.34
	- yield	60	77	85
Beans	- price (resid.)	-23	0	23
	- yield	4	4.35	4.55
Corn	- price	46	58	76
	- yield	6.35	8.1	8.65

	Outstanding principal	Interest rate	P & I payment
Loan A	60,000	.1225	16,528
Loan B	198,400	.095	20,173.43

Interest rate paid on cash deficits	.1225
Interest rate received on cash surpluses	.10
Beginning cash balance (year 1)	2,500
Net capital purchases	4,500
Living expense and withdrawals	16,000
Credit reserve (maximum exposure)	798,260
Acreage of Wheat	133.33
Acreage of Beans	133.33
Acreage of Corn	133.33
Other cash income	0
Total fixed cash expense	118,571
Number of dependents	4
Depreciation	13,348

TABLE 32. Risk Results for Marion County Case Farm - No Prior Debt Load

	Trial No. 1	Trial No. 2
Average ending balance	-7,342	-6,780
Low balance	-310,469	-310,469
High balance	153,588	153,588
Probability of a negative cash balance	.58	.68
Probability of bankruptcy	0	0

Other cash income = 10,000

Living expenses and withdrawals = 14,000

	Trial No. 1	Trial No. 2
Average ending balance	29,628	28,936
Low balance	-252,907	-252,907
High balance	172,750	172,750
Probability of a negative cash balance	.06	.07
Probability of bankruptcy	0	0

TABLE 33. Input Data for Risk Analysis for Marion County Case Farm - Debt Load Includes Loan #6

Number of runs	100
Number of years	4

		Lowest	Most likely	Highest
Wheat	- price (resid.)	-.62	0	1.34
	- yield	60	77	85
Beans	- price (resid.)	-23	0	23
	- yield	4	4.35	4.55
Corn	- price	46	58	76
	- yield	6.35	8.1	8.65

	Outstanding principal	Interest rate	P & I payment
Loan A	60,000	.1225	16,258
Loan B	198,400	.095	20,173.43
Loan C	92,779.19	.09	9,344.29

Interest rate paid on cash deficits	.1225
Interest rate received on cash surpluses	.10
Beginning cash balance (year 1)	2,500
Net capital purchases	4,500
Living expense and withdrawals	16,000
Credit reserve (maximum exposure)	647,642
Acreage of Wheat	133.33
Acreage of Beans	133.33
Acreage of Corn	133.33
Other cash income	0
Total fixed cash expense	118,571
Number of dependents	4
Depreciation	13,348

TABLE 34. Risk Results for Marion County Case Farm - Debt Load Includes Loan #6

	Trial No. 1	Trial No. 2
Average ending balance	-39,440	-37,609
Low balance	-355,292	-355,292
High balance	139,705	139,705
Probability of a negative cash balance	.94	.95
Probability of bankruptcy	0	0

Other cash income = 15,000

Living expenses and withdrawals = 13,000

	Trial No. 1	Trial No. 2
Average ending balance	15,583	20,057
Low balance	-268,949	-268,949
High balance	168,742	168,742
Probability of a negative cash balance	.17	.12
Probability of bankruptcy	0	0

Input data are listed in Table 35 that includes loans #6 and #7. Initially, other cash income (OCI) equals $10,000, and living expenses and withdrawals (LEW) equals $14,000. Results in Table 36 indicate a more than 90 percent chance for a negative cash flow at the end of four years. The decision maker stands to suffer a negative cash balance of over $350,000 due to low prices and yields.

Other cash income (OCI) and living expenses and withdrawals (LEW) were changed to $20,000 and $12,000, respectively. A very small average ending cash balance is generated, but a negative cash balance (in year 4) of up to 44 percent is projected. Nevertheless, the chance for firm survival appears to be good.

Conclusions

Like the results found in Sherman County, decision makers in Marion County are dependent on continued appreciation in land values in order to receive a 10 percent after-tax rate of return. Given current product prices and yields and operating costs, difficulty in meeting fixed debt commitments could very well be encountered. Results presented in this chapter indicate that income from other sources, e.g., off-farm income, is an important alternative for meeting financial obligations and avoiding cash flow problems.

The crops being considered in the Marion County case farm, particularly sweet corn and bush beans, are enterprises that contain a higher element of risk than the dry-land wheat farm cases presented in Sherman County. While the opportunity for substantial

TABLE 35. Input Data for Risk Analysis for Marion County Case Farm - Debt Load Includes Loans #6 and #7

Number of runs			100	
Number of years			4	
		Lowest	Most likely	Highest
Wheat	- price (resid.)	-.62	0	1.34
	- yield	60	77	85
Beans	- price (resid.)	-23	0	23
	- yield	4	4.35	4.55
Corn	- price	46	58	76
	- yield	6.35	8.1	8.65
		Outstanding principal	Interest rate	P & I payment
	Loan A	60,000	.1225	16,258
	Loan B	198,400	.095	20,173.43
	Loan C	92,779.19	.09	9,344.29
	Loan D	125,851.47	.085	11,910.47
Interest rate paid on cash deficits			.1225	
Interest rate received on cash surpluses			.10	
Beginning cash balance (year 1)			2,500	
Net capital purchases			4,500	
Living expense and withdrawals			14,000	
Credit reserve (maximum exposure)			395,939	
Acreage of Wheat			133.33	
Acreage of Beans			133.33	
Acreage of Corn			133.33	
Other cash income			10,000	
Total fixed cash expense			118,571	
Number of dependents			4	
Depreciation			13,348	

TABLE 36. Risk Results for Marion County Case Farm - Debt Load Includes Loans #6 and #7

Other cash income = 10,000
Living expenses and withdrawals = 14,000

	Trial No. 1	Trial No. 2
Average ending balance	-38,193	-31,074
Low balance	-354,863	-354,863
High balance	141,703	141,703
Probability of a negative cash balance	.92	.92
Probability of bankruptcy	0	0

- -

Other cash income = 20,000
Living expenses and withdrawals = 12,000

	Trial No. 1	Trial No. 2
Average ending balance	2,849	3,848
Low balance	-297,300	-297,300
High balance	161,170	161,170
Probability of a negative cash balance	.37	.44
Probability of bankruptcy	0	0

gain is present, the chance for very large losses exists as well. However, given the large asset holdings of the case farm, the probability of bankruptcy is very low.

Decision makers most capable of purchasing land would appear to be those with large asset holdings and relatively little previous long-term debt. Those who own land holdings "free and clear" are most capable of generating adequate cash flows. In addition, those decision makers capable of generating off-farm income will enhance their cash flow position.

CHAPTER VI

SUMMARY

Characteristics of Net Present Value Model

The net present value for one acre of land is different for each decision maker. Even for producers with identical receipts and costs, personal items such as tax filing status and number of dependents claimed make each case farm situation unique.

In a 1976 study, Lee and Rask found three variables to be of major importance in considering a proposed land investment decision: 1) net receipts per acre of the add-on tract, 2) annual increase in net receipts, and 3) annual appreciation in land values. Results of this study find that while costs and returns per acre and land appreciation rates are of major importance, the variable to include allowances for increases to net receipts (INR) is of minor consequence. The reason for this is the progressive nature of the tax rate structure that Lee and Rask did not take into account. INR is used to calculate the net receipts per acre and to increase the taxable income for both the present and expanded operations before calculating the change in taxes (CHT). These two effects tend to cancel one another with little change in the net present value.

One of the most distinguishable characteristics of the net present value model used in this study is concerned with the calculation of change in taxes (CHT), as opposed to assuming a constant marginal tax rate. Immediately following a land purchase, taxable income is reduced due to increased debt burdens. The tax paid by the expanded business is consequently reduced. Therefore, in the early years of the planning horizon, the years which are discounted the least, CHT will be lower than in the later years. This characteristic tends to increase the net present value.

The discount factor used in this study considers the after-tax return to equity capital rather than a weighted cost of capital approach. In general, decision makers can more easily identify with returns to their equity capital than to a weighted cost of capital approach that considers both debt and equity capital.

