Farm business analysis

# FINANCIAL ANALYSIS OF EXPANSION ALTERNATIVES

# FOR

# CASH GRAIN FARMS IN ONTARIO

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The purpose of this study was to investigate the influence on a farmer's financial position of farm expansion through investment in land and/or investment in cattle feeding facilities. Special attention is given to financing strategies, capital constraints, and the feasible timing of investments in "lumpy" or "indivisible" assets over a multi-year planning horizon.

The study on which this report is based constituted one project in an on-going program of research into agricultural finance being conducted in the School of Agricultural Economics and Extension Education of the University of Guelph. This research program is supported by the Ontario Department of Agriculture and Food under a contract with the University for research in agricultural economics.

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CONTENTS

FARM FINANCIAL MANAGEMENT AND FIRM GROWTH

Production and marketing decisions have generally dominated farm management analysis. While production and marketing efficiency are important, a farmer may still experience an inadequate, unreliable income if he has too small a resource base or if he makes poor financial decisions. This income situation impels a lengthening of the planning horizon to encompass farm expansion and other long term objectives.

The core of the farm expansion process is acquiring control of durable assets (land, machinery, buildings, etc.) which will add to the present value of the business by continuing to generate returns in excess of their cost. The nature of financial management can be summarized in four areas: investment, financing, reinvestment, and risk management. The important interrelationships between these areas will become apparent in the analysis of the following growth model.

$$(1)\quad g = \left[\frac{rA - iD}{E}\right] (1 - c)\ (1 - t)$$

where g = the growth rate: annual percentage change in equity (E)

$\frac{D}{E}$ = the leverage ratio; D = debt and E = equity

r = the rate of return on total assets (A) in the firm, net except for interest and taxes

i = the interest rate paid on debt

t = the rate of income taxation

c = the rate spent on consumption out of firm earnings

While this model is a simplification and may not be adequate in terms of functional form, it identifies several factors which are important in firm growth analysis. Furthermore the model combines balance sheet (A,D,E) and income statement (r,i) elements as well as specifying a rate of reinvestment through external cash withdrawals (c,t). If the rate of return (r) exceeds the interest rate (i) and other variables remain constant, increases in the financial leverage ratio $[\frac{D}{E}]$ will increase the rate of growth [2]. Thus, if growth in farm size is a plausible objective, additional borrowing to finance investments would appear desirable.

Investment refers to the acquisition and/or disposal of assets by the firm over the relevant planning horizon. The analysis of prospective investments cannot occur in isolation from their means of financing. If new investments are financed by reinvestment of savings already generated by the business, the effect on asset structure may modify the liquidity position of the business.[1] For example, the conversion of cash into real estate assets would reduce the firm's liquidity position. If this type of liquidity is valuable to the farm manager as a means of countering risk, then such a transaction may significantly influence expansion of the business [1].

Self-financing of farm expansion is seldom adequate. The inability of internal savings to provide the immediate funds needed for investment in durable assets and the traditional seasonality of cash flows in many types of farming place great emphasis on borrowing and efficient credit use--credit defined as the farmer's borrowing capacity, albeit measured and identified by lender evaluation. If borrowing is used as a source of finance, the preference of the lender as expressed through loan limits, length, downpayment, method and frequency of repayment, interest rate, insurance and other requirements may influence resource allocation and expansion [2].

Held as an unused reserve, credit is a valuable source of liquidity because it is available to counter uncertain expectations or to take advantage of favourable investment opportunities. However, borrowing depletes this source of firm liquidity. Thus an optimal allocation of credit between use for loans and use in reserve must consider the value of the credit reserve to the decision maker as well as the returns from use of the borrowed funds [3].

Finally, credit can be managed: increased, decreased, or changed structurally by production, marketing or financial decisions. The measurement of these changes and their influence on managerial decisions and financial position only becomes apparent in a multiperiod analysis.

## Formulation of the Problem

### Constraints on growth

The constraints on growth which are suggested by the variables in equation (1) include external capital controls, increases in interest rates, non farm drains on cash flow, diminishing resource or management productivity, and financial risk and attitude toward risk. This report focusses primarily on the influence of capital constraints on growth.

While capital budgeting methods [14] may indicate the expected profitability of an investment, capital rationing (external or internal) may delay the investment.[2] The manager is then interested in the rapidity with which capital rationing may be overcome. Under these circumstances the investment is treated as an intermediate goal and enusing decision choices seek the optimal financing strategy. It is not uncommon to find goals of farm ownership, expansion of business size, modernization of production systems, etc. [eg. 11, 12]. All these goals may serve to increase the income capacity of the firm.

The timing of investment is critical when the availability and acquisition of many resources and resource services do not occur in continuous or fractional sized units. Examples of such investments include land purchases in specified sizes (i.e., 50 acres, 100 acres, etc.), purchases of buildings and other components of mechanized systems of production, large scale machinery, and others. Even labour exclusive of very short term seasonal labour is often an indivisible item.

Such lumpiness or indivisibilities complicate investment planning when capital is limiting; also large price changes may be required to warrant a reallocation of indivisible resources. Finally, full utilization of one indivisible resource may not be compatible with full utilization of certain others because they have different capacities.

Several opportunities exist for alleviating the effect on cash flow of indivisible investments. Often the manager may choose between different sizes of equipment, machinery, and buildings, although the range of sizes is not infinite. In addition, alternative financing arrangements permit flexibility in investment requirements. Cash purchases, loan financing, leasing, and their concomitant terms may affect cash flows, production choices, and rate of growth.

This study investigates the potential financial progress of a cash grain farmer in south western Ontario who is considering expansion of his business by investment in additional land and/or beef cattle feeding facilities. Land is assumed to become available for purchase only in units of 50 acres or some multiple thereof (i.e. 50,100,150,200). Purchase of machinery and grain storage capacity must accompany any land purchase. New cattle feeding facilities are assumed to be saleable only in units of 150 head capacity or some multiple thereof. The investment planning considers the feasible timing of these investments as well as their profitability given a specified farm situation with alternative capital structures, financing choices, and liquidity demands.

## Method of Analysis

Multiperiod linear programming [eg. 1,3] is used to model the decision situation and measure financial progress. A properly specified multiperiod programming model may reach an optimal solution for production, marketing, and financial choices as well as choosing among variables which serve to transfer cash, assets, and debts between periods that are mutually dependant.

Proper specification of the elements of a decision situation (objectives, alternatives, constraints, technical relationships) is essential for useful analysis. In a multiperiod planning horizon this specification is complicated since the decision elements may change. Objective functions should reflect relevant decision objectives: income, consumption, wealth, risk aversion. Credit constraints may constantly change. Finally, financial models with multiperiod planning horizons introduce risk and uncertainty not found, or at least well beyond that found, in single period production models.

A critical assumption underlying linear programming requires that all the firm's resources and products are perfectly divisible. Thus, solution variables may take on any non-negative values. The divisibility assumption is limiting when investments in large, indivisible assets are included as alternatives. Model solutions including fractional lvels of these assets are included as alternatives. Model solutions including fractional levels of these assets could depict unattainable situations in the real world and could lead to errors in decision-making. Some integer programs have been attempted with limited success in developing comprehensive and generally applicable models [eg. 7, 15]. Simulation models [eg. 10] have also been adapted for asset indivisibility; however, they often lack the operational flexibility and optimization which are characteristic of mathematical programming techniques.

Linear programming can accommodate indivisibility by requiring the inclusion of the indivisible investment in the solution. This can be supported empirically when the requirement contributes to the manager's objectives. In this fashion the linear programming approach takes on characteristics similar to the general simulation approach. However, the model objective is still capable of reaching an optimal production, marketing, and financing organization for a business situation, albeit conditioned by the forced investment.

In order to assess the timing, feasibility, and the profitability of various investments, the linear programming approach is patterned as follows: A farming situation is specified in a linear programming model with an N period planning horizon (i.e., 10 years). One investment alternative might be the purchase of a neighbouring 100 acre tract of land. The manager is concerned with the feasibility of this objective with respect to time. A land purchase activity is specified in the programming model in period one at prevailing land prices and specified financing terms. If the optimal solution indicates a purchase of less than 100 acres, then the 100 acre purchase is not feasible in period one. The land purchase activity is removed from period one and reintroduced in period two for the same analysis. If the optimal solution eventually indicates a purchase of 100 acres or more, then one can conclude that sufficient resources (probably cash and credit) have been generated to make the 100 acre purchase. Once this occurs, the 100 acre purchase is required in the solution in its respective year of feasibility, and additional land investments are tested. Investment planning is then based on growth in income and equity for each investment pattern over the planning horizon.

## Outline of the Case Farm and Planning Model

### Case farm

A case farm is developed to provide the unit of analysis in this study. The physical and financial organization of the farm is typical of many farms in southwestern Ontario. The farm manager is 28 years old, married, two young children, and has been farming for four years. His wife has a part-time job off the farm which returns $2,000 per year. He currently owns and operates 150 acres all of which are tillable.

The farmer has demonstrated superior management ability through high yields and an efficiently run business. He raises corn and soybeans on all his land in a corn - corn - soybeans rotation. In order to avoid heavy machinery investments, he has shared machinery with a neighbour and acquired used equipment.

The farmer realizes that he must expand the size of his business to meet his rising income needs in future years. He is considering the purchase of additional land as well as adding beef cattle feeding facilities. While the land market has not been active in this area, several farmers in the neighbourhood who are approaching retirement age, will be selling their farms in the near future. This land is expected to sell in size units of 50, 100, 150, and 200 acres.

The case farmer realizes that this size of land investment will also require the purchase of sufficient machinery for the operation and purchase of dryer - storage facilities for flexibility in the sale of his corn crop. The farmer plans land investment on the basis of a 150 acre purchase with investment in other sizes of acreage, machinery, and storage considered in proportion to the 150 acre requirements in each of the next 10 years for machinery, storage, and land which appreciates in value at a compound rate of four percent per year. Alternatively, investment requirements for 150 head cattle feeding facilities are budgeted as $20,000 with $23,287 required annually for the purchase of 150 cattle.

Table 1 Annual investment requirements in 150 acres land, machinery, and storage when land values increase at a four percent compund rate

| Year | Land Value | Machinery* | Storage* | Total |
|---|---|---|---|---|
| 1 | $60,000 | $20,475 | $10,000 | $90,475 |
| 2 | 62,400 | 20,475 | 10,000 | 92,875 |
| 3 | 64,896 | 20,475 | 10,000 | 95,371 |
| 4 | 67,500 | 20,475 | 10,000 | 97,975 |
| 5 | 70,200 | 20,475 | 10,000 | 100,675 |
| 6 | 73,008 | 20,475 | 10,000 | 103,483 |
| 7 | 75,930 | 20,475 | 10,000 | 106,405 |
| 8 | 78,968 | 20,475 | 10,000 | 109,443 |
| 9 | 82,125 | 20,475 | 10,000 | 112,600 |
| 10 | 85,410 | 20,475 | 10,000 | 115,885 |

* Detailed machinery and storage facilities are in appendix.

The farmer's current balance sheet is presented in Table 2, under two situations: a) low equity, mortgage on owned land; b) high equity, no liabilities. Hence growth potential can be measured from these two beginning situations. Investment in real estate dominates the asset structure. However, the farmer also has a $12,000 cash balance at the beginning of the planning horizon. In the low equity case the farmer presumably purchased his 150 acre farm four years ago for $51,280. The farm was financed by loan from the Farm Credit Corporation for $38,460 for 30 years at a 7.5 percent interest rate. In the high equity situation the farmer was assumed to inherit the farm four years ago.

Table 2 LOW EQUITY AND HIGH EQUITY NET WORTH STATEMENT, CASE FARM, YEAR 0

| Assets | a) Low Equity | b) High Equity |
|---|---|---|
| Land | $57,600 | $57,600 |
| Machinery | 10,000 | 10,000 |
| Grain & misc. | 13,000 | 13,000 |
| Other | | |
| Cash | 12,000 | 12,000 |
| Total | $92,600 | $92,600 |
| **Liabilities** | | |
| Real Estate | $37,260 | |
| Total | 37,260 | 0 |
| Net Worth | $55,340 | $92,600 |

The Linear Programming Model

In mathematical terms [8] the central problem of linear programming consists of finding values of $X_1, X_2, \ldots X_j$ satisfying simultaneously the system of equations of the form:

$$\text{Maximize } Z = \sum_t \sum C_j^t X_j^t$$

$$\text{Subject to } \sum A_{ij}^t X_{ij}^t \leq b_i^t$$

$$X_j \geq 0$$

where $Z$ is the objective value to be maximized

$C_j^t$ is the weight assigned to the $j^{th}$ activity in the $t^{th}$ period in the valuation of the objective function.

$X_j^t$ is the $j^{th}$ activity in the $t^{th}$ period

$A_{ij}^t$ is the entry in the $i^{th}$ equation of the $j^{th}$ activity of the $t^{th}$ period

$b_i^t$ is the constraint level for the $i^{th}$ equation in the $t^{th}$ period.

A less-than or equal-to sign ($\leq$) designates those equations in which resources are available for use in the model but do not have to be completely used up. Equal-to (=) signs specify requirements which must be exactly met in the model.

Crop production and marketing alternatives are limited in the model to allow emphasis on alternative financial specifications. The limited alternatives accord well with empirical experiences of cash grain farmers in south western Ontario. No explicit specifications of risk are included in the analysis. In an ex ante prescriptive-use, linear programming assumes single-valued expectations regarding future events. The feasibility of this assumption rests on the value of more complete specifications on organization structure including risk aversion and on the intuitive appeal that over multiperiods, departures from mean expectations are likely to be offsetting.

When the model was specified, data were collected for variables which significantly affected production and financial decisions over the planning horizon. Such data included crop yields, prices, costs of production, and labour requirements which were obtained from summaries of farm business records (Appendix tables 15-20). Consumption functions were based on summaries of home account records. Tax rates reflected actual rates expected to exist during the period. Land value changes reflected the historical increase in land values.

Titles of constraints and activities in the linear programming model are described in Table 3. Components of the model are identified in more detail for the first year in Appendix tables 10-14. Coefficients and model design for the other nine years are similar to the first period. Land values are the only variable parameter in the model. The columns and rows for each period represent blocks of activities or constraints. Hence, the entries refer to submatrices of coefficients.

## Objective Function

The objective function to be maximized in the model is the sum of the activity levels, each multiplied by the value weight ($C_j$) specified for the activity. The objective was postulated as the maximum of the value of all assets minus debts at the end of the ten year planning period, plus the present value of all consumption expenditures above a specified minimum during the planning period, plus

Table 3. Glossary describing abbreviated titles of rows and activities in the linear programming model

| Title | Description |
|---|---|
| A. Rows | |
| CA | Cash |
| LA | Labour |
| LD | Land |
| SC | Storage capacity |
| MC | Machinery capacity |
| CC | Cattle capacity |
| CR | Non real estate credit |
| REC | Real estate credit |
| LBRD | Real estate loan balance |
| MRR | Repayment requirement |
| AE | Income accounting bracket |
| TB | Tax bracket |
| CT | Minimum consumption |
| LR | Land purchase requirement |
| FR | Cattle purchase requirement |
| B. Activities | |
| CS | Producing and marketing crops |
| FC | Purchase, feeding, and sale of cattle |
| HL | Hiring labour |
| BLME | Buying land with mortgage |
| BSC | Buying storage facilities, cash |
| BSL | Buying storage facilities, loan |
| BMC | Buying machinery, cash |
| BML | Buying machinery, loan |
| CCC | Buying cattle facilities, cash |
| CCL | Buying cattle facilities, loan |
| NF | Non farm investment |
| B | Short term borrowing |
| MR | Minimum repayment |
| AR | Advance repayment |
| TRED | Transfer real estate debt |
| NR | Reserve non real estate credit |
| RE | Reserve real estate credit |
| TC | Transfer cash |
| CT | Minimum consumption |
| TP | Tax and marginal consumption |

the present value of credit reserves during the planning period. Consumption and credit reservation prices were discounted to present values at a rate of eight percent. The design of the objective function resembles that of Cocks [5,6].

## Constraints and requirements

Rows and constraint levels of the linear programming model are identified in Appendix, Table 10. Production is constrained by resource limits on land, labour, and capital capacities. Production constraints may be increased over time by net investment and labour hiring. Financial components in the constraint set include cash, credit, debt, and income tax constraints. Cash rows iCAt account for the cash flow of the business over time. The letter i refers to the respective year while t refers to the subperiod of the year. A sum of $12,000 cash is available to the firm at the beginning of the 10 year period. The equalities for all cash rows require that cash either is used in the specified subperiod or transferred to the following subperiod. The year is divided into four subperiods. Subperiod 0 is the first day of the productive year. Subperiod one includes April, May, June, and July. Subperiod two includes August, September, October, and November. Subperiod three includes December, January, February, and March. This designation coincides approximately with the production period of a cash grain farmer. Subperiod one covers the period for corn and soybeans in which all inputs are committed that are subject to decision within the year. Subperiod two covers the harvest period. Subperiod three is assumed to cover the sale and planning period.

The iLAt rows restrict the labour available from the farm operator. Farm operator labour may be supplemented by hired labour; operator and hired labour are assumed to be a homogeneous mixture.

The labour supply is assumed to be 26 days of 10 hours each per month. Two hundred hours of overhead are removed in each month. In addition labour in August is assumed to be unconstraining on a cash grain farm.

Land rows iLD restrict production to the acres of land available or purchased in the model. One hundred and fifty acres were available initially.

Machinery and storage capacity rows require that specified amounts of machinery and storage be purchased for each purchase of land in its respective year over the ten year period. Similarly, cattle capacity rows assure that the appropriate amount of cattle capacity is furnished to feed cattle.

Non real estate credit iCRt and real estate credit iREC are available for borrowing or for reserve. The credit constraints are modified by an asset acquisition, income expectations, borrowing, repayment commitments, and appreciation or depreciation of land values as they materialize over the planning horizon.

For non real estate credit, lenders were assumed to require the borrower to have at least a one third equity in non real estate assets (i.e. debt: equity ratio equals 2:1). Thus the case farmers initial non real estate equity of $35,000 would support $70,000 of debt. In addition the credit constraint in year one was reduced by $1441 to $68,559 because of the existence of a repayment commitment on initial real estate debt. The reason for this reduction will be explained later.

The level of the initial real estate credit constraint was based on excess equity in owned land. Lenders were assumed to require at least a 25 percent equity (debt: equity ratio equals 3:1) in real estate. Thus the initial real estate debt of $37,260 would require $12,420 equity. The actual real estate debt of the borrower was $22,740 ($60,000 minus $12,420). This excess equity could serve as the 25 percent required equity in financing the purchase of $30,960 of land. Thus the initial real estate credit reserve is $30,960. This reserve increases over time as real estate equity increases due to debt repayment and land value appreciation.[4]

The loan balance on real estate debt rows iLBRD require that real estate debt in each period, as well as initial debt, be either paid or transferred to the following period. The iMRR rows require that minimum contractual repayments on real estate debt be met in the specified period.

Accounting rows iAE relate to all activities which affect taxable income and its allocation between consumption, savings, and income taxes. The sign of an iAE entry is negative if the activity increases the income position (i.e. crop production, cattle feeding, non farm investment) and positive if the activity reduces the income position (depreciation, interest, taxes, consumption).

Income tax brackets iTBs limit the range of income subject to given income tax rates by limiting the level at which tax-consume-save activities can enter the solution. The s refers to income tax brackets. The right hand side values of the tax brackets are intervals within which the combined marginal rate of taxation, consumption, and savings is a constraint.

The MLT and iLR rows with right hand sides equal to one assure that the minimum consumption activity and investment requirements will enter the solution at the desired level. Above this minimum level, consumption is specified by a declining marginal propensity to consume as income increases.

## Production and marketing activities

Production and marketing activities in the linear programming model are specified in Appendix, Table 11.

1. Crop production and marketing activities

A corn-corn-soybeans rotation is assumed for all acres farmed. The production and marketing activity iCSD assumes two-thirds acre of corn and one-third acre of soybeans. The positive cash entries in the iCSD activities reflect the costs of growing and harvesting the crop in the iCA1 and iCA2 time periods. The iCA3 rows are negative reflecting an addition to cash from the sale of crops. Growing crops also generate credit as they approach maturity. Forty percent and eighty percent of the gross value of the crops are added to iCR1 and iCR2 respectively. These additions are not cumulative since borrowing in subperiod one absorbs non real estate credit in both subperiod one and two at the same rate. Entries in the iLD, iLAt, and iAE rows indicate that producing crops use land and labour and generate net income at the specified rates.

2. Cattle feeding activities

Investment in land was considered as one route of expansion. Alternatively, cattle feeding was considered as a second route. Thus activities related to cattle feeding and investment in cattle feeding facilities were tested in a variation of the model. A 150 head capital intensive feeding system was specified in the model. Recent research [4] indicates that this general size and intensity of system would exhaust the credit constraint for a cash grain farmer who was considering expansion into cattle feeding. In this system cattle are purchased in subperiod 3 (i.e. December) at 450 pounds and sold in the following subperiod two (August) at approximately 1050 pounds. The cattle are fed a ration of ground shell corn and corn silage with purchased protein supplement.[5] Cattle feeding activities for 150 head are identified as iFC. Entries in 1CA1 and 1CA2 represent costs of producing, harvesting, and storing crops for feeding cattle. The 1CA3 entry represents the cost of cattle, marketing expense, purchased feed and other livestock expense; 2CA1 entries are cattle feeding expenses; and 2CA2 indicates returns from cattle sales reduced for feed purchase and marketing costs. Credit entries 1CR1-2 indicate credit generated by growing crops. Credit entries 1CR3 and 2CR1-2 indicate credit generated by the initial value of the livestock. The initial value is multiplied by 3.5 to offset the 3.5 rate of absorption in the short term borrowing activities. This occurs because loans for feeder cattle seem to be most preferred by lenders [4,9].

Labour entries 1LA1-2 indicate labour requirements for crop production. Labour entries 1-LA3 and 2LA1-2 indicate labour requirements for cattle production. Feeding 150 cattle requires 100 acres of land and investment in buildings and equipment of $20,000. Entries in AE rows reflect the influence on taxable income of costs and returns associated with cattle feeding in the respective years. These net income entries are calculated on an accrual basis to account for increases in inventory during expansion to offset large cash expenditures. In the final period, the value of cattle on inventory enters the objective function.

3. Labour hiring activities

Labour may be hired in the iHLt activities at a wage rate of $2.00 per hour.

## Investment and term financing activities

Three general investment activities were assumed for the cash grain farmer. These activities include land purchases accompanied by required additions of machinery and storage, purchase of cattle feeding facilities, and a non farm investment. Cash purchase, mortgage, and intermediate term loans were cast as financing alternatives for the farm investments. These activities are outlined for period 1 in Appendix, Table 12.

1. Land purchase

The terms of the mortgage loan for land purchase were: 1) equity financing (no cash down); 2) 30 year maturity; 3) seven and one half percent interest rate and 4) repayments by either equal annual principal payments or equally amortized payment of principal plus interest.

Land was assumed to become available for purchase only in units of 50 acres or some multiple thereof (i.e. 50, 100, 150, 200). All entries in the land purchase activity are budgeted in terms of a 150 acre purchase. The objective function entries are the expected value ($85,410) of 150 acres of land at the end of the ten year planning period.

Entries in cash rows reflect savings in production costs (i.e. economies of scale) associated with the land purchase, or fixed costs which are not increased through the land purchase.

Non real estate credit entries are composite values representing an increase in non real estate credit by the amount of machinery purchased ($20,475) and by the undepreciated amount of storage purchased ($9,500 in year one). Non real estate credit is reduced by the derived coefficients for the effect of real estate debt payment commitments on non real estate credit. Non real estate credit reduction as a response to real estate debt commitments depends on the derived rate of non-real estate credit absorption for the type and terms of real estate loan and the level of real estate debt repayment at which this reduction begins. Both of these values were inferred from empirical research in Illinois by Smith [13]. While credit conditions and institutions are somewhat different in Ontario, the general reaction of non real estate lenders to real estate debt still seems consistent. The rate of reduction of non real estate credit was assumed to be $1.20 per $1.00 real estate debt repayment. For a 150 acre purchase, this reduction began when real estate payments reached $2055. This figure was adapted from Smith's study due to variations in assumed land values. Since debt repayments were due on pre-existing debt in this study, the reduction of non real estate credit was made in the right hand side values. For example the debt repayment in year one is $3946 ($1282 principal plus $2664 interest). The reduction in non real estate credit is $2269 [= 1.2 (3946-20550)].

Within the land purchase activity iBLME, non real estate credit is generated by the required machinery and storage and reduced by the non real estate repayment which in the equal amortized payment plan is 1.2 times the sum of principle $580 and interest $4500. Thus the 1CRt entry is computed as follows: $20,475 + $9500 - $6097 = $23,878. The coefficient is negative to indicate a net credit generation.

Real estate credit is absorbed in the period of purchase by the amount of the loan. Thus in 1BLME the 1REC entry is $60,000 which is the assumed value of 150 acres of land.

Real estate credit is generated in periods following purchase as equity in land is increased by principal repayments on real estate debt and by land value appreciation. For example in 1BLME with equal annual payments, land is valued at $400 per acre. If 150 acres are purchased $60,000 must be borrowed. Payments on principal during year one are $580; thus the debt at the end of year one is $59,420. The twenty five percent equity required to support this debt is $19,807. In addition it is assumed that the value of the 150 acres has appreciated at a four percent compound rate to $62,400 in year two. Thus the buyer's equity in the recently purchased land has now risen to $2,980 ($62,400 land value minus $59,420 debt). Since required equity was $19,807 and accumulated equity in new land is $2,980, then the difference $16,827 must be furnished by equity in initial land. This equity commitment removes the $16,827 as the 25 percent equity for additional land purchase in year two and thus reduces real estate credit by $50,481. Eventually as excess equity accumulates in the recently purchased land through continual appreciation in value and debt repayment, additional real estate credit will be generated; this begins to occur in the 5REC entry.

The entries in the iLBRD rows are the real estate debts generated by land purchase in the respective years. The iMRR entries are the minimum principal repayments required under mortgage terms. The iAE entries indicate the addition to net income of savings in production costs.

2. Machinery purchase activities

Machinery requirement of $20,475 are required for each additional 150 acre purchase. Machinery may be purchased by cash, iBMC, or by loan iBML. The objective function entries are the undepreciated values of $1.00 of machinery assets at the end of the ten year planning period. Investment in machinery is maintained each year by depreciation charges in the production activities.

A cash machinery purchase of $1.00 reduces cash by $1.00 in iCA1 and increases machinery capacity by $1.00 in the MC rows. The addition to non real estate credit of machinery assets was indicated in the land purchase activity. At the same time it is assumed that a cash purchase of machinery reduces the non real estate credit reserve by $1.20 per $1.00 purchased. This reduction reflects the loss of liquidity resulting from the conversion of liquid cash into a less liquid machinery assets.

Purchase of $1.00 of machinery by a four year intermediate term loan (iBML) requires a cash payment of $.25 in the respective years. Interest on the loan at eight and one half percent requires a total cash outlay of $.335 in the year of purchase. In the second year of the loan the cash row entry would be composed of $.25 principal plus $0.64 interest (= .085 times .75).

The purchase of $1.00 of machinery by loan reduces non real estate credit by $2.00 [9] in the year of the loan. Smaller, proportionate reductions occur in following years as the loan is repaid. As with the cash purchase, credit collateral generated by machinery purchase is accounted for in the land purchase activities. The AE entries reduce taxable income for interest paid on the loan.

3. Purchase storage facilities

Dryer storage facilities may also be purchased by cash, iBSL or by borrowing iBSL. The coefficients in these activities resemble those of the machinery investment activities although the storage loan is six years and storage facilities have an expected life of 20 years. Objective function entries represent the undepreciated equity in storage facilities at the end of the 10 year planning period. The six year loan requires cash and credit entries over the entire period of the loan. Positive iAE entries reflect reductions in taxable income due to depreciation charges on storage facilities and interest in the BSL activities.

4. Purchase cattle facilities

Cattle feeding facilities are purchased by either cash iCCC or loan iCCL. Coefficients in these activities resemble those of the machinery and storage investment. The cattle facilities loan is six years and the facilities have an expected life of 15 years. Objective function entries are the undepreciated equity in cattle facilities at the end of the planning horizon. Credit entries are a composite value for each activity. One dollar of non real estate credit is generated for each $1.00 purchase of facilities. This generation is depreciated over the 15 year life. At the same time credit is absorbed due to reduction in liquidity. In iCCC credit is absorbed in the year of purchase at a rate of $1.20 per $1.00 of purchase. In iCCL credit is absorbed at a rate of $2.00 per $1.00 of purchase [9]. Thus in 1CCL the net rate of credit absorption is $1.00. This rate is modified in future periods as the loan is reduced by repayment and as the assets depreciate.

5. Non farm investment activities

A non farm investment is included in the model yielding a six percent annual rate of return. Minimum contractual time for the investment is six months. Thus an increase in this activity of $1.00 would remove $1.00 from iCA0 and return $1.03 in iCA2. The AE entries indicate increases in taxable income arising from investment returns in their respective year of receipt. No specification is made as to the type of investment. It resembles a savings account, certificate of deposit or bond.

<u>Short term borrowing, debt management, and credit reserve activities</u>

Table 13 in the Appendix indicates the specifications in the following activities.

1. Short term borrowing activities

The iBt activities allow borrowing for short term purposes. Funds borrowed in iB1, iB2, and iB3 subperiods are assumed repaid in nine, five and twelve months respectively at eight and one half percent interest per annum. Short term funds are borrowed for fertilizer, operating expenses, and maintenance of positive cash balance. The non real estate credit reserve was reduced at the rate of $3.50 per $1.00 of short term borrowing [9]. Income rows are reduced for interest charges on borrowed funds.

2. Real estate debt servicing activities

Debt servicing activities allow repayments of principal and interest or transferral of debt to the following year. In the final year of the planning period the objective function is reduced for each dollar of outstanding debt. Minimum repayment requirements are met through the iMR activities. Cash is absorbed for principal plus interest. Entries in the iLBRD rows reduce real estate debt while the iAE entries reflect reductions in taxable income for interest paid. Real estate debt payments do affect credit reserves but this effect is described in the discussion of land purchasing activities.

Advance payments on the real estate debt are permitted with the iAR activities. The coefficients are the same as the iMR coefficients except no entry is included in the row specifying minimum repayment requirements.

3. Reserve credit activities

Reserve credit activities allow the decision maker to maintain some portion of his real estate credit and non real estate credit as unused. Such a credit reserve provides a valuable source of liquidity in countering uncertain expectations [3]. In effect the credit reserve activities serve as slack vectors for the credit constraints. Objective function entries represent present values for credit reservation prices. As such they provide a measure of the manager's debt aversion. Model solutions are obtained with reservation prices on credit of zero and $.05 per dollar of credit indicating low and intermediate levels of debt aversion.

Cash management, tax, and consumption activities

1. Transferring cash activities

Activities iTCt are provided to transfer surplus cash savings from subperiod, period to period, and to the objective function at the end of the ten year planning horizon (Table 18).

2. Tax and Consumption activities

Minimum consumption requirements of $3000 in year one are met in the CT activity, hence the reduction of cash in the 1CAt rows. The 1AE entry removes this tax free income from taxable income. The $2000 earned by the farmers wife contributes to this requirement; thus only $1000 in year one is required from the farm business. This minimum consumption level is assumed to increase $75 each year which approximates the rate of increase in cost of living during the period 1960-1970.

Each dollar of taxable income above the minimum, tax free consumption is divided between taxes, consumption and savings. Consumption and taxes are specified respectively by a declining marginal propensity to consume and a progressive tax rate structure. The iTPs activities draw on cash rows iCA1 and iCA2 at the rate of one-third of the marginal propensity to consume income above the minimum requirement. The coefficients in the iCA3 rows draw on cash at the rate of one third of the marginal propensity to consume plus the marginal propensity to tax. Thus taxes are paid in subperiod three. The objective function values are the present values of the marginal propensities to consume for the respective year. Each iTPs activity corresponds with an iTBs row denoting a specified income range within which the marginal propensities to tax and consume are constant.

# QUANTITATIVE INFORMATION DERIVED FROM THE LINEAR PROGRAMMING MODEL

Results of the analysis are presented for the various specifications of the model. The basic model was initially specified with real estate debt in the capital structure, equally amortized principal (EA) and interest repayments, no debt aversion on the borrower's part, and no farm investment alternatives. Subsequent variations of the model included investment and financing alternatives, variations in minimum size of investment, cattle feeding, high debt aversion, and equal annual principal payments (EPP). In addition model solutions were obtained with no initial debt in the capital structure.

The following summaries of model variations present detailed information on balance sheets, income, investment, financing, and other relevant information. Primary attention is given to the feasible rate of investment in these individuals or lumpy assets.

## Model results with financial real estate debt in the capital structure

### 1. Investment alternatives omitted

An optimal solution was obtained with all land, machinery, and storage purchase alternatives removed from the model. Thus the farm size was limited to 150 owned acres throughout the 10 year planning horizon. Table 4 indicates financial statements and other information arising from this plan over the 10 year period. Owner equity increased from $55,340 at the beginning of the planning period to $100,074 at the end of the period. Land value appreciation accounted for $27,810 of this increase. The equity total asset ratio increased considerably with short term borrowing

Table 4 Results of linear programming model with no farm investment activities and initial real estate debt.

| | | Years | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Acres farmed, acres | | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Assets - Land | 57,600 | 60,000 | 62,400 | 64,890 | 67,500 | 70,200 | 73,005 | 75,930 | 78,960 | 82,125 | 85,410 |
| Machinery | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Storage, grain, other | 13,000 | 13,000 | 13,000 | 13,000 | 13,000 | 13,000 | 13,000 | 13,000 | 13,000 | 13,000 | 13,000 |
| Cash | 12,000 | | | | | | | | | | |
| Nonfarm investment | | 855 | | | | | | | | | |
| Total | 92,600 | 83,855 | 85,400 | 87,890 | 90,500 | 93,200 | 96,005 | 98,930 | 101,960 | 105,125 | 108,410 |
| Liabilities - Long term | 37,260 | 24,555 | 22,069 | 20,429 | 18,772 | 17,096 | 15,401 | 13,610 | 11,873 | 10,115 | 0 |
| Short term | | | | | | | | | | | 8,336 |
| Total | 37,260 | 24,555 | 22,069 | 20,429 | 18,772 | 17,096 | 15,401 | 13,610 | 11,873 | 10,115 | 8,336 |
| Owner's equity (end of year) | 55,340 | 59,300 | 63,331 | 67,461 | 71,728 | 76,104 | 80,604 | 85,320 | 90,087 | 95,010 | 100,074 |
| Equity: Total assets | .593 | .70 | .742 | .767 | .792 | .816 | .840 | .862 | .884 | .905 | .922 |
| Net Farm income | | 5,717 | 5,969 | 6,066 | 6,186 | 6,407 | 6,430 | 6,557 | 6,685 | 6,812 | 6,941 |
| Average annual income = 6,337 | | | | | | | | | | | |
| Short term borrowing | | 0 | 10,549 | 11,410 | 11,470 | 11,526 | 11,586 | 11,598 | 11,708 | 11,770 | 20,166 |

used to offset seasonality in receipts and expenses. Annual net farm income increased from $5,717 in year one to $6,941 in year 10. Average annual income was $6,377. The increase in income occurred as interest payments on outstanding real estate debt declined. Cash savings in excess of consumption and tax requirements were used in required and advance repayments on real estate debt.

2. Land, machinery, and storage investments: 50 acre minimum purchase: no debt aversion

Model solutions were obtained with activities iBLME, iBMC, iBML, iBSC, and iBSL included as alternatives. Since timing of investment in lumpy assets was of major concern, the approach followed that suggested in the earlier methodology section. Thus land was assumed available for purchase only in units of 50 acres or integer multiples thereof. Initially the above investment activities were introduced only in year one. If less than 50 acres were purchased in the solution, the activities were removed from year one and reintroduced in year two. If more than 50 but less than 100 acres were purchased in year one, then a 50 acre purchase was required in year one. If more than 100 but less than 150 acres were purchased in year one, then a 100 acre purchase was required in year one. Once a decision was made for year one, the process was repeated for each subsequent year in the planning horizon. Thus, the decision maker is able to trace his feasible rate of timing of land purchase and associated investments. This timing is conditioned, of course, by the specification in the planning model of all elements of the decision making situation (objectives, constraints, alternatives, risk behaviour, and parameter values).

Table 5 indicates financial information obtained from model solutions for optimal timing of land investments under equally amortized repayment

Table 5 Results of linear programming model with farm investment activites, equally amortized real estate debt repayment, 50 acre minimum purchase, and no debt aversion

| A. Financial Outcomes | Years 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acres purchased | | 50 | 50 | | 50 | | | | | 50 | |
| Acres farmed | | 200 | 250 | 250 | 300 | 300 | 300 | 300 | 300 | 350 | 350 |
| Assets - Land | 57,600 | 80,000 | 104,000 | 108,150 | 135,000 | 140,400 | 146,010 | 151,860 | 157,920 | 191,625 | 199,290 |
| Machinery | 10,000 | 16,825 | 23,650 | 23,650 | 30,475 | 30,475 | 30,475 | 30,475 | 30,475 | 37,190 | 37,190 |
| Storage, grain, other | 13,000 | 16,166 | 19,166 | 18,833 | 21,666 | 20,666 | 20,166 | 19,666 | 19,166 | 21,779 | 21,112 |
| Cash | 12,000 | 8,279 | 3,008 | 1,015 | | | | | | | |
| Total | 92,600 | 121,270 | 149,824 | 151,648 | 187,141 | 191,041 | 196,651 | 202,001 | 207,561 | 250,594 | 257,592 |
| Liabilities - Long term | 37,260 | 56,570 | 76,429 | 75,416 | 96,610 | 95,206 | 93,697 | 92,074 | 90,329 | 115,128 | 112,808 |
| Intermediate term | | 5,118 | 8,530 | 5,118 | 6,824 | 3,412 | 1,706 | 0 | 0 | 7,770 | 5,545 |
| Short term | | 0 | 0 | 0 | 5,968 | 8,005 | 8,387 | 8,747 | 7,534 | 8,821 | 10,228 |
| Total | 37,260 | 61,688 | 84,959 | 80,534 | 109,402 | 106,623 | 103,970 | 100,821 | 97,863 | 131,719 | 128,581 |
| Owners equity (end of year) | 55,340 | 59,582 | 64,865 | 71,114 | 77,739 | 84,418 | 92,861 | 101,180 | 109,698 | 118,875 | 129,001 |
| Equity· Total assets | .598 | .491 | .433 | .469 | .415 | .442 | .472 | .501 | .528 | .474 | .501 |
| Net farm income (average = 7,722) | | 6,385 | 7,026 | 7,151 | 7,636 | 7,709 | 7,931 | 8,153 | 8,380 | 8,307 | 8,541 |
| Consumption - minimum | | 1,000 | 1,075 | 1,150 | 1,225 | 1,300 | 1,375 | 1,450 | 1,525 | 1,600 | 1,675 |
| marginal | | 2,215 | 2,385 | 2,400 | 2,523 | 2,520 | 2,567 | 2,611 | 2,657 | 2,612 | 2,659 |
| Income taxes | | 1,385 | 1,555 | 1,570 | 1,693 | 1,700 | 1,736 | 1,781 | 1,827 | 1,782 | 1,830 |
| Machinery purchase - loan | | 6,825 | 6,825 | | 6,825 | | | | | 6,825 | |
| Storage purchase - cash | | 3,333 | 3,333 | | 3,333 | | | | | | |
| loan | | | | | | | | | | 3,280 | |
| Hired labour | | | | | 93 | 93 | 93 | 93 | 93 | 207 | 207 |
| Short term borrowing | | 5,226 | 11,797 | 13,943 | 28,321 | 28,121 | 28,581 | 28,972 | 27,888 | 32,086 | 33,576 |

patterns with no farmer aversion to debt. The farmer was able to purchase 200 acres over the ten year period. Hence farm size more than doubled from 150 acres to 350 acres. The investment pattern which maximized the farmer's specified objectives contained 50 acre purchases of land in year one, two, four, and nine.[6]

Owner equity increased from $55,340 at the beginning of the period to $129,001 at the end of the ten year period. This growth exceeds end of period equity in the solution without land investment alternatives by $28,927 (28.9 percent). A substantial portion of this increase is due to capital gains in land. The equity total asset ratio declined from a beginning .598 to .501 at the end of the period. During this period the ratio fluctuated from .415 to .528. Net farm income increased from $6,385 in year one to $8,541 in year 10. The average annual income of $7,722 was about 20.2 percent greater with the purchase of 200 acres of land over the planning horizon.

All machinery which was purchased to farm additional land was financed by intermediate term loan. Storage facilities were purchased by cash in years one, two, and four and by intermediate term loan in year nine. Annual short term borrowing increased to more than $30,000 in later years of the period. During the first four years of the planning period, seasonal cash surpluses were invested for six months in the non farm investment activity.

The contribution of land value appreciation to the manager's objectives is evident in the measure of annual rates of returns to owner's equity. When capital gains are not included as returns, the annual rate of income return on beginning of year equity declines from 11.5 percent to 7.2 percent at the end of the planning horizon. When capital gains are included in returns, the annual rate of return

| A. Financial Outcomes | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Non farm investment - subper. 1 | | 7,251 | 7,936 | 3,007 | 1,015 | | | | | | |
| Credit reserves | | | | | | | | | | | |
| Real estate credit | | 10,960 | 2,201 | 18,482 | 13,852 | 35,178 | 57,532 | 81,022 | 105,579 | 104,432 | 135,671 |
| Non real estate credit-per. 1 | | 50,009 | 26,845 | 36,030 | 27,413 | 20,174 | 19,230 | 20,754 | 22,180 | 8,139 | 7,266 |
| per. 2 | | 59,442 | 38,647 | 41,613 | 13,447 | 14,127 | 13,044 | 14,517 | 15,714 | 1,015 | 0 |
| per. 3 | | 58,869 | 56,343 | 66,835 | 42,494 | 49,100 | 54,088 | 55,742 | 62,900 | 44,999 | 43,850 |
| Rate of return on beginning of year equity | | | | | | | | | | | |
| Without land appreciation, % | | 11.5 | 11.8 | 11.0 | 10.8 | 9.9 | 9.4 | 8.8 | 8.3 | 7.6 | 7.2 |
| With land appreciation, % | | 15.9 | 17.2 | 17.4 | 16.8 | 16.9 | 16.0 | 15.1 | 14.3 | 13.3 | 13.6 |

| B. Limiting Constraints | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Marginal Value Products, Dollars | | | | | | | | | | |
| Cash, subperiod 0 | | 1.71 | 1.65 | 1.59 | 1.53 | 1.47 | 1.40 | 1.35 | 1.29 | 1.22 | 1.18 |
| Cash, subperiod 1 | | 1.71 | 1.65 | 1.59 | 1.53 | 1.46 | 1.40 | 1.34 | 1.28 | 1.22 | 1.17 |
| Cash, subperiod 2 | | 1.68 | 1.62 | 1.56 | 1.50 | 1.44 | 1.38 | 1.32 | 1.26 | 1.20 | 1.16 |
| Cash, subperiod 3 | | 1.65 | 1.59 | 1.53 | 1.47 | 1.41 | 1.35 | 1.29 | 1.24 | 1.18 | 1.00 |
| Non real estate credit, subperiod 2 | | | | | | | | | | | .04 |
| Land | | 48.89 | 46.58 | 44.36 | 38.45 | 36.45 | 34.57 | 32.81 | 31.15 | 29.58 | 18.76 |
| Real estate debt | | 1.55 | 1.48 | 1.42 | 1.36 | 1.29 | 1.24 | 1.18 | 1.13 | 1.08 | 1.04 |
| Required repayment | | .16 | .17 | .17 | .18 | .17 | .16 | .16 | .15 | .14 | 0 |
| Land requirement-period 1 | | 10,364 | | | | | | | | | |
| 2 | | | 8,514 | | | | | | | | |
| 3 | | | | | 5,174 | | | | | | |

varies between 17.4 percent and 13.3 percent.

Marginal value products of relevant constraining rows in the final solution are indicated under limiting constraints in Table 5. Actually the limiting constraint on land purchase is the 50 acre requirement which is imposed on model solutions. In the absence of this requirement, primary constraints on growth were initial cash level, repayment requirements, and non real estate credit.

From a returns standpoint this pattern of investment appears quite favourable for the farmer. However, more than economic returns must be considered in the final analysis. One interpretation of these results might point out that, by increasing farm size (acreage) by 233 percent, end of period equity increases by 28.9 percent and average annual net income increases by 20.2 percent. Are the returns worth the cost, especially the cost in the form of increased financial risk facing the farmer? Total liabilities at the end of the period are well in excess of $100,000. The equity: total asset ratio varies around .5. Thus the exposure of owner equity to fluctuation in asset values is magnified. Similarly the potential variation of the manager's disposable income is magnified by the increase in interest payments on debt.

Finally, the liquidity postion of the business, measured in terms of both asset structure and size of credit reserve, is reduced. Farm assets, particularly land, dominate the balance sheet. Most of these farm assets have a relatively low degree of liquidity. Furthermore, land purchases nearly deplete the non real estate credit reserve in latter years of the planning period.

3. Land, machinery, and storage investments: 100 acre minimum purchase

A variation of the model restricted land availability and purchase to a minimum size of 100 acres (Table 10). While the farmer was still able to purchase 200 acres over the ten year planning period, the timing of investment pattern which maximized the farmer's specified objectives allowed 100 acre purchases in years three and eight respectively. Thus, given the farmer's specifications on all decision elements, he would not have sufficient resources to purchase an available 100 acre tract of land and machinery--storage until the third year.

In this investment pattern, owner equity increased from $55,340 at the beginning of the period to $122,128 at the end of the period. Thus end of period equity declined by $6,873 from end of period equity with 50 acre purchases. Similarly, average annual income declined from $7,722 with 50 acre purchases to $7,232 with 100 acre purchases. Perhaps even more important to the decision maker is the relatively greater decline in income in early years of the planning horizon for 100 acre purchases. These results indicate that the farmer may benefit in terms of financial position by seeking smaller and more frequent purchases of land.

4. Land, machinery, and storage investments: 50 acre minimum: high debt aversion.

Model results were obtained for a borrower with a relatively high degree of debt aversion. Debt aversion was specified in the model by a positive reservation price in the objective function entries of the reserve credit activities. Credit reservation prices of .05 were specified with the value in each respective year discounted at an eight percent rate to present value. In essence this reservation price represents a required rate of return on borrowing capacity which is over and above the interest rate.

Table 6 Results of linear programming model with farm investment activities and variations in repayment pattern, minimum size land purchase, and debt aversion

| | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| A. 100 acre minimum purchase, EA repayments, no debt aversion | | | | | | | | | | | |
| Acres purchased | | | | 100 | | | | | 100 | | |
| Acres farmed | | 150 | 150 | 250 | 250 | 250 | 250 | 250 | 350 | 350 | 350 |
| Total assets | 92,600 | 95,418 | 98,952 | 156,006 | 155,747 | 159,317 | 163,634 | 168,201 | 245,470 | 252,259 | 259,591 |
| Total liabilities | 37,260 | 36,208 | 35,675 | 88,185 | 83,707 | 79,150 | 76,085 | 73,489 | 143,513 | 140,516 | 137,463 |
| Owner equity | 55,340 | 59,210 | 63,277 | 67,821 | 72,040 | 80,167 | 87,549 | 94,712 | 101,955 | 111,743 | 122,128 |
| Equity: total assets | .598 | .620 | .639 | .435 | .462 | .503 | .535 | .563 | .415 | .443 | .470 |
| Net farm income (average = 7,232) | | 5,717 | 5,837 | 7,041 | 7,014 | 7,244 | 7,465 | 7,668 | 7,883 | 8,104 | 8,343 |
| B. 50 acre minimum purchase, EA repayments, .05 credit reservation prices | | | | | | | | | | | |
| Acres purchased | | | 50 | | | | | | | | |
| Acres farmed | | 150 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| Total assets | 92,600 | 96,064 | 126,211 | 128,706 | 131,336 | 134,063 | 138,609 | 143,345 | 148,247 | 153,275 | 158,405 |
| Total liabilities | 37,260 | 36,764 | 62,688 | 60,045 | 57,342 | 54,577 | 53,448 | 52,246 | 51,113 | 49,894 | 48,586 |
| Owner equity: | 55,340 | 59,300 | 65,523 | 68,661 | 73,994 | 79,846 | 85,161 | 91,099 | 97,134 | 103,381 | 109,819 |
| Equity: total assets | .598 | .610 | .519 | .533 | .563 | .596 | .614 | .636 | .655 | .674 | .693 |
| Net farm income (average = 6,856) | | 5,717 | 6,413 | 6,476 | 6,650 | 6,820 | 6,993 | 7,144 | 7,297 | 7,449 | 7,604 |

Table 6(contd)

| | Year 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C. 50 acre minimum purchase, EPP repayment, no debt aversion | | | | | | | | | | | |
| Acres purchased | | 100 | | | | | | | | | |
| Acres farmed | | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| Total assets | 92,600 | 144,846 | 146,648 | 150,645 | 154,482 | 158,649 | 162,991 | 167,533 | 172,250 | 177,192 | 182,334 |
| Total liabilities | 33,330 | 80,952 | 76,538 | 73,939 | 71,293 | 68,594 | 65,849 | 62,975 | 60,121 | 57,212 | 54,247 |
| Owner equity | 59,270 | 63,894 | 70,110 | 76,526 | 83,189 | 90,055 | 97,142 | 104,558 | 112,129 | 119,980 | 128,087 |
| Equity: total assets | .64 | .441 | .478 | .508 | .538 | .568 | .596 | .624 | .651 | .677 | .702 |
| Non farm income | 8,084 | 7,314 | 7,351 | 7,577 | 7,765 | 7,957 | 8,156 | 8,362 | 8,573 | 8,786 | 9,003 |

As credit liquidity becomes more valuable to a decision maker, the incentive to borrow declines. This diminution is evident in Table 6 which indicates financial outcomes for a model solution with .05 credit reservation prices. One 50 acre purchase was made in the second year of the planning period; hence, from size increased from 150 to 200 acres over the 10 year period. Owner equity increased to $109,819 at the end of the period. Net farm income increased from $5,717 in year one to $7,604 in year ten. Average annual income was $6,856. While the decision maker has optimally allocated credit between use for borrowing and use in reserve, his increased demand for liquidity is accompanied by a slower growth of equity and income.

5. Equal principal payments on real estate debt

Another variation of the model (Table 6) specified equal principle payments on all real estate debt rather than equally amortized payments of principal and interest. Initial owner equity was higher in this case due to the more rapid repayment of debt. The farmer was able to purchase 100 acres in the first year of the planning period with no additional purchases thereafter. Owner equity increased from $59,270 at the beginning of the period to $128,087 at the end of the period. This rate of growth of equity of 216 percent was somewhat less than the 233 percent growth rate in the EA case. On the other hand average annual net farm income ($8,084) in the EPP case exceeded average income ($7,722) in the EA case. This difference in income is due primarily to the lower interest obligation on outstanding real estate debt in the EPP case. Comparison of these incomes can be misleading since required principal payments come out of net income. Thus income which is allocable among consumption and voluntary savings may actually be less in the EPP case. No doubt the existence of higher principal and interest payments in early years of the EPP case would also reduce credit available for non real estate investments. This reduction of non real estate credit could be important to many expanding farmers.

6. Beef cattle feeding as an alternative

In the absence of land, machinery, and storage purchase activities, cattle feeding activities iFC, 1CCC, and 1CCL were introduced as alternatives in the model. The size of the activity was limited to 150 head to reflect the minimum feasible size of facilities recommended by agribusiness dealers and the maximum size which the chartered Canadian banks would prefer to finance [4]. Under the parameter values specified in the model, beef feeding did not enter the optimum solution at any level in the initial variation. The objective was maximized by using surplus funds to make advance repayments on real estate debt. When the advance repayment activity was removed from the model, the cattle feeding activity entered the solution at the .17 level indicating a cattle feeding enterprise of about 25 head. This size was deemed infeasible from a real world point of view. Thus given the specifications of the model, particularly a negative price spread on cattle of $4.50 per cwt., the farmer was better off financially to remain out of the cattle feeding business.

The 150 head cattle feeding activity was forced into the optimal solution of the model at the unit level to obtain measures of financial position. This requirement was feasible in year one and financial outcomes are indicated in Table 7. Owner equity increased to $102,472 at the end of the planning period. Net farm income averaged $6,975 over the ten year period. Earlier model solutions with land investment alternatives yielded both higher end of period equity and income. Annual short term borrowing ranged from $22,477 to $44,433

Table 7 Results of linear programming model with investment in 150 head cattle feeding facilities, equally amortized debt repayment, and no debt aversion

| | Years 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acres farmed | | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Cattle fed | | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Assets - Land | 57,600 | 60,000 | 62,400 | 64,896 | 67,500 | 70,200 | 73,008 | 75,930 | 78,968 | 82,125 | 85,410 |
| Machinery | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Cattle facilities | | 18,660 | 17,320 | 15,980 | 14,640 | 13,300 | 11,960 | 10,620 | 9,280 | 7,940 | 6,600 |
| Grain, cattle, other | 13,000 | 53,163 | 53,163 | 53,163 | 53,163 | 53,163 | 53,163 | 53,163 | 53,163 | 53,163 | 53,163 |
| Non farm investment | | 458 | 9,154 | 9,195 | 9,238 | 9,280 | 9,299 | 9,367 | 9,411 | 9,456 | |
| Cash | 12,000 | | | | | | | | | | |
| Total assets | 92,600 | 142,281 | 152,037 | 153,234 | 154,541 | 155,943 | 157,430 | 159,080 | 160,822 | 162,684 | 155,173 |
| Liabilities - Long term | 37,260 | 36,764 | 36,231 | 35,658 | 35,042 | 34,380 | 33,668 | 32,902 | 32,079 | 31,194 | 30,224 |
| Intermediate term | | 20,000 | 16,667 | 13,334 | 10,001 | 6,668 | 3,335 | | | | |
| Short term | | 25,894 | 35,550 | 36,435 | 37,316 | 38,163 | 38,963 | 39,716 | 37,156 | 34,577 | 22,477 |
| Total | 37,260 | 82,658 | 88,428 | 85,427 | 82,359 | 79,211 | 75,966 | 72,618 | 69,235 | 65,771 | 52,701 |
| Owner's equity | 55,340 | 59,623 | 63,609 | 67,807 | 72,182 | 76,732 | 81,464 | 86,462 | 91,587 | 96,973 | 102,472 |
| Equity: Total assets | .598 | .419 | .418 | .442 | .467 | .492 | .517 | .544 | .569 | .596 | .660 |
| Net income (average = 6,975) | | 5,926 | 5,946 | 6,310 | 6,557 | 6,830 | 7,089 | 7,354 | 7,630 | 7,911 | 8,198 |
| Short term borrowing | | 25,894 | 44,433 | 36,435 | 37,316 | 38,163 | 38,963 | 39,716 | 37,156 | 34,577 | 22,477 |

with cattle feeding. In addition, all cattle feeding facilities were purchased with an inter= mediate term loan.

The required cattle feeding activity was reintroduced in subsequent years of the planning period in order to double the size of the cattle feeding enterprises. However all solutions were infeasible for the 300 head requirement indicating that returns from, and/or resources required for, cattle feeding were not sufficient to support this requirement.

The land-machinery-storage purchase activities were introduced into the model with 150 cattle fed each year (Table 8 ). A 50 acre purchase became feasible in year six; however, no additional land purchases were feasible. In this investment pattern, owner equity increased to $103,175 at the end of the planning period and net income averaged $6,934 per year. Equity:total asset rations varied from .418 to .535. Larger amounts of short term borrowing were used to supplement seasonal cash flows. Non real estate credit reserves were completely depleted in subperiod three of years six through nine. Financial risk in the asset structure was reduced somewhat due to the higher liquidity associated with cattle and crop inventories. In general, given the model specifications, investment in cattle and cattle feeding facilities does not appear to be a favourable alternative at this time for cash grain farmers.

<u>Model Results with no initial debt in the capital structure</u>

In order to broaden the scope of this study to alternative capital structures, model solutions were obtained for timing of land investments under equally amortized real estate debt repayments with no initial estate debt. Table 9 indicates

Table 8 Results of linear programming model with investment in 150 head cattle feeding facilties and land, equally amortized debt repayment, and no debt aversion

| | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Acres purchased | | | | | | | 50 | | | | |
| Acres farmed | | 150 | 150 | 150 | 150 | 150 | 200 | 200 | 200 | 200 | 200 |
| Cattle fed | | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Total assets | 92,600 | 142,281 | 152,037 | 153,234 | 154,541 | 158,134 | 189,984 | 193,190 | 196,979 | 200,957 | 192,990 |
| Total liabilities | 37,260 | 82,658 | 88,428 | 85,427 | 82,359 | 81,402 | 108,462 | 109,073 | 106,777 | 104,397 | 89,815 |
| Owner equity | 55,340 | 59,623 | 63,609 | 67,807 | 72,182 | 76,732 | 81,522 | 84,117 | 90,202 | 96,560 | 103,175 |
| Equity: Total assets | .598 | .419 | .418 | .442 | .467 | .485 | .429 | .435 | .458 | .480 | .535 |
| Net farm income (average = 6,934) | | 5,926 | 5,946 | 6,310 | 6,557 | 6,830 | 7,199 | 7,189 | 7,486 | 7,792 | 8,103 |
| Short term borrowing | | 25,894 | 44,433 | 36,435 | 37,316 | 40,354 | 41,764 | 49,250 | 49,090 | 48,449 | 33,97[illegible] |

Table 9 Results of linear programming model with no initial real estate debt and variations in investments and debt aversion

| | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| A. Nonfarm investmerts and no debt aversion | | | | | | | | | | | |
| Acres farmed | | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Total assets | 92,600 | 97,674 | 102,754 | 107,958 | 113,320 | 118,809 | 124,441 | 130,308 | 136,245 | 142,359 | 148,635 |
| Total liabilities | | | | | | | | | | | |
| Owner equity | 92,600 | 97,674 | 102,754 | 107,958 | 113,320 | 118,809 | 124,441 | 130,308 | 136,245 | 142,359 | 148,635 |
| Net farm income (average = 9,193) | | 8,503 | 8,592 | 8,755 | 8,921 | 9,089 | 9,260 | 9,434 | 9,612 | 9,792 | 9,972 |
| B. Land-machinery-storage investments, EA repayments no debt aversion | | | | | | | | | | | |
| Acres purchased | | 200 | | | | | | 50 | | | 50 |
| Acres farmed | | 350 | 350 | 350 | 350 | 350 | 350 | 400 | 400 | 400 | 450 |
| Total assets | 92,600 | 205,003 | 207,898 | 213,041 | 218,464 | 224,097 | 229,975 | 271,434 | 278,680 | 286,286 | 332,672 |
| Liabilities-Long term | | 79,227 | 78,395 | 77,501 | 76,540 | 75,507 | 74,936 | 98,268 | 96,722 | 95,060 | 102,506 |
| Intermediate term | | 27,187 | 19,020 | 10,853 | 2,686 | 1,343 | 0 | 7,896 | 5,635 | 3,374 | 9,009 |
| Short term | | | 2,626 | 7,240 | 11,800 | 9,486 | 7,128 | 5,739 | 4,400 | 3,044 | 23,243 |
| Total | | 106,414 | 100,581 | 95,324 | 91,026 | 86,336 | 81,524 | 111,903 | 106,757 | 101,478 | 134,758 |
| Owner's equity | 92,600 | 98,589 | 107,317 | 117,717 | 127,438 | 137,761 | 148,451 | 159,531 | 171,923 | 184,808 | 197,914 |
| Equity: Total assets | 1.0 | .481 | .516 | .552 | .583 | .615 | .645 | .588 | .617 | .645 | .594 |
| Net farm income (average = 12,134) | | 10,673 | 10,933 | 11,341 | 11,705 | 12,070 | 12,452 | 12,577 | 12,985 | 13,406 | 13,199 |

Table 9 (contd)

| | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| C. Land-machinery-storage investments, EA repayments, .05 credit reservation prices | | | | | | | | | | | |
| Acres purchased | | 50 | 50 | | | | | | | | |
| Acres farmed | | 200 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| Total assets | | 125,383 | 157,775 | 160,220 | 162,928 | 167,557 | 174,119 | 181,512 | 189,597 | 195,373 | 203,926 |
| Total liabilities | | 27,498 | 53,562 | 48,642 | 43,688 | 40,404 | 38,738 | 37,645 | 37,014 | 33,769 | 33,014 |
| Owner's equity | 92,600 | 97,885 | 104,213 | 111,578 | 119,240 | 127,153 | 135,331 | 143,867 | 152,583 | 161,604 | 170,912 |
| Equity: Total asset | | .781 | .661 | .696 | .732 | .759 | .777 | .793 | .805 | .827 | .838 |
| Net farm income (average = 10,480) | | 9,000 | 9,648 | 9,960 | 10,283 | 10,605 | 10,903 | 11,182 | 11,460 | 11,734 | 12,030 |

financial outcomes derived from the model for the following cases: 1) No investment alternatives; 2) land-machinery-storage investments, minimum 50 acres, no debt aversion; 3) debt aversion as reflected by $.05 credit reservation prices.

When farm size was limited to 150 acres through the removal of land investment activities, owner equity increased from $92,600 at the beginning of the planning period to $148,635 at the end of the planning period. Annual net farm income averaged $9,193 over the ten year period. Cash savings in excess of consumption and tax requirements were used in the nonfarm investment activities.

When land-machinery-storage purchase activities were introduced in the model, the decision maker was able to purchase 300 acres over the ten year period. Hence total farm size tripled from 150 to 450 acres. The investment pattern which maximized the farmer's specified objectives allowed a 200 acre purchase in year one and 50 acre purchase in years seven and ten respectively.

Owner equity increased from $92,600 at the beginning of the planning period to $197,914 at the end of the planning period, an increase of 214 percent. This rate of increase of equity in the initial debt free case is slightly less than the rate of increase (233 percent) in the case with initial real estate debt. This reduction is probably due to the drain on income arising from the progressive tax rate structure. Net farm income increased from $10,673 in year one to $13,199 in year ten. Average annual net farm income was $12,134. All machinery was purchased by cash and loan in year one and by loan in years seven and ten. Primary constraints on additional investment included the 50 acre requirement, initial cash, non real estate credit, and debt repayment requirements.

# SUMMARY, CONCLUSIONS, AND IMPLICATIONS

## Summary

Several features highlight this study. First, the effect of a farmer's objectives and management decisions on financial position are analyzed over ten year periods. Second, decision making elements (objectives, alternatives, constraints, technical coefficients) are primary oriented toward financial management problems rather than the more traditional production and marketing decisions. Thus items, which are related to investments, financing, reinvestment, cash flow, and liquidity management, are an essential feature of the study. Third, specific account is taken of the effect of asset "lumpiness" or "indivisibility" on the timing of investments and on the financial position of the decision maker.

A multiperiod linear programming model was specified to portray farm decision making over a future ten year period for a cash grain farmer in southwestern Ontario. While data and decision elements represent a specific farm size, the implications for investment timing should be applicable to farms of any size. The objective specified for the model farmer included asset equity measured at the end of the planning period, consumption during the planning period, and liquidity management as reflected by the reservation price for credit. Investment alternatives included land purchase, with required additions of machinery and storage, and investment in cattle feeding facilities. Financing alternatives included cash purchase, mortgage, intermediate term loans, and short term borrowing.

The general purpose of this study was to demonstrate the degree to which the timing and choice of investments are influenced by capital constraints and asset indivisibility. The indivisibility of investments was reflected in the availability of land

in 50 acre units or integer multiple thereof and minimum cattle capacities of 150 head. These indivisible units were required when the respective investment activities entered the model solution. Given this situation the manager is interested in the rapidity with which capital constraints may be overcome. Thus the investment planning considers the feasible timing of the prospective investments as well as their profitability given the production organization, initial capital structure, resource endowment, and objectives of the decision maker.

Results obtained for optimal timing of land investments with initial real estate debt, equally amortized debt repayments, and no farmer aversion to debt indicated that 200 acres could be purchased over a ten year planning period. Thus farm size more than doubled from 150 acres to 350. The essential feature was the timing of land investment which indicated 50 acre purchases of land in years one, two, four, and nine. Cash, credit and the land requirement were the primary limiting factors.

When land was assumed to be available for sale in minimum units of 100 acres, 200 acres were still purchased over the ten year period. However, the timing of investment was altered in that the 100 acre purchases occurred in years three and eight respectively. Thus following the 100 acre purchase in year three, five years were required for the farmer to accumulate sufficient cash and credit resources to support purchase of an additional 100 acres.

As one might expect, owner equity at the end of the ten year period and average annual income over the period were larger in the case where 50 acre purchases were possible. This occurred because the manager was able to acquire the use of land resource more rapidly. Equal principal payments on real estate debt, higher debt aversion, and acquisition of cattle feeding facilities all slowed the investment process and reduced growth in equity and disposable farm income.

Model results were also obtained with initial real estate debt removed in order to test the scope of results with alternative capital structures. The farmer was able to purchase 300 acres over the planning period with 200 acres purchased in year one and 50 acres purchased in years seven and ten respectively. The rates of growth of owner equity and annual income were quite similar to growth rates in the case with initial real estate debt.

## Conclusions and implications

The results of the study suggest that asset indivisibility and capital constraints may significantly affect the timing of investments by a farm manager and his financial position as measured by owner equity and annual net income. It is even quite plausible that the allocation of resources between investment alternatives differing in both expected profits and degree of asset divisibility could be influenced by rate of acquisition of these assets. Given an effective capital constraint, expansion might occur with less divisible assets even though profit possibilities appear more favourable with the other, simply because the less divisible assets could be more rapidly acquired. Thus investment timing plays a key role in forward planning by expanding farmers. In addition investment timing and financial position are also influenced by the financing strategies used, attitudes toward risk, and initial debt: equity position. Over and above these variables in the study, a large number of parameter values, activities, constraints, as well as objectives were taken as given in order to isolate the effects on expansion of capital constraints and asset indivisibility.

Expected appreciation in land values made land acquisition an attractive alternative in the model. The prospective purchaser of land might be well advised to seek purchases of land in the smallest possible size of unit. This behaviour will more rapidly enable him to overcome capital constraints, receive income from the acquired land, and add to equity for later purchase through debt repayment and appreciation in value. Similarly, the prospective seller of land may find that buyers are more readily available for the sale of several small sized units rather than one large unit.

This study was based on a ten year planning period for the decision maker. While the planning horizons of most farm managers are generally shorter than ten years, the dynamic nature of farm business management often requires multiyear planning horizons at any stage in the life of a business and its manager. Accurate and comprehensive information contribute a useful basis for forward planning especially when the nature of risk and uncertainty encountered in longer term planning serves to shorten planning horizons.

While the use of linear programming in this study assumes single valued expectations on future parameter values, detailed risk averting behaviour was included through product diversification, crop storage and a liquid credit reserve with alternative credit reservation prices. A study of this nature could be extended by incorporation of measure of variability of prices, yields, gross margins and other parameter values so that probabalistic measures of outcomes and risk-return trade-offs could be indicated. For example, the increased returns from land investments are accompanied by increased risk as indicated by the reduction of a liquid credit reserve and potentially increased variation of expected returns and owner equity. Precise measurements of variability arising from the financial risk would aid investment decision making and enable a more comprehensive evaluation of risk avertaing alternatives.

Other types of uncertainty are more difficult to measure. For example, imperfections in the land market may impede investment planning. Model outcomes were contingent upon land becoming available for sale at the right time and in the appropriate size of unit. The manager who expects to purchase 50 acres five years in the future may find his plans stymied if there are no 50 acre units for sale within a feasible distance.

The manager who must rely at this time on institutional loans (e.g. Farm Credit Corporation) for land purchase may also find his investment plans constrained because of loan limits. While it is likely that such loan limits will rise over time, the timing and level of such increases are quite uncertain. No doubt the existence of institutional loan limits have accounted for the apparent increase in individually or seller financed loan transactions and agribusiness credit. The real estate credit constraints in this study were based only on a required proportion of equity by the buyer. Thus no particular source of long term borrowing is implied.

Finally, the development of planning techniques whether computerized, mathematically sophisticated, or otherwise can quite readily be extended and broadened. Greater detail in short term production planning can be introduced in the analysis so that, for example, the farmer who invests in land can also determine the optimal production and marketing organization of the purchased land. Also experimentation with programming devices to link together various farm planning techniques, such as simulation and linear programming, may improve the efficiency with which solutions are obtained.

## Footnotes

[1] Liquidity refers to the ease with which assets or borrowing capacity may be converted into cash.

[2] External capital rationing exists when the borrower has exhausted all sources of loanable funds but still finds the marginal value product of borrowing to exceed the marginal cost of borrowing. Internal capital rationing or debt aversion reflects self imposed limitations on credit use.

[3] Financial choices include decisions in investment, financing, reinvestment, and liquidity management.

[4] The same procedure is used to determine real estate credit with debt payments based on equal principle payments. However, the numbers are different.

[5] Detailed data for cattle feeding and investment activities are in the Appendix.

[6] In year nine, 49.987 acres were purchased without a 50 acre requirement. This figure was rounded to a 50 acre purchase.

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APPENDIX TABLES

THE LINEAR PROGRAMMING MODEL

Table 10 Rows and constraint levels of the linear programming model

| Row ID[a] | Row description | Relation[b] | Restriction Level | Units |
|---|---|---|---|---|
| OBJ1 | Objective function | E | Z (maximum) | $ |
| 1CAO | Beginning cash | E | 12,000 | $ |
| iCAt | Cash, period i, subperiod t | E | 0 | $ |
| iLAt | Operator labour, period i, subperiod t | L | 840 | hours |
| iLD | Land, period i | L | 150 | acres |
| iSC | Storage capacity, period i | E | 0 | $ |
| iMC | Machinery capacity, period i | E | 0 | $ |
| iCC | Cattle capacity, period i | E | 0 | $ |
| iCRt | Non real estate credit, period i, subper. t | E | 68,559 | $ |
| 1REC | Real estate credit, period 1 | E | 30,960 | $ |
| 2REC | Real estate credit, period 2 | E | 39,828 | $ |
| 3REC | Real estate credit, period 3 | E | 49,479 | $ |
| 4REC | Real estate credit, period 4 | E | 59,424 | $ |
| 5REC | Real estate credit, period 5 | E | 69,816 | $ |
| 6REC | Real estate credit, period 6 | E | 80,703 | $ |
| 7REC | Real estate credit, period 7 | E | 92,136 | $ |
| 8REC | Real estate credit, period 8 | E | 104,079 | $ |
| 9REC | Real estate credit, period 9 | E | 116,616 | $ |
| 10REC | Real estate credit, period 10 | E | 129,762 | $ |
| 1LBRD | Real estate loan balance, period 1 | E | 37,260 | $ |
| iLBRD | Real estate loan balance, period 2-10 | E | 0 | $ |
| 1MRR | Repayment requirement, period 1 | E | 496 | $ |
| 2MRR | 2 | E | 533 | $ |
| 3MRR | 3 | E | 573 | $ |

Table 10 (contd)

| | | | | |
|---|---|---|---|---|
| 4MRR | Repayment requirement, period 4 | E | 616 | $ |
| 5MRR | 5 | E | 662 | $ |
| 6MRR | 6 | E | 712 | $ |
| 7MRR | 7 | E | 766 | $ |
| 8MRR | 8 | E | 823 | $ |
| 9MRR | 9 | E | 885 | $ |
| 10MRR | 10 | E | 950 | $ |
| iAE | Income accounting, period i | E | 0 | $ |
| iTB1 | Tax bracket 1, period i | L | 2,000 | $ |
| 2 | 2 | L | 2,000 | $ |
| 3 | 3 | L | 4,000 | $ |
| 4 | 4 | L | 4,000 | $ |
| CT | Minimum consumption | E | 1 | |
| iLR | Land purchase requirements | E | 1 | |
| iFR | Cattle purchase requirements | E | 1 | |

a. i = period or year 1-10
   t = subperiod or season 1-4

b. E = equality
   L = less than inequality

Table 11 Production and marketing activities of the linear programming model

| | Producing and marketing crops per acre | Purchase, feeding, and sale of cattle per 150 head | Hiring Labour per hour | | |
|---|---|---|---|---|---|
| | 1CS | 1FC | 1HL1 | 1HL2 | 1HL3 |
| 1CA1 | 45.47 | 4626 | 2.0 | | |
| 1CA2 | 16.27 | 1900 | | 2.0 | |
| 1CA3 | -117.93 | 26227 | | | 2.0 |
| 2CA1 | | 1430 | | | |
| 2CA2 | | -45920 | | | |
| 1CR1 | - 47.17 | - 4717 | | | |
| 1CR2 | - 94.34 | - 9434 | | | |
| 1CR3 | | -81504 | | | |
| 2CR1 | | -81504 | | | |
| 2CR2 | | -81504 | | | |
| 1LD | 1.0 | 100 | | | |
| 1LA1 | 2.31 | 345 | -1.0 | | |
| 1LA2 | 2.31 | 345 | | -1.0 | |
| 1LA3 | | 345 | | | -1.0 |
| 2LA1 | | 345 | | | |
| 2LA2 | | 345 | | | |
| iCC | | -20000 | | | |
| 1AE | - 56.19 | - 8600 | 2.0 | 2.0 | 2.0 |
| 2AE | | | | | |

Table 12 Investment and term financing activities

| Rows** | Buy Land Via Mortgage No Cash Down* | Buy Storage Cash | Buy Storage Loan | Buy Machinery Cash | Buy Machinery Loan | Buy Cattle Facilities Cash | Buy Cattle Facilities Loan | Non Farm Investment | |
|---|---|---|---|---|---|---|---|---|---|
| | 1BLME | 1BSC | 1BSL | 1BMC | 1BML | 1CCC | 1CCL | 1NF1 | 1NF2 |
| OBJ1 | 85410 | .50 | .50 | 1.0 | 1.0 | .333 | .333 | | |
| 1CA0 | | | | | | | | 1.0 | |
| 1CA1 | - 570 | | | 1.0 | | | | | |
| 1CA2 | - 570 | 1.0 | | | | 1.0 | | 1.03 | 1.0 |
| 1CA3 | | | .252 | | .335 | | | | |
| 2CA0 | | | | | | | | | -1.03 |
| 2CA1 | - 570 | | | | | | | | |
| 2CA2 | - 570 | | | | | | .252 | | |
| 2CA3 | | | .238 | | .3138 | | | | |
| 3CA1 | - 570 | | | | | | | | |
| SCA2 | - 570 | | | | | | .238 | | |
| 3CA3 | | | .224 | | .2925 | | | | |
| 4CA1 | - 570 | | | | | | | | |
| 4CA2 | - 570 | | | | | | .224 | | |
| 4CA3 | | | .209 | | .2712 | | | | |
| 5CA1 | - 570 | | | | | | | | |
| 5CA2 | - 570 | | | | | | .209 | | |
| 5CA3 | | | .195 | | | | | | |
| 6CA1 | - 570 | | | | | | | | |
| 6CA2 | - 570 | | | | | | .195 | | |
| 6CA3 | | | .181 | | | | | | |
| 7CA1 | - 570 | | | | | | | | |
| 7CA2 | - 570 | | | | | | .181 | | |

Table 12 (contd)

| | 1BLME | 1BSC | 1BSL | 1BMC | 1BML | 1CCC | 1CCL | 1NF1 | 1NF2 |
|---|---|---|---|---|---|---|---|---|---|
| 7CA3 | | | | | | | .181 | | |
| 8CA1 | - 570 | | | | | | | | |
| 8CA2 | - 570 | | | | | | | | |
| 9CA1 | - 570 | | | | | | | | |
| 9CA2 | - 570 | | | | | | | | |
| 10CA1 | - 570 | | | | | | | | |
| 10CA2 | - 570 | | | | | | | | |
| 1CRt | -23878 | 1.2 | 2.0 | 1.2 | 2.0 | .2 | 1.0 | | |
| 2CRt | -23378 | | 1.67 | | 1.5 | -.933 | .737 | | |
| 3CRt | -22878 | | 1.33 | | 1.0 | -.866 | .463 | | |
| 4CRt | -22378 | | 1.0 | | .5 | -.799 | .201 | | |
| 5CRt | -21878 | | .67 | | | -.732 | -.062 | | |
| 6CRt | -21378 | | .33 | | | -.665 | -.335 | | |
| 7CRt | -20878 | | | | | -.598 | -.598 | | |
| 8CRt | -20378 | | | | | -.531 | -.531 | | |
| 9CRt | -19878 | | | | | -.464 | -.464 | | |
| 10CRt | -19378 | | | | | -.397 | -.397 | | |
| iSC | 10000 | -1.0 | -1.0 | | | | | | |
| iMC | 20475 | | | -1.0 | -1.0 | | | | |
| iCC | | | | | | -1.0 | -1.0 | | |
| iLD | - 150 | | | | | | | | |
| 1REC | 60000 | | | | | | | | |
| 2REC | 50481 | | | | | | | | |
| 3REC | 40497 | | | | | | | | |
| 4REC | 27120 | | | | | | | | |
| 5REC | 15921 | | | | | | | | |
| 6REC | 4164 | | | | | | | | |
| 7REC | - 8202 | | | | | | | | |

Table 12 (contd)

| | 1BLME | 1BSC | 1BSL | 1BMC | 1BML | 1CCC | 1CCL | 1NF1 | 1NF2 |
|---|---|---|---|---|---|---|---|---|---|
| 8REC | -21144 | | | | | | | | |
| 9REC | -34752 | | | | | | | | |
| 10REC | -48741 | | | | | | | | |
| 1LBRD | -60000 | | | | | | | | |
| 1MRR | - 580 | | | | | | | | |
| 2MRR | - 624 | | | | | | | | |
| 3MRR | - 670 | | | | | | | | |
| 4MRR | - 721 | | | | | | | | |
| 5MRR | - 775 | | | | | | | | |
| 6MRR | - 833 | | | | | | | | |
| 7MRR | - 895 | | | | | | | | |
| 8MRR | - 962 | | | | | | | | |
| 9MRR | - 1034 | | | | | | | | |
| 10MRR | - 1190 | | | | | | | | |
| 1AE | - 1140 | .05 | .135 | | .085 | .067 | .067 | -.03 | |
| 2AE | - 1140 | .05 | .121 | | .0638 | .067 | .152 | | -.03 |
| 3AE | - 1140 | .05 | .107 | | .0425 | .067 | .138 | | |
| 4AE | - 1140 | .05 | .092 | | .0212 | .067 | .124 | | |
| 5AE | - 1140 | .05 | .078 | | | .067 | .109 | | |
| 6AE | - 1140 | .05 | .064 | | | .067 | .095 | | |
| 7AE | - 1140 | .05 | .05 | | | .067 | .081 | | |
| 8AE | - 1140 | .05 | .05 | | | .067 | .067 | | |
| 9AE | - 1140 | .05 | .05 | | | .067 | .067 | | |
| 10AE | - 1140 | .05 | .05 | | | .067 | .067 | | |
| 1LR | A | | | | | | | | |

** In order to save table space, annual and subperiod subscripts are designated as i and : respectively when entries in all periods are identical.

Table 13 <u>Short term financing, debt management, and credit reserve activities</u>

| | Short term borrowing | | | Debt Management | | | Reserve non real estate credit | | | Reserve real estate credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Minimum Repayment | Advance Repayment | Transfer Real Estate Debt | | | | |
| | 1B1 | 1B2 | 1B3 | 1MR | 1AR | 1TRED | 1NR1/Ci | 1NR2/Ci | 1NR3/Ci | 1RE/Ci |
| 1CA1 | -1.0 | | | | | | | | | |
| 1CA2 | | -1.0 | | | | | | | | |
| 1CA3 | 1.0675 | 1.0375 | -1.0 | 1.075 | 1.075 | .075 | | | | |
| 2CA3 | | | 1.085 | | | | | | | |
| 1CR1 | 3.5 | | | | | | 1.0 | | | |
| 1CR2 | 3.5 | 3.5 | | | | | | 1.0 | | |
| 1CR3 | | | 3.5 | | | | | | 1.0 | |
| 2CR1 | | | 3.5 | | | | | | | |
| 2CR2 | | | 3.5 | | | | | | | |
| 1LBRD | | | | 1.0 | 1.0 | 1.0 | | | | |
| 2LBRD | | | | | | -1.0 | | | | |
| 1MRR | | | | 1.0 | | | | | | |
| 1AE | .0675 | .0375 | | .075 | .075 | .075 | | | | |
| 2AE | | | .085 | | | | | | | |
| 1REC | | | | | | | | | | 1.0 |

Table 14 Cash management, tax, and consumption activities

| | Transfer cash between subperiod: 0 to 1 | 1 to 2 | 2 to 3 | 3 to 0 | Minimum consumption requirement | Tax and marginal consumption | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1TC1 | 1TC2 | 1TC3 | 1TC4 | CT | 1TP1 | 1TP2 | 1TP3 | 1TP4 |
| OBJ1 | | | | | | .4629 | .3704 | .2778 | .2315 |
| 1CA0 | 1.0 | | | | | | | | |
| 1CA1 | -1.0 | 1.0 | | | 333 | .167 | .133 | .100 | .083 |
| 1CA2 | | -1.0 | 1.0 | | 333 | .167 | .133 | .100 | .083 |
| 1CA3 | | | -1.0 | 1.0 | 334 | .382 | .403 | .400 | .438 |
| 2CA0 | | | | -1.0 | | | | | |
| 1AE | | | | | 1000 | 1.0 | 1.0 | 1.0 | 1.0 |
| 1TB1 | | | | | | 1.0 | | | |
| 1TB2 | | | | | | | 1.0 | | |
| 1TB3 | | | | | | | | 1.0 | |
| 1TB4 | | | | | | | | | 1.0 |
| MLT | | | | | 1.0 | | | | |

Table 15 Expenses for crop production activities per acre[c]

| | Subperiod 1 | Subperiod 2 |
|---|---|---|
| | dollars | |
| Fertilizer | 16.67 | 0 |
| Seed and crop | 8.97 | 0 |
| Machinery and equipment (operating) | 4.46 | 4.47 |
| Property taxes | 3.57 | 0 |
| Machinery and equipment (depreciation) | 5.00 | 5.00 |
| Truck and auto | 1.80[a] | 1.80[a] |
| Buildings repair and maintenance | 1.00 | 1.00 |
| General expenses | 4.00[b] | 4.00[b] |
| Total | 45.47 | 16.27 |
| Labour, hours | 2.31 | 2.31 |

[a] Reduced to zero in land purchase activity

[b] Reduced to $2.00 in land purchase activity

[c] Sources [16,17,18,19]

Table 16 <u>Returns from crop production activities per acre*</u>

| | Corn | Soybean |
|---|---|---|
| Price per bushel, dollars | 1.20 | 2.60 |
| Yield per acre, bushels | 111.7 | 33 |
| Gross value per acre, dollars | 134.00 | 85.80 |
| Gross value of one acre of corn---corn-soybean rotation, dollars | 117.93 | |

* Sources [16,17]

Table 17 Machinery and storage requirements for land purchase activity*

| | |
|---|---|
| **A. Machinery (dollars)** | |
| Tractor | 5,625 |
| Plough | 865 |
| Combine | 12,000 |
| Wagons | 800 |
| Augers | 150 |
| Sprayer | 860 |
| Harrow | 175 |
| Total | 20,475 |
| **P. Storage** | |
| Two 10,000 bushel bins | 5,000 |
| Bin construction | 5,000 |
| Total | 10,000 |

* Sources: [16] and consultation with School of Engineering, Ontario Agricultural College, University of Guelph.

Table 18 Marginal propensities to tax, consume, and save farm income[a]

Period 1

| Tax Bracket | Income (dollars) | Marginal Propensity to tax | Marginal[b] Propensity to consume | Marginal Propensity to save |
|---|---|---|---|---|
| 0 | 1,000 | 0 | 1.0 | 0 |
| 1 | 1,000-3,000 | .215 | .500 | .285 |
| 2 | 3,000-5,000 | .270 | .400 | .330 |
| 3 | 5,000-9,000 | .300 | .300 | .400 |
| 4 | 9,000-13,000 | .355 | .250 | .395 |
| 5 | 13,000-16,000 | .430 | .200 | .370 |

[a] Two thousand dollars of non farm income is considered tax free and completely consumed by the farm family. Thus family tax exemptions are $3,000.

[b] Basic data source [20]

Table 19 Receipts and expenses for cattle feeding activities[a]

| | Receipts | Dollars | Expenses |
|---|---|---|---|
| Subperiod 1 | | | |
| Feed and livestock expense | | | 1,430 |
| Crop planting, 100 acres | | | 4,626 |
| Subperiod 2 | | | |
| Sale of 150 cattle at $30 cut, ave. wt. 1050 lbs. | 47,500 | | |
| Feed | | | 380 |
| Shipping and marketing | | | 1,200 |
| Crop harvesting, 100 acres | | | 1,900 |
| Subperiod 3 | | | |
| Purchase of 150 cattle at $34.5 cut. ave. wt. 450 lbs. | | | 23,287 |
| Shipping and marketing | | | 2,100 |
| Feed and livestock expense | | | 840 |
| Total | 47,500 | | 35,763 |
| Inventory change[b] | | 0 | |
| Net income from feeding 150 cattle | | 11,737 | |

[a] Date sources [4,16,18]

[b] In the first year of cattle feeding, income derivation would be adjusted for inventory changes.

Table 20 Building and equipment requirements for cattle feeding[a]

| | dollars |
|---|---|
| A. Building facilities (20 year life) | |
| Pole barn 36' by 60' | 3,800 |
| Feed building 10' by 20' | 500 |
| Corral system and fencing | 1,300 |
| Feed bunk | 700 |
| Water system | 200 |
| Concrete tower silo, 24' by 50' | 4,500 |
| Electrical work and misc. | 1,000 |
| Total | 12,000 |
| B. Equipment | |
| Silo unloader and equip. | 2,800 |
| Feed meters and bins | 950 |
| Corn grinder and motor | 900 |
| Manure loader and spreader | 800 |
| Scales | 550 |
| Automatic feeding system | 2,000 |
| Total | 8,000 |

[a] Date source [4]