THE UNIVERSITY OF MANITOBA

A MULTIPERIOD LINEAR PROGRAMMING ANALYSIS OF NET FARM INCOME GOAL ATTAINMENT IN MANITOBA CROP DISTRICT NUMBER 10

by

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ABSTRACT

In developing this thesis, it was pointed out that the Agricultural Industry is faced with many severe problems. One of the most persistent of these, and one which attracts much discussion, is the problem of low net farm incomes. Evidence that incomes are low is ample. For example, over the period 1963 to 1969 Manitoba farmers averaged only 3,772 dollars net farm income. Another group of one hundred and thirty-six farmers, who were members of the Manitoba Farm Business Group Program, earned an average of 6,992 dollars net farm income in 1969.

An income goal or target was selected at a level of 10,000 dollars annual net farm income, to serve as a standard for comparison of results of the multiperiod linear programming models developed in the thesis. It was deemed that this value of income would give most farmers a reasonable return on their labor, management, and investment. The objective of this study therefore, was to determine whether optimum organization of a farm's resources and enterprises, within the existing institutional framework, would allow the farmer's net farm income to grow to the level of 10,000 dollars annually by 1980.

Several factors were studied for their effects on the growth of net farm income. Among them were: initial size of farm unit in terms of acres of land base, supply of working capital for the operation of the farm, opportunity to rent or purchase land, and ability to limit personal withdrawals from the farm business.

As adjustments in any growth process take time to occur, the most crucial element in developing the model used in this thesis was the method of incorporating the time variable. Multiperiod linear programming was chosen as the marginal analysis technique since it is capable of handling time-dated variables. It is also tailored to the use of a finite number of activities, which had to be considered in this study. Within this framework a discounting procedure was also utilized to bring the streams of income over time to a present value for comparison to the income goal.

The area selected for study was Crop District Number 10 of the Province of Manitoba. This area was chosen for two main reasons: 1) there is a very large percentage of the area with a homogeneous soil type, represented by the Newdale Soil Association, and 2) there are many farmers who keep good records, which were required for analysis to give the initial resource base for each of the three representative farm sizes used in the study.

The model constructed for use in this thesis, in addition to the usual activities covering crop and livestock production, included a comprehensive range of management activities. These were mostly of a financial nature, for example, activities and restraints to cause income taxes to be paid, activities to allow for a cash flow system throughout the twelve years of the model, and activities to allow the land base to be augmented through either rental or purchase procedures.

In terms of the physical plans generated by the multiperiod linear programs run for this project, there tended to be a stabilization in types and levels of activities over the last few years of each model.

This was especially so for the cropping program from year to year. Emphasis in the cropping plan was on production of barley and rapeseed. Among the livestock enterprises the main activity entering the various solutions was the production of feeder cattle from a stocker program.

The major part of the investigative effort in this project was directed toward financial activities within the models. The most important findings in this area were as follows:

1. Activities which called for large withdrawals of cash from the system had a very pronounced negative effect on each farm size in terms of increasing net farm income over the time period covered by the models. This finding was most evident in solutions in which withdrawals for family consumption were varied and ones in which income taxes were not required to be paid.

2. Lengthening of repayment schedules for initial intermediate and long-term debts produced little response in terms of increasing net farm income.

3. Availability of land which could be rented gave an increase in the flow of net farm income compared to those solutions in which land holdings could only be increased by land purchases.

4. Off-farm investment in safe, Government of Canada Savings Bonds increased net farm income only slightly above the return earned from internal investment of farm funds.

It was concluded from the results of the multiperiod linear programming solutions for the three representative farm sizes, that only the large size farm, over 760 acres initial size, had a consistant opportunity of earning the target income of 10,000 dollars or more net farm income per year by 1980. The major impediment to the growth of all sizes of farms was the level of capital withdrawal for non-farm purposes.

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CHAPTER I

INTRODUCTION

The agricultural industry always seems to be in a state of crisis. New situations, with unexpected problems arising from them, face the industry much as one breathtaking display replaces another with each turn of a kaleidoscope. Much of the recent discussion has been an expression of concern over the apparent lack of a clear cut National Agricultural Policy. The desire to improve the contribution that agriculture makes to the economy is always present. However, this desire often manifests itself in terms of programs to alleviate certain short-run developments engendered in each crisis that confronts policy makers. Indeed, some of the programs instituted in the past as short-run solutions now constitute part of the problem in developing a long-run set of goals for agriculture. For example, the Feed Freight Assistance and Prairie Farm Assistance programs were introduced as short-run solutions to problems current during the war, yet are still with us in the 1970's.