Another characteristic of the net present value model used in this study is the ability to handle the case where the planning horizon is shorter in years than the loan repayment period. In this case, it is assumed that the add-on purchase is sold, the loan balance repaid, and the appropriate capital gains taxes are paid at that time.

Characteristics of the Risk Model

The risk model used in this study simulates cash flows necessary to meet operating and debt expenses associated with the farm firm. Product prices and yields are determined stochastically, using the triangular probability distribution. The worst scenario of prices and yields is considered to determine the lowest cash balance possible and its effect on firm survival.

In this study, cash flows were simulated for four years because these are the most critical in a major investment decision. Output includes the average cash balance at the end of the fourth year, the low balance, high balance, the probability of a negative cash flow and the probability of bankruptcy. In all cases, the model was run 100 times in order to obtain an acceptable statistical distribution.

All tax effects are considered in the model. Operating costs, yearly interest payments, depreciation, and personal exemptions are deducted from gross income to obtain taxable income. Yearly cash flow is determined by adding gross income and deducting operating expenses, amortized payments on long-term debt, yearly net capital purchases, living expenses and withdrawals, and all taxes.

Empirical Results

Given the current costs and receipts data assumed, decision makers must rely on 9 percent land appreciation rates in order to receive a 10 percent after-tax rate of return on equity capital. Decision makers with sizable land holdings and relatively little debt appear to be the most capable of generating adequate cash flow to meet fixed commitments with an acceptable level of risk. In addition, farmers with a large net worth are more capable of handling cash flow shortfalls.

Selected results from this study are summarized in Table 37. The Sherman County full ownership case with a medium debt burden faces a 30 percent chance of a negative cash balance at the end of four years but no chance of bankruptcy. When given a heavy debt

TABLE 37. Summary of Selected Empirical Results for All Three Case Farms

	Breakeven economic purchase price	Probability of negative balance	Probability of bankruptcy
Sherman County Full Ownership			
Medium debt burden	$ 310	.30	0
Heavy debt burden	311	.62	0
Sherman County Partial Ownership			
Heavy debt burden	310	.80	.72
Heavy debt burden with increased other cash income and decreased living expenses and withdrawals.	310	.13	.12
Marion County			
Light debt burden	3,154	.63	0
Medium debt burden	3,100	.95	0

burden, the full ownership case farm has a 62 percent chance of a negative cash balance at the end of the fourth year and zero chance of bankruptcy. The partial ownership case, on the other hand, has an 80 percent chance of a negative cash balance occurring and a 72 percent chance of bankruptcy. Adding off-farm income and reducing living expenses and withdrawals improves the situation considerably, however. Results of the Marion County case farm indicate the decision maker may have problems generating adequate cash flow balances, but the probability of bankruptcy is zero. In all cases, changing hypothetical debt burdens has a relatively minor impact on the breakeven economic purchase price but has a significant effect on the risk involved with the decision maker generating adequate cash flows.

While increasing land values will aid in the net present value analysis, it will not benefit the decision maker in generating cash flow. Assuming that land values do not continue to appreciate, the decision maker capable of making debt payments could purchase the farmland and accept a lower rate of return, providing that this fit within the management objectives of the farm. In any event, the amount of risk to bear is dependent on each individual decision maker.

Application in an Extension Setting

The programmable calculator provides a method of quantifying information that previously was required to be performed on a larger computer. The programmable calculator can be easily transported to Extension clientele for "hands on" experience. The calculator can be operated with few instructions. Another advantage of the calculator is the relative low cost.

A sizable amount of data is required when considering both present and expanded businesses. However, this obstacle can be overcome with some research by the decision maker. In cases where the decision maker cannot provide adequate data, the Extension economist should be able to supply product price and yield information as well as enterprise cost studies.

The time required for the calculator to perform calculations can be a disadvantage when used in an Extension setting. The net present value model requires 15 minutes to calculate for a 20-year planning horizon. The risk model, when run for 4 years and 100 runs, takes approximately 4 hours to calculate. These time constraints can be a problem when the calculators are used at a meeting or conference. However, if the calculators are being used at the home of the decision maker, this represents a relatively small problem as the programs can be executed and operating while the decision maker is performing other activities.

Limitations of the Study

Effects of federal, state, and self-employment taxes are considered in both models used in this study. The decision maker is assumed to file a tax return using standard deductions. This serves as an approximation, because some decision makers may elect to itemize personal deductions. Investment tax credit for depreciable items is not considered in either model. Therefore, in cases where depreciable items are eligible for investment credit, taxes will be overstated. Yearly tax management is ignored, and for this reason taxes may be overstated in some cases.

The net present value model assumes that capital gains taxes are paid at the end of the planning horizon. Given income averaging possibilities that exist today, capital gains taxes will be overstated. The variables for the discount factor (DF), increase in net receipts (INR), and increase in land values (ILV) each are assumed to have the same value throughout the planning horizon. It may be desirable, for instance, in some cases to increase net receipts at one rate for the first ten years in the planning horizon and at another rate for the second ten years.

The risk model used in this study does not make an allowance for changing net receipts over time like the net present value model does. However, this is not as critical for a 4-year time period as it is for a 20-year planning horizon. The risk model does not consider possible appreciation in land values. This would have the effect of increasing the maximum exposure limit over time and giving the marginal farm firm a greater chance of survival.

Implications for Future Research

Results of the net present value model are in the form of a single value. An alternative approach would be to assign probabilistic information to critical variables, for instance appreciation in land values, and obtain a result that gave a probability of the net present value being greater than a certain amount. For example, there might be a 75 percent chance that the net present value would exceed zero for a given investment.

Changing the value of certain variables over time would add flexibility to the net present value model. For example, the decision maker may be willing to accept a lower rate of return for the first three years of the land investment.

One major disadvantage of the triangular probability distribution is that the probabilities of extreme values may not be accurately represented. Although these values can be given special attention as they are chosen for the risk model in this study, alternative functional forms should be considered for representing the probability distributions.

For each model used in this study, nearly all of the maximum storage and programming space is utilized in the programmable calculator. Therefore, given existing technology, any major revision or addition to any of the models would result in exceeding the calculator's programming capacity.

Applicability of the Analysis

Results presented in this study are to be considered as a portion of the information necessary for decision making. Farmers may use the results as a planning tool in making decisions in an uncertain world with complex interactions of economic variables over time.

However, decisions made by agricultural producers are dependent on a number of subjective factors which cannot be quantified in this analysis. The ultimate decision is based on results of this study combined with personal preferences of the farm manager.

BIBLIOGRAPHY

1. Adler, Michael. "On Risk-Adjusted Capitalization Rates and Valuation by Individuals." The Journal of Finance, Vol. XXV, No. 4, September 1970, pp. 819-835.

2. Alpin, Richard D., George L. Casler, and Cheryl P. Francis. Capital Investment Analysis Using Discounting Cash Flows. Columbus, Ohio: Grid, Inc., 1977.

3. Anderson, Jock R., John L. Dillon, and J. Brian Hardaker. Agricultural Decision Analysis. Ames: The Iowa State University Press, 1977.

4. Becker, Manning H. Professor of Agricultural and Resource Economics, Oregon State University, personal interview, April 1980.

5. Byrne, R., A. Charnes, W.W. Cooper, and K. Kortamek. "Some New Approaches to Risk." The Accounting Review, Vol. XLIII, No. 1, January 1968, pp. 18-37.

6. Carter, Eugene E. "A Simulation Approach to Investment Decision." California Management Review, Vol. XIII, No. 4, Summer 1971, pp. 18-26.

7. Cassidy, P.A., J.L. Rodgers, and W.O. McCarthy. "A Simulation Approach to Risk Assessment in Investment Analysis." Review of Marketing and Agricultural Economics, Vol. 38, No. 1, March 1970, pp. 3-24.

8. Castle, Emery N., Manning H. Becker, and Frederick J. Smith. Farm Business Management. New York: MacMillan Publishing Co., Inc., 1972.

9. Cook, Gordon H., David L. Holst, and Sandy Macnab. "Estimated Wheat Production and Marketing Costs on a 2,000-acre Dryland Farm, Oregon Columbia Plateau, 1979-80." Special Report 528, Oregon State University Extension Service, November 1979.

10. Crowley, William D. "Actual Versus Apparent Rates of Return on Farmland Investment." Agricultural Finance Review, Vol. 35, October 1974, pp. 52-57.

11. Denholm, John A. "Investment by Simulation." Journal of Management Studies, Vol. 6, No. 2, May 1969, pp. 167-180.

12. Dent, J.B., and P.F. Byrne. "Investment Planning by Monte Carlo Simulation." Review of Marketing and Agricultural Economics, Vol. 37, No. 2, June 1969, pp. 104-120.

13. Fisher, Irving. The Theory of Interest as Determined by Impatience to Spend Income and Opportunity to Invest It. New York: Sentry Press, 1965.

14. Halter, A.N., G.W. Dean. "Use of Simulation in Evaluating Management Policies Under Uncertainty: Application to a Large Scale Ranch." Journal of Farm Economics, Vol. 47, No. 3, August 1965, pp. 557-573.

15. Hardin, Mike L. "A Simulation Model for Analyzing Farm Capital Investment Alternatives." Unpublished Ph.D. dissertation, Oklahoma State University, July 1978.

16. Hein, Norlin A. "Missouri Ag Lender Letter." University of Missouri Cooperative Extension Service, August 1979.

17. Hertz, David B. "Risk Analysis in Capital Investment." Harvard Business Review, Vol. 57, No. 5, September-October 1979, pp. 169-181.

18. _____. "Investment Policies that Pay Off." Harvard Business Review, Vol. 46, No. 1, January-February 1968, pp. 96-108.

19. Hess, Sidney W. and Harry A. Quigley. "Analysis of Risk in Investments Using Monte Carlo Techniques." Chemical Engineering Progress Symposium Series: Statistics and Numerical Methods in Chemical Engineering, Vol. 59, No. 42, 1963, pp. 55-63.

20. Hickerson, Hugh J. "Winter Wheat--Mid-Willamette Valley." Enterprise Cost Study, Oregon State University Extension Service, March 1976.

21. Hillier, Frederick S. "The Derivation of Probabilistic Information for the Evaluation of Risky Investments." Management Science, Vol. 9, No. 3, April 1963, pp. 443-457.

22. Holst, David L., A. Gene Nelson, and Carl W. O'Connor. The Economics of Producing and Marketing Soybeans in Oregon." Circular of Information 679, Agricultural Experiment Station, Oregon State University, October 1979.

23. Hopkin, John A., Peter J. Barry, and C.B. Baker. Financial Management in Agriculture. Danville, Illinois: The Interstate Printers and Publishers, 1973.

24. Jones, G.T. Simulation and Business Decisions. Harmondsworth, England: Penguin Books Ltd., 1972.

25. Kennedy, Miles. "Risk in Capital Budgeting: An Interactive Sensitivity Approach." Industrial Management Review, Vol. 9, No. 3, Spring 1968, pp. 121-140.

26. Lee, Warren F., and Norman Rask. "Inflation and Crop Profitability: How Much Can Farmers Pay for Land?" American Journal of Agricultural Economics, Vol. 58, No. 5, December 1976, pp. 984-990.

27. Lee, W.F. "A Capital Budgeting Model for Evaluating Farm Real Estate Purchases." Canadian Farm Economics, Vol. 11, No. 3, June 1976, pp. 1-10.

28. Lewellen, Wilbur G., and Michael S. Long. "Simulation Versus Single-Value Estimates in Capital Expenditure Analysis." Decision Sciences, Vol. 3, No. 4, October 1972, pp. 19-33.

29. Magee, John F. "How to Use Decision Trees in Capital Investment." Harvard Business Review, Vol. 42, No. 5, September-October 1964, pp. 79-96.

30. Marion County Assessor's Office. Personal conversation with staff personnel, Salem, Oregon. April 1980.

31. McGrann, James M. and William M. Edwards. "Application of the Programmable Calculator to Extension Agricultural Management Programs: Experience from Iowa." North Central Journal of Agricultural Economics, Vol. 1, No. 2, July 1979, pp. 147-153.

32. Miles, Stanley D. County Agricultural Statistics, Economic Information Office, Department of Agricultural and Resource Economics, Oregon State University.

33. Myers, Stewart C. "Procedures for Capital Budgeting Under Uncertainty." Industrial Management Review, Vol. 9 No. 3, Spring 1968, pp. 1-19.

34. Nelson, A. Gene. "Evaluating the Financial Risk Involved in Land Investment Decisions." Cooperative Extension Service, Oregon State University. Paper presented at Extension workshop, "Dealing with Risk in Farm Decision Making." Denver, Colorado, July 11-14, 1978.

35. Nelson, Aaron G., Warren F. Lee, and William G. Murray. Agricultural Finance. Ames: The Iowa State University Press, 1973.

36. Officer, R.R., and J.R. Anderson. "Risk, Uncertainty and Farm Management Decisions." Review of Marketing and Agricultural Economics, Vol. 36, No. 1, March 1968, pp. 3-19.

37. Oregon 1979 Individual Income Tax Return. Oregon Department of Revenue, Department of Publications, Salem, Oregon.

38. Poliquen, Louis Y. Risk Analysis in Project Appraisal. World Bank Staff Occasional Paper, No. 11, Baltimore: The John Hopkins University Press, 1970.

39. Reutlinger, Shlomo. Techniques for Project Appraisal Under Conditions of Uncertainty. Work Bank Staff Occasional Paper, No. 10, Baltimore: The John Hopkins University Press, 1970.

40. Richardson James W., and Harry P. Mapp, Jr. "Use of Probabilistic Cash Flows in Analyzing Investments Under Conditions of Risk and Uncertainty." Southern Journal of Agricultural Economics, Vol. 8, No. 2, December 1976, pp. 19-24.

41. Robichek, Alexander A., and Stewart C. Myers. "Conceptual Problems in the Use of Risk-Adjusted Discount Rates." The Journal of Finance, Vol. XXI, No. 4, December 1966, pp. 727-730.

42. Salazar, Rodolfo C., and Subrata K. Sen. "A Simulation Model of Capital Budgeting Under Uncertainty." Management Science, Vol. 15, No. 4, December 1968, pp. B-161 - B-179.

43. Shapiro, Edwin. Macroeconomic Analysis. New York: Harcourt Brace Janovich, Inc., 1974.

44. Smith, Lee H. "Ranking Procedures and Subjective Probability Distributions." Management Science, Vol. 14, No. 4, December 1967, pp. B-236 - B-249.

45. Spokane Federal Land Bank District. Personal conversation with staff personnel, April 1980.

46. Sprow, Frank B. "Evaluation of Research Expenditures Using Triangular Distribution Functions and Monte Carlo Methods." Journal of Industrial and Engineering Chemistry, Vol. 59, No. 7, July 1967, pp. 35-38.

47. Sudem, Gary L. "Evaluating Capital Budgeting Methods in Simulated Environments." The Journal of Finance, Vol. XXX, No. 4, September 1975, pp. 977-992.

48. Swirles, John, and Peter A. Lusztig. "Capital Expenditure Decisions Under Uncertainty." Cost and Management, Vol. 42, No. 8, September 1968, pp. 13-19.

49. U.S. 1979 Farmer's Tax Guide. Department of the Treasury, Internal Revenue Service, Washington, D.C.: U.S. Government Printing Office.

50. U.S. 1979 Package X, Informational Copies of Federal Tax Forms. Department of the Treasury, Internal Revenue Service, Washington, D.C.: U.S. Government Printing Office.

51. U.S. Department of Agriculture. Agricultural Finance Outlook. AFO-20, Economics, Statistics, and Cooperatives Service, November 1979.

52. _____. Agricultural Prices. Crop Reporting Board, ESCS, Washington, D.C., 1976-1979.

53. _____. Agricultural Statistics. Various issues, Washington, D.C.: U.S. Government Printing Office.

54. _____. Farm Real Estate Market Developments. Various issues, Washington, D.C.

55. _____. Farm Real Estate Market Developments. Supplement No. 1 to CD-84, Washington, D.C., March 1980.

56. _____. State Farm Income Statistics. Supplement to Statistical Bulletin No. 627, Washington, D.C., October 1979.

57. U.S. Government. Economic Report of the President. Washington, D.C.: U.S. Government Printing Office, 1980.

58. Walker, Odell L. and A. Gene Nelson. "Agricultural Research and Education Related to Decision Making Under Uncertainty: An Interpretative Review of Literature." Oklahoma Agricultural Experiment Station Research Report P-747, March 1977.

59. Weston, J. Fred and Eugene F. Brigham. Essentials of Managerial Finance. Hinsdale, Illinois: The Dryden Press, 1974.

60. Willett, Gayle S. and Myron E, Wirth. "Making Land Investment Decisions." Farm Management Business Reports, EM 4384, Washington State University Cooperative Extension Service, September 1978.

61. Woods, Donald H. "Improving Estimates that Involve Uncertainty." Harvard Business Review, Vol. 44, No. 4, July-August 1966, pp. 91-98.

APPENDICES

APPENDIX A

TAX CALCULATION PROCEDURE

Federal, state, and self-employment (social security) taxes are calculated in both models, as previously discussed. It is assumed that the decision maker is married filing a joint return using 1979 tax schedules. Due to space limitations with the programmable calculator, it is not possible to calculate taxes exactly by the stepwise schedules used in actual practice. Instead, both federal and state taxes are estimated with a polynomial formula. Self-employment taxes are calculated exactly as they would be by the decision-maker.

Self-employment taxes are calculated by:

If $SETI \geq 22{,}900$, $SET = 1854.90$

If $SET < 400$, $SET = 0$

Otherwise, $SET = SETI * .081$

where:

SETI - self-employment taxable income,

SET - self-employment tax.

One disadvantage to estimating federal and state taxes with a polynomial approach is the error (or residual) incurred in the estimation. For this reason, certain criteria are employed to keep these deviations at an acceptable level. The criteria used in federal income tax estimation are two-fold:

(1) the error to be within \$20 of the actual federal income tax, <u>or</u>

(2) the error to be within 4 percent of the actual tax.

Federal taxable income is adjusted by subtracting the zero bracket amount, which is \$3,400 in the case of married filing jointly. The polynomial formula is subsequently forced through the origin. The following equation was estimated:

$$FT = .12732093\ I + .48544723\ E\text{-}05\ I^2 - .20542802\ E\text{-}10\ I^3 + .33572557\ E\text{-}16\ I^4$$

where:

FI - estimated federal tax,

I - federal taxable income minus \$3,400

Therefore, federal income tax is calculated in the following manner:

If $FTI \geq 212{,}000$, $FT = 117{,}504 + 70\% * (FTI - 212{,}000)$

For $FTI < 212{,}000$, use polynomial equation.

where:

FTI - federal taxable income.

The following equation was estimated for Oregon state taxes:

$$ST = .41121308\ E\text{-}01\ STI + .28384403\ E\text{-}05\ STI^2$$

where:

ST = Oregon state tax,

STI = Oregon state taxable income.

Oregon state income tax is calculated as follows:

If STI $\geq$ 10,000, ST = 690 + 10% * (STI - 10,000)

For STI < 10,000, use polynomial equation.

The largest error associated with the state tax estimation at any point is $5.

APPENDIX B

PROGRAM LISTINGS

Three programs were written for the Hewlett-Packard 41C. The net present value program was used in the analysis for both Sherman and Marion Counties. A different program for the risk analysis was written for each county. "RISK 1" was written for the Sherman County analysis, while "RISK 2" was used for the Marion County analysis.

```
PRP "CONTROL"

01♦LBL "CONTROL"
02 XEQ "DATA"
03 1
04 STO 00
05 XEQ "CLCINIT"

06♦LBL "TOP"
07 XEQ "INTERES"
08 RCL 81
09 STO 12
10 RCL 80
11 STO 13
12 RCL 83
13 STO 14
14 RCL 71
15 RCL 72
16 +
17 STO 18
18 XEQ "MAIN"
19 RCL 73
20 ST+ 18
21 RCL 15
22 STO 20
23 RCL 96
24 STO 12
25 RCL 95
26 STO 13
27 RCL 91
28 STO 14
29 RCL 00
30 RCL 76
31 X=Y?
32 XEQ "ADJ"
33 XEQ "MAIN"
34 RCL 85
35 RCL 00
36 X>Y?
37 XEQ "OAPN"
38 RCL 15
39 RCL 20
40 -
41 CHS
42 RCL 57
43 -
44 STO 11
45 RCL 88
46 RCL 89
47 -
48 RCL 79
49 -
50 RCL 94
51 -
52 RCL 78
53 *
54 1
55 RCL 82
56 +
57 RCL 00
58 Y↑X
59 *
60 RCL 11
61 +
62 1
63 RCL 86
64 +
65 RCL 00
66 Y↑X
67 /
68 ST+ 90
69 1
70 ST+ 00
71 RCL 76
72 RCL 00
73 X>Y?
74 GTO B
75 GTO "TOP"

76♦LBL B
77 RCL 92
78 RCL 78
79 *
80 RCL 63
81 -
82 1
83 RCL 86
84 +
85 RCL 76
86 Y↑X
87 /
88 RCL 90
89 +
90 RCL 84
91 -
92 RCL 78
93 /
94 BEEP
95 RTN
96 END

PRP "CLCINIT"

01♦LBL "CLCINIT"
02 0
03 STO 93
04 RCL 77
05 RCL 78
06 *
07 RCL 84
08 -
09 STO 70
10 RCL 60
11 1
12 +
13 RCL 85
14 Y↑X
15 1/X
16 CHS
17 1
18 +
19 1/X
20 RCL 60
21 *
22 RCL 70
23 *
24 STO 57
25 0
26 STO 90
27 RCL 79
28 RCL 78
29 *
30 RCL 83
31 +
32 STO 91
33 RCL 75
34 1
35 +
36 RCL 76
37 Y↑X
38 RCL 74
39 *
40 STO 92
41 RCL 92
42 RCL 77
43 -
44 RCL 78
45 *
46 .4
47 *
48 STO 99
49 RCL 87
50 1 E03
51 +
```

```
 52 101
 53 STO Z
 54 RDN
 55 STO IND Y
 56 RCL 88
 57 RCL 78
 58 *
 59 RCL 80
 60 +
 61 STO 95
 62 RCL 89
 63 RCL 78
 64 *
 65 RCL 81
 66 +
 67 STO 96
 68 XEQ "INIT1"
 69 RTN
 70 END
```

```
 PRP "MAIN"

 01♦LBL "MAIN"
 02 RCL 13
 03 RCL 12
 04 -
 05 RCL 14
 06 -
 07 STO 11
 08 1
 09 RCL 02
 10 +
 11 RCL 00
 12 Y↑X
 13 RCL 11
 14 *
 15 RCL 18
 16 -
 17 XEQ "CHECK"
 18 STO 16
 19 STO 03
 20 1.00201
 21 STO 05
 22 XEQ "COMPARE"

 23♦LBL "BB"
 24 RCL 10
 25 STO 17
 26 101
```

```
 27 STO Z
 28 RDN
 29 RCL IND Y
 30 CHS
 31 RCL 16
 32 +
 33 RCL 93
 34 +
 35 STO 12
 36 RCL 97
 37 -
 38 XEQ "CHECK"
 39 STO 03
 40 4.00401
 41 STO 05
 42 XEQ "COMPARE"

 43♦LBL "BB1"
 44 RCL 10
 45 STO 19
 46 RCL 16
 47 STO 03
 48 6.00701
 49 STO 05
 50 XEQ "COMPARE"

 51♦LBL "BB2"
 52 RCL 19
 53 XEQ "CHECK1"
 54 RCL 12
 55 X<>Y
 56 -
 57 RCL 10
 58 -
 59 XEQ "CHECK"
 60 STO 03
 61 9.00901
 62 STO 05
 63 XEQ "COMPARE"

 64♦LBL "BB3"
 65 RCL 10
 66 RCL 19
 67 +
 68 RCL 17
 69 +
 70 STO 15
 71 END
```

```
 PRP "COMPARE"

 01♦LBL "COMPARE"
 02 RCL 05
 03 INT
 04 STO 08
 05 RCL IND 08
 06 RCL 03
 07 X<=Y?
 08 GTO IND 08
 09 ISG 05
 10 GTO "COMPARE"
 11 RCL 05
 12 INT
 13 GTO IND X

 14♦LBL 01
 15 0
 16 STO 10
 17 RTN

 18♦LBL 02
 19 RCL 03
 20 .001
 21 *
 22 STO 10
 23 RTN

 24♦LBL 03
 25 1854.9
 26 STO 10
 27 RTN

 28♦LBL 04
 29 RCL 03
 30 STO 50
 31 1
 32 STO 51
 33 RCL 46
 34 STO 52
 35 0
 36 STO 53
 37 XEQ "POLY"
 38 RCL 53
 39 STO 10
 40 RTN

 41♦LBL 05
 42 RCL 03
 43 RCL 04
 44 -
 45 .7
```

```
46 *
47 RCL 44
48 +
49 STO 10
50 RTN

51♦LBL 06
52 RCL 54
53 STO 10
54 RTN

55♦LBL 07
56 RCL 03
57 .13
58 *
59 STO 10
60 RTN

61♦LBL 08
62 RCL 98
63 STO 10
64 RTN

65♦LBL 09
66 RCL 03
67 STO 50
68 1
69 STO 51
70 RCL 49
71 STO 52
72 0
73 STO 53
74 XEQ "POLY"
75 RCL 53
76 STO 10
77 RTN

78♦LBL 10
79 RCL 03
80 RCL 09
81 -
82 .1
83 *
84 RCL 45
85 +
86 STO 10
87 RTN
88 END
```

```
PRP "INTERES"

01♦LBL "INTERES"
02 55
03 STO 65
04 58
05 STO 67
06 61
07 STO 66
08 71
09 STO 64

10♦LBL "CALC"
11 RCL IND 66
12 XEQ "CHECK"
13 RCL IND 67
14 *
15 STO IND 64
16 RCL IND 66
17 XEQ "CHECK"
18 +
19 RCL IND 65
20 -
21 XEQ "CHECK"
22 STO IND 66
23 1
24 ST+ 65
25 ST+ 67
26 ST+ 66
27 ST+ 64
28 RCL 64
29 74
30 X≠Y?
31 GTO "CALC"
32 RTN
33 END
```

```
PRP "POLY"

01♦LBL "POLY"
02 RCL 52
03 INT
04 RCL IND X
05 RCL 50
06 RCL 51
07 Y↑X
08 *
09 ST+ 53
10 1
11 ST+ 51
12 ISG 52
13 GTO "POLY"
14 RTN
15 END
```

```
PRP "INIT1"

01♦LBL "INIT1"
02 RCL 68
03 STO 61
04 RCL 69
05 STO 62
06 RCL 70
07 STO 63
08 RTN
09 END
```

```
PRP "CHECK1"

01♦LBL "CHECK"
02 X>0?
03 RTN
04 0
05 STO Y
06 RDN
07 RTN

08♦LBL "CHECK1"
09 100
10 RCL IND X
11 RCL Z
12 X<=Y?
13 RTN
14 RCL Y
15 END
```

```
PRP "ADJ"

01♦LBL "ADJ"
02 RCL 99
03 STO 93
04 END
```

```
PRP "OAPN"

01+LBL "OAPN"
 02 0
 03 STO 57
 04 END
```

```
PRP "DATA"

01+LBL "DATA"
 02 212000
 03 STO 04
 04 117504
 05 STO 44
 06 10000
 07 STO 09
 08 690
 09 STO 45
 10 3400
 11 STO 97
 12 1050
 13 STO 54
 14 8100
 15 STO 06
 16 1500
 17 STO 98
 18 11500
 19 STO 07
 20 100
 21 ENTER↑
 22 7000
 23 STO IND Y
 24 RCL 43
 25 STO 46
 26 RCL 48
 27 STO 49
 28 .END.
```

```
PRREG

R00=  1.0000
R01=  400.0000
R02=  22,900.0000
R03=  0.0000
R04=  9.9900+99
R05=  0.0000
R06=  9.9900+99
R07=  9.9900+99
R08=  0.0000
R09=  9.9900+99
R10=  0.0000
R11=  0.0000
R12=  0.0000
R13=  0.0000
R14=  0.0000
R15=  0.0000
R16=  0.0000
R17=  0.0000
R18=  0.0000
R19=  0.0000
R20=  0.0000
R21=  0.1411
R22=  5.9043-06
R23= -2.1311-11
R24=  0.1212
R25=  6.1739-06
R26= -3.2253-11
R27=  6.5635-17
R28=  0.1270
R29=  9.7297-06
R30= -8.2474-11
R31=  2.6964-16
R32=  0.1273
R33=  4.8545-06
R34= -2.0543-11
R35=  3.3573-17
R36=  0.0416
R37=  5.5647-06
R38=  0.0411
R39=  2.8384-06
R40=  21.0230
R41=  24.0270
R42=  28.0310
R43=  32.0350
R44=  9.9900+99
R45=  9.9900+99
R46=  0.0000
R47=  36.0370
R48=  38.0390
R49=  0.0000
R50=  0.0000
R51=  0.0000
R52=  0.0000
R53=  0.0000
R54=  9.9900+99
R55=  9.9900+99
R56=  9.9900+99
R57=  0.0000
R58=  9.9900+99
R59=  9.9900+99
R60=  9.9900+99
R61=  0.0000
R62=  0.0000
R63=  0.0000
R64=  0.0000
R65=  0.0000
R66=  0.0000
R67=  0.0000
R68=  9.9900+99
R69=  9.9900+99
R70=  0.0000
R71=  0.0000
R72=  0.0000
R73=  0.0000
R74=  9.9900+99
R75=  9.9900+99
R76=  9.9900+99
R77=  9.9900+99
R78=  9.9900+99
R79=  9.9900+99
R80=  9.9900+99
R81=  9.9900+99
R82=  9.9900+99
R83=  9.9900+99
R84=  9.9900+99
R85=  9.9900+99
R86=  9.9900+99
R87=  9.9900+99
R88=  9.9900+99
R89=  9.9900+99
R90=  0.0000
R91=  0.0000
R92=  0.0000
R93=  0.0000
R94=  0.0000
R95=  0.0000
R96=  0.0000
R97=  9.9900+99
R98=  9.9900+99
R99=  0.0000
R100=  7,000.0000
R101=  0.0000
```

```
PRP "RISK 1"

01+LBL "RISK 1"
02+LBL A
03 CLRG
04 1.05201
05 STO 00
06 FIX 0

07+LBL 00
08 "MR"
09 ARCL 00
10 "⊢=?"
11 PROMPT
12 STO IND 00
13 ISG 00
14 GTO 00
15 "END ENTRIES"
16 PROMPT

17+LBL B
18 FIX 2
19 10
20 RCL 02
21 X>Y?
22 XEQ 02
23 1
24 STO 00
25 53
26 STO 73
27 XEQ 03

28+LBL 01
29 RCL 22
30 RCL 23
31 *
32 RCL 25
33 RCL 26
34 *
35 +
36 RCL 28
37 RCL 29
38 *
39 +
40 RCL 31
41 RCL 32
42 *
43 +
44 STO IND 73
45 1
46 ST+ 73
47 RCL 22
48 RCL 25
49 +
50 RCL 28
51 +
52 RCL 31
53 +
54 STO IND 73
55 1
56 RCL 23
57 +
58 RCL 22
59 *
60 RCL 24
61 -
62 STO 22
63 STO 76
64 1
65 RCL 26
66 +
67 RCL 25
68 *
69 RCL 27
70 -
71 STO 25
72 STO 77
73 1
74 RCL 29
75 +
76 RCL 28
77 *
78 RCL 30
79 -
80 STO 28
81 STO 78
82 1
83 RCL 32
84 +
85 RCL 31
86 *
87 RCL 33
88 -
89 STO 31
90 STO 79
91 RCL 76
92 X<0?
93 XEQ 04
94 XEQ 05
95 RCL 77
96 X<0?
97 XEQ 04
98 XEQ 05
99 RCL 78
100 X<0?
101 XEQ 04
102 XEQ 05
103 RCL 79
104 X<0?
105 XEQ 04
106 RCL 76
107 RCL 77
108 +
109 RCL 78
110 +
111 RCL 79
112 +
113 ST- IND 73
114 1
115 ST+ 73
116 ST+ 00
117 XEQ 03
118 RCL 00
119 10
120 X>Y?
121 GTO 01
122 GTO C

123+LBL 02
124 10
125 STO 02
126 RTN

127+LBL 03
128 22
129 STO 74
130 76
131 STO 75
132 RTN

133+LBL 04
134 0
135 STO IND 75
136 STO IND 74
137 RTN

138+LBL 05
139 1
140 ST+ 75
141 3
142 ST+ 74
143 RTN

144+LBL C
145 1
146 STO 22
```

```
147 0
148 STO 24
149 STO 25
150 STO 26
151 9999999
152 STO 27
153 CHS
154 STO 28

155♦LBL 06
156 RCL 36
157 STO 80
158 1
159 STO 23
160 4
161 STO 73
162 5
163 STO 74
164 6
165 STO 75
166 76
167 STO 33
168 53
169 STO 29
170 54
171 STO 30
172 40
173 STO 31
174 41
175 STO 32

176♦LBL 07
177 RCL 22
178 1
179 X=Y?
180 GTO 31
181 RCL 22
182 2
183 X=Y?
184 GTO 32
185 RCL 22
186 3
187 X=Y?
188 GTO 33
189 RCL 03
190 9821
191 *
192 .211327
193 +
194 FRC
195 STO 03
196 RCL IND 75
197 RCL IND 73
198 -
199 RCL IND 74
200 RCL IND 73
201 -
202 *
203 STO 80
204 RCL IND 75
205 RCL IND 73
206 -
207 RCL IND 75
208 RCL IND 74
209 -
210 *
211 STO 81
212 RCL IND 74
213 RCL IND 73
214 X↑2
215 RCL 80
216 /
217 RCL 03
218 X<=Y?
219 GTO 08
220 1
221 RCL 03
222 -
223 RCL 81
224 *
225 SQRT
226 CHS
227 RCL IND 75
228 +
229 STO IND 33
230 GTO 09

231♦LBL 08
232 RCL 03
233 RCL 80
234 *
235 SQRT
236 RCL IND 73
237 +
238 STO IND 33

239♦LBL 09
240 3
241 ST+ 73
242 ST+ 74
243 ST+ 75
244 1
245 ST+ 33
246 15
247 RCL 75
248 X>Y?
249 GTO 10
250 GTO 07

251♦LBL 31
252 RCL 05
253 STO 76
254 RCL 08
255 STO 77
256 RCL 11
257 STO 78
258 RCL 14
259 STO 79
260 GTO 10

261♦LBL 32
262 RCL 04
263 STO 76
264 RCL 07
265 STO 77
266 RCL 10
267 STO 78
268 RCL 13
269 STO 79
270 GTO 10

271♦LBL 33
272 RCL 06
273 STO 76
274 RCL 09
275 STO 77
276 RCL 12
277 STO 78
278 RCL 15
279 STO 79

280♦LBL 10
281 0
282 STO 80
283 STO 81
284 RCL 76
285 RCL 77
286 *
287 RCL 16
288 *
289 RCL 78
290 RCL 79
291 *
292 RCL 17
293 *
294 +
```

```
295 RCL 18
296 +
297 RCL 77
298 RCL 19
299 *
300 RCL 16
301 *
302 -
303 RCL 79
304 RCL 20
305 *
306 RCL 17
307 *
308 -
309 RCL 21
310 -
311 STO 73
312 0
313 RCL 80
314 X>Y?
315 XEQ 12
316 RCL 80
317 0
318 X>Y?
319 XEQ 13
320 RCL 81
321 RCL 80
322 -
323 RCL IND 29
324 +
325 STO 74
326 0
327 STO 81
328 STO 80
329 RCL 73
330 RCL 52
331 -
332 RCL 74
333 -
334 RCL IND 31
335 +
336 STO 75
337 X<0?
338 GTO 14
339 RCL 50
340 1000
341 *
342 -
343 3400
344 -
345 STO 79
346 X<0?
347 GTO 15
348 .485447 E-5
349 RCL 79
350 X↑2
351 *
352 .127321
353 RCL 79
354 *
355 +
356 .205428 E-10
357 RCL 79
358 3
359 Y↑X
360 *
361 -
362 .335726 E-16
363 RCL 79
364 4
365 Y↑X
366 *
367 +
368 STO 80
369 STO 81

370♦LBL 15
371 RCL 51
372 X=0?
373 GTO 16
374 7000
375 RCL 81
376 X>Y?
377 XEQ 17
378 .13
379 RCL 75
380 *
381 STO 79
382 1050
383 X>Y?
384 XEQ 18
385 1500
386 RCL 79
387 X>Y?
388 XEQ 19
389 RCL 75
390 RCL 81
391 -
392 RCL 79
393 -
394 1000
395 RCL 50
396 *
397 -
398 STO 79
399 X<0?
400 GTO 16
401 10000
402 X<=Y?
403 XEQ 20
404 RCL 79
405 10000
406 X>Y?
407 XEQ 21
408 RCL 76
409 X<0?
410 GTO 16

411♦LBL 11
412 .081
413 RCL 75
414 *
415 STO 77
416 2098
417 RCL 77
418 X>Y?
419 XEQ 22
420 RCL 77
421 X<0?
422 XEQ 23
423 RCL 80
424 RCL 76
425 +
426 RCL 77
427 +
428 STO 78
429 RCL 73
430 RCL 74
431 -
432 RCL IND 31
433 +
434 RCL IND 32
435 +
436 RCL 78
437 -
438 RCL 38
439 -
440 RCL 37
441 -
442 RCL IND 30
443 -
444 ST+ 80
445 RCL 80
446 RCL 39
447 CHS
448 X>Y?
```

```
449 XEQ 24
450 1
451 ST+ 23
452 RCL 02
453 RCL 23
454 X>Y?
455 GTO D
456 2
457 ST+ 29
458 ST+ 30
459 ST+ 31
460 ST+ 32
461 4
462 STO 73
463 5
464 STO 74
465 6
466 STO 75
467 76
468 STO 33
469 GTO 07

470♦LBL 12
471 RCL 80
472 RCL 35
473 *
474 STO 00
475 RTN

476♦LBL 13
477 RCL 80
478 CHS
479 RCL 34
480 *
481 STO 81
482 RTN

483♦LBL 14
484 0
485 STO 00
486 STO 76
487 GTO 11

488♦LBL 16
489 0
490 STO 76
491 GTO 11

492♦LBL 17
493 7000
494 STO 81
495 RTN

496♦LBL 18
497 1050
498 STO 79
499 RTN

500♦LBL 19
501 1500
502 STO 79
503 RTN

504♦LBL 20
505 .1
506 RCL 79
507 *
508 310
509 -
510 STO 76
511 RTN

512♦LBL 21
513 .0411213
514 RCL 79
515 *
516 .283844 E-5
517 RCL 79
518 X↑2
519 *
520 +
521 STO 76
522 RTN

523♦LBL 22
524 2098
525 STO 77
526 RTN

527♦LBL 23
528 0
529 STO 77
530 RTN

531♦LBL 24
532 1
533 STO 82
534 RTN

535♦LBL D
536 RCL 80
537 X<0?
538 XEQ 25
539 RCL 80
540 ST+ 26
541 RCL 80
542 RCL 27
543 X>Y?
544 XEQ 26
545 RCL 28
546 RCL 80
547 X>Y?
548 XEQ 27
549 RCL 82
550 X>0?
551 XEQ 28
552 0
553 STO 82
554 "END RUN"
555 "├"
556 ARCL 22
557 AVIEW
558 1
559 ST+ 22
560 RCL 01
561 RCL 22
562 X>Y?
563 GTO 29
564 GTO 06

565♦LBL 25
566 1
567 ST+ 24
568 RTN

569♦LBL 26
570 RCL 80
571 STO 27
572 RTN

573♦LBL 27
574 RCL 80
575 STO 28
576 RTN

577♦LBL 28
578 1
579 ST+ 25
580 RTN

581♦LBL 29
582 BEEP
583 RCL 26
584 RCL 01
585 /
586 "AEB="
587 "├"
```

```
ARCL X
PROMPT
RCL 27
"LBAL="
"├"
ARCL X
PROMPT
RCL 28
"HBAL="
"├"
ARCL X
PROMPT
RCL 24
RCL 01
/
"P NB="
"├"
ARCL X
PROMPT
RCL 25
RCL 01
/
"P BKO="
"├"
ARCL X
PROMPT
"ADD RUNS?"
PROMPT
X>0?
GTO 30
"END"
PROMPT

♦LBL 30
ST+ 01
GTO 06
.END.
```

```
PRP "RISK 2"

01+LBL "RISK 2"
02+LBL A
03 CLRG
04 1.05001
05 STO 00
06 FIX 0

07+LBL 00
08 "MR"
09 ARCL 00
10 "├=?"
11 PROMPT
12 STO IND 00
13 ISG 00
14 GTO 00
15 "END ENTRIES"
16 PROMPT

17+LBL B
18 FIX 2
19 1
20 STO 00
21 53
22 STO 73
23 XEQ 03

24+LBL 01
25 RCL 22
26 RCL 23
27 *
28 RCL 25
29 RCL 26
30 *
31 +
32 RCL 28
33 RCL 29
34 *
35 +
36 RCL 31
37 RCL 32
38 *
39 +
40 STO IND 73
41 1
42 ST+ 73
43 RCL 22
44 RCL 25
45 +
46 RCL 28
47 +
48 RCL 31
49 +
50 STO IND 73
51 1
52 RCL 23
53 +
54 RCL 22
55 *
56 RCL 24
57 -
58 STO 22
59 STO 76
60 1
61 RCL 26
62 +
63 RCL 25
64 *
65 RCL 27
66 -
67 STO 25
68 STO 77
69 1
70 RCL 29
71 +
72 RCL 28
73 *
74 RCL 30
75 -
76 STO 28
77 STO 78
78 1
79 RCL 32
80 +
81 RCL 31
82 *
83 RCL 33
84 -
85 STO 31
86 STO 79
87 RCL 76
88 X<0?
89 XEQ 04
90 XEQ 05
91 RCL 77
92 X<0?
93 XEQ 04
94 XEQ 05
95 RCL 78
96 X<0?
97 XEQ 04
98 XEQ 05
99 RCL 79
100 X<0?
101 XEQ 04
102 RCL 76
103 RCL 77
104 +
105 RCL 78
106 +
107 RCL 79
108 +
109 ST- IND 73
110 1
111 ST+ 73
112 ST+ 00
113 XEQ 03
114 RCL 00
115 10
116 X>Y?
117 GTO 01
118 GTO C

119+LBL 03
120 22
121 STO 74
122 76
123 STO 75
124 RTN

125+LBL 04
126 0
127 STO IND 75
128 STO IND 74
129 RTN

130+LBL 05
131 1
132 ST+ 75
133 3
134 ST+ 74
135 RTN

136+LBL C
137 1
138 STO 22
139 0
140 STO 24
141 STO 25
142 STO 26
143 9999999
144 STO 27
145 CHS
146 STO 28
```

```
147♦LBL 06
148 RCL 36
149 STO 51
150 1
151 STO 23
152 4
153 STO 73
154 5
155 STO 74
156 6
157 STO 75
158 76
159 STO 33
160 53
161 STO 29
162 54
163 STO 30

164♦LBL 07
165 RCL 22
166 1
167 X=Y?
168 GTO 31
169 RCL 22
170 2
171 X=Y?
172 GTO 32
173 RCL 22
174 3
175 X=Y?
176 GTO 33
177 RCL 03
178 9821
179 *
180 .211327
181 +
182 FRC
183 STO 03
184 RCL IND 75
185 RCL IND 73
186 -
187 RCL IND 74
188 RCL IND 73
189 -
190 *
191 STO 00
192 RCL IND 75
193 RCL IND 73
194 -
195 RCL IND 75
196 RCL IND 74
197 -
198 *
199 STO 52
200 RCL IND 74
201 RCL IND 73
202 X↑2
203 RCL 00
204 /
205 RCL 03
206 X<=Y?
207 GTO 08
208 1
209 RCL 03
210 -
211 RCL 52
212 *
213 SQRT
214 CHS
215 RCL IND 75
216 +
217 STO IND 33
218 GTO 09

219♦LBL 08
220 RCL 03
221 RCL 00
222 *
223 SQRT
224 RCL IND 73
225 +
226 STO IND 33

227♦LBL 09
228 3
229 ST+ 73
230 ST+ 74
231 ST+ 75
232 1
233 ST+ 33
234 21
235 RCL 75
236 X>Y?
237 GTO 10
238 GTO 07

239♦LBL 31
240 RCL 05
241 STO 76
242 RCL 08
243 STO 77
244 RCL 11
245 STO 78
246 RCL 14
247 STO 79
248 RCL 17
249 STO 80
250 RCL 20
251 STO 81
252 GTO 10

253♦LBL 32
254 RCL 04
255 STO 76
256 RCL 07
257 STO 77
258 RCL 10
259 STO 78
260 RCL 13
261 STO 79
262 RCL 16
263 STO 80
264 RCL 19
265 STO 81
266 GTO 10

267♦LBL 33
268 RCL 06
269 STO 76
270 RCL 09
271 STO 77
272 RCL 12
273 STO 78
274 RCL 15
275 STO 79
276 RCL 18
277 STO 80
278 RCL 21
279 STO 81

280♦LBL 10
281 0
282 STO 00
283 STO 52
284 RCL 80
285 .052
286 *
287 .39
288 +
289 RCL 76
290 +
291 RCL 77
292 *
293 RCL 40
294 *
295 RCL 80
296 1.94
297 *
```

```
298 34.5
299 +
300 RCL 78
301 +
302 RCL 79
303 *
304 RCL 41
305 *
306 +
307 RCL 80
308 RCL 81
309 *
310 RCL 42
311 *
312 +
313 RCL 43
314 +
315 RCL 44
316 RCL 77
317 *
318 RCL 40
319 *
320 -
321 RCL 45
322 RCL 79
323 *
324 RCL 41
325 *
326 -
327 RCL 46
328 RCL 81
329 *
330 RCL 42
331 *
332 -
333 RCL 47
334 -
335 STO 73
336 0
337 RCL 51
338 X>Y?
339 XEQ 12
340 RCL 51
341 0
342 X>Y?
343 XEQ 13
344 RCL 52
345 RCL 00
346 -
347 RCL IND 29
348 +
349 STO 74
350 0
351 STO 52
352 STO 00
353 RCL 73
354 RCL 50
355 -
356 RCL 74
357 -
358 STO 75
359 X<0?
360 GTO 14
361 RCL 48
362 1000
363 *
364 -
365 3400
366 -
367 STO 79
368 X<0?
369 GTO 15
370 .485447 E-5
371 RCL 79
372 X↑2
373 *
374 .127321
375 RCL 79
376 *
377 +
378 .205428 E-10
379 RCL 79
380 3
381 Y↑X
382 *
383 -
384 .335726 E-16
385 RCL 79
386 4
387 Y↑X
388 *
389 +
390 STO 00
391 STO 52

392♦LBL 15
393 RCL 49
394 X=0?
395 GTO 16
396 7000
397 RCL 52
398 X>Y?
399 XEQ 17
400 .13
401 RCL 75
402 *
403 STO 79
404 1050
405 X>Y?
406 XEQ 18
407 1500
408 RCL 79
409 X>Y?
410 XEQ 19
411 RCL 75
412 RCL 52
413 -
414 RCL 79
415 -
416 1000
417 RCL 48
418 *
419 -
420 STO 79
421 X<0?
422 GTO 16
423 10000
424 X<=Y?
425 XEQ 20
426 RCL 79
427 10000
428 X>Y?
429 XEQ 21
430 RCL 76
431 X<0?
432 GTO 16

433♦LBL 11
434 .081
435 RCL 75
436 *
437 STO 77
438 2098
439 RCL 77
440 X>Y?
441 XEQ 22
442 RCL 77
443 X<0?
444 XEQ 23
445 RCL 00
446 RCL 76
447 +
448 RCL 77
449 +
```

```
450 STO 78
451 RCL 73
452 RCL 74
453 -
454 RCL 78
455 -
456 RCL 38
457 -
458 RCL 37
459 -
460 RCL IND 30
461 -
462 ST+ 51
463 RCL 51
464 RCL 39
465 CHS
466 X>Y?
467 XEQ 24
468 1
469 ST+ 23
470 RCL 02
471 RCL 23
472 X>Y?
473 GTO D
474 2
475 ST+ 29
476 ST+ 30
477 4
478 STO 73
479 5
480 STO 74
481 6
482 STO 75
483 76
484 STO 33
485 GTO 07

486+LBL 12
487 RCL 51
488 RCL 35
489 *
490 STO 00
491 RTN

492+LBL 13
493 RCL 51
494 CHS
495 RCL 34
496 *
497 STO 52
498 RTN

499+LBL 14
500 0
501 STO 00
502 STO 76
503 GTO 11

504+LBL 16
505 0
506 STO 76
507 GTO 11

508+LBL 17
509 7000
510 STO 52
511 RTN

512+LBL 18
513 1050
514 STO 79
515 RTN

516+LBL 19
517 1500
518 STO 79
519 RTN

520+LBL 20
521 .1
522 RCL 79
523 *
524 310
525 -
526 STO 76
527 RTN

528+LBL 21
529 .0411213
530 RCL 79
531 *
532 .283844 E-5
533 RCL 79
534 X↑2
535 *
536 +
537 STO 76
538 RTN

539+LBL 22
540 2098
541 STO 77
542 RTN

543+LBL 23
544 0
545 STO 77
546 RTN

547+LBL 24
548 1
549 STO 82
550 RTN

551+LBL D
552 RCL 51
553 X<0?
554 XEQ 25
555 RCL 51
556 ST+ 26
557 RCL 51
558 RCL 27
559 X>Y?
560 XEQ 26
561 RCL 28
562 RCL 51
563 X>Y?
564 XEQ 27
565 RCL 82
566 X>0?
567 XEQ 28
568 0
569 STO 82
570 "END RUN"
571 "⊢"
572 ARCL 22
573 AVIEW
574 1
575 ST+ 22
576 RCL 01
577 RCL 22
578 X>Y?
579 GTO 29
580 GTO 06

581+LBL 25
582 1
583 ST+ 24
584 RTN

585+LBL 26
586 RCL 51
587 STO 27
588 RTN
```

```
♦LBL 27
RCL 51
STO 28
RTN

♦LBL 28
1
ST+ 25
RTN

♦LBL 29
BEEP
RCL 26
RCL 01
/
"AEB="
"├"
ARCL X
PROMPT
RCL 27
"LB="
"├"
ARCL X
PROMPT
RCL 28
"HB="
"├"
ARCL X
PROMPT
RCL 24
RCL 01
/
"P HB="
"├"
ARCL X
PROMPT
RCL 25
RCL 01
/
"P BK="
"├"
ARCL X
PROMPT
"ADD RUNS?"
PROMPT
X>0?
GTO 30
"END"
PROMPT

♦LBL 30
ST+ 01
GTO 06
.END.
```

APPENDIX C

HISTORICAL PRICE AND YIELD SERIES

TABLE C-1. Historic Time Series, Sherman County Wheat

	Nominal price $/bu.	Real price in 1979 dollars	Yield bu./acre
1962	2.00	4.69	36
1963	1.93	4.46	36
1964	1.36	3.10	35
1965	1.39	3.10	25
1966	1.63	3.51	30
1967	1.46	3.06	27
1968	1.38	2.77	26
1969	1.35	2.58	30
1970	1.47	2.66	35
1971	1.43	2.46	41
1972	2.04	3.38	34
1973	5.01	7.84	21
1974	4.53	6.46	31
1975	3.93	5.12	36
1976	2.80	3.46	35
1977	2.81	3.28	26
1978	3.61	3.93	32
1979	4.05	4.05	30

Source: County Agricultural Statistics, Economic Information Office, Department of Agricultural and Resource Economics, Oregon State University.

TABLE C-2. Historic Time Series, Marion County Wheat

	Nominal price $/bu.	Real price in 1979 dollars	Yield bu./acre
1962	1.97	4.62	48
1963	1.89	4.37	50
1964	1.33	3.03	50
1965	1.40	3.12	52
1966	1.61	3.47	53
1967	1.45	3.04	45
1968	1.13	2.26	48
1969	1.27	2.42	57
1970	1.49	2.70	59
1971	1.39	2.40	57
1972	2.05	3.39	61
1973	4.30	6.73	74
1974	4.48	6.39	65
1975	3.67	4.78	66
1976	2.90	3.59	72
1977	2.70	3.15	74
1978	3.38	3.68	47
1979	4.05	4.05	80

Source: County Agricultural Statistics, Economic Information Office, Department of Agricultural and Resource Economics, Oregon State University.

TABLE C-3. Historic Time Series, Marion County Bush Beans

	Nominal price $/ton	Real price in 1979 dollars	Yield tons/acre
1969	100.60	191.98	4.4
1970	107.80	195.29	4.2
1971	103.00	177.52	4.2
1972	111.00	183.71	3.8
1973	108.60	169.87	4.3
1974	208.40	297.29	4.3
1975	147.10	191.46	4.1
1976	131.40	162.64	4.4
1977	150.30	175.54	4.2
1978	135.30	147.27	4.2
1979	150.00	150.00	4.4

Source: County Agricultural Statistics, Economic Information Office, Department of Agricultural and Resource Economics, Oregon State University.

TABLE C-4. Historic Time Series, Marion County Sweet Corn

	Nominal price $/ton	Real price in 1979 dollars	Yield tons/acre
1962	25.70	60.29	5.2
1963	26.40	61.03	4.7
1964	25.90	58.96	5.8
1965	25.20	56.11	5.4
1966	25.80	55.63	7.3
1967	29.40	61.57	6.6
1968	30.00	60.13	7.6
1969	29.40	56.11	8.4
1970	28.30	51.27	7.0
1971	28.90	49.81	6.1
1972	29.90	49.49	7.4
1973	40.00	62.57	7.8
1974	76.40	108.99	7.3
1975	62.80	81.74	8.0
1976	58.70	72.66	7.9
1977	66.40	77.55	7.1
1978	59.00	64.22	7.8
1979	60.00	60.00	8.0

Source: County Agricultural Statistics, Economic Information Office, Department of Agricultural and Resource Economics, Oregon State University.

PREDICTIVE PRICE AND YIELD EQUATIONS

Prices:

Marion County Bush Beans ($/ton) = 249.32 - 5.64 T
(17.64) (1.82)

$R^2 = .41$

Yields:

Marion County Wheat (bu./acre) = 44.78 + 1.47 T
(3.76) (.35)

$R^2 = .53$

where: T denotes time and given by:

(1, 2, 3, •••, Y)

where: Y = number of years of data used in regression.

where: the numbers in parentheses are standard errors.

Both equations above were estimated using ordinary least squares (OLS).