The fact that major problems in decision making at both macro and micro levels are facing the agricultural industry is well documented. Of particular recent importance were the reports of three studies, two directly on agriculture, the third including a section on agriculture as part of a larger study; they were, the Report of the Federal Task Force on Agriculture [57], the Report of the Special Committee on Farm Income in Ontario [58], and the Manitoba Report on Targets for Economic Development (T.E.D.) [56]. These reports examined the difficulties that plague the industry in all their ramifications. A fairly inclusive list, developed by researchers for the Federal Task Force on Agriculture, showed the magnitude and scope of the problems. One can note that all are closely related; that each has implications for all the rest. The list includes problems of:

> . . . (1) low net farm income, (2) prevalence of small, non-viable farms with low incomes, (3) regional disparity of incomes within agriculture, (4) instability of yields, prices, and incomes, (5) cost-price squeeze, (6) marketing, (7) misdirected research efforts, (8) decline of the rural community, (9) international marketing situation, (10) surpluses of farm products, and (11) low level of education found among farm people [64, pp. 3-18].

Obviously much study is required if reasonable solutions to these problems are to be determined.

Another obvious fact in considering the above list is that one cannot study all those problems in a complete way at the same time. Each problem must be studied in depth while realizing that recommendations derived from such study may contradict recommendations from studies of the other problems. There must be developed some vehicle for integrating solutions from all studies. Criteria are necessary for deciding on the trade-offs which will ultimately be required in setting forth over-all policies for the agricultural industry.

Low Net Farm Incomes

Consistent with the above approach the purpose of this thesis is to study the first problem cited; that of low net farm income. That this problem is very real may best be illustrated by showing some of the statistics on net farm income of Manitoba farmers. The following table was derived from the Yearbook of Manitoba Agriculture series from 1963 through 1969.

Table 1.1

Average Net Farm Income of Manitoba Farmers
1963-1969

Year	Average Net Farm Income*
	. . . . dollars . . . .
1963	2,857
1964	3,900
1965	4,145
1966	3,889
1967	3,997
1968	4,309
1969	3,306
Average Net Farm Income 1963-1969	3,772

*For an example of the calculation of Net Farm Income see Appendix A, Table A.7, page 161.

When one considers that net farm income is the return to all farm family labor, to the operator's management, and to the capital investment in the farm, the impact of the above figures becomes more forceful. The average yearly net farm income over this period, as calculated in Table 1.1, is 3,772 dollars. Assuming that the average farm family were able to live on a payment for labor and management as low as 3,000 dollars, this leaves a 772 dollar return to farm capital investment. The census year, 1966, is the only year for which the per farm value of farm capital investment is available. It is, however, the middle of the range of years over which net farm income was averaged in Table 1.1. In 1966 average farm capital investment in Manitoba was 44,200 dollars [49, 1969, p. 72]. Taking 772 dollars as a return on that investment gives a yield of only 1.75 percent.

If one assumed a reasonable return on investment were six percent annum, and calculated the residual as a return to farm family labor and management, the following would be determined:

Net Farm Income	$3,772.
Inputed Return to Investment	2,652.
Residual Return to Farm Family Labor and Management	$1,120.

Such a return, of course, is far below what could be considered a bare subsistence level.

To further document the levels of net farm income earned by Manitoba farmers, the following information was obtained. Fifty-five farmers who belonged to the Western Manitoba Farm Business Association* (W.M.F.B.A.) in 1968 earned an average of 7,366 dollars net farm income [20, p. 10]. One hundred and thirty-six farmers who were members of the Manitoba Farm Business Group Program** (M.F.B.G.P.) in 1969 earned an average of 6,992 dollars net farm income [41, p. 8]. Although these returns

*The Western Manitoba Farm Business Association is a voluntary association of farmers in the Neepawa-Hamiota-Miniota area. It has been in operation since 1961. The members are interested in improving their own farm business and management techniques as well as providing data for research work in the field of farm management [20, Foreword].

**The Manitoba Farm Business Group Program was an educational service provided to interested Manitoba farmers by the Manitoba Department of Agriculture. Information was provided to farmers on many aspects of farm management, both physical and economic. While the Farm Business Group Program is no longer formalized, the Department still provides an analysis of the Farm Account Books for farmers with much valuable information retained for research purposes.

were much higher than for the average of all Manitoba farmers for the years 1968 and 1969, it must be remembered that their average farm capital investment was probably more than double the average for all farmers. Again assuming a minimal return to labor and management, the residual income as a return to farm capital investment was far from spectacular. This is clearly demonstrated in Table 1.2.

Table 1.2

Return to Investment-Selected Farms

	W.M.F.B.A. Farms 1968	M.F.B.G.P. Farms 1969
	. . . . dollars	. . . .
Net Farm Income	7,366.	6,992.
Farm Family Labor and Management	3,000.	3,000.
Residual Return to Investment	4,366.	3,992.
Capital Investment	125,853.	116,947.
Percent Return on Investment	3.47	3.41

To study the problem of low net farm incomes, a specific geographical area was chosen for analysis. This was Manitoba Crop District Number 10.* The analysis of the financial statements of farms in this area indicated that the phenomena of low net farm income was also a problem here. The complete financial statements of three representative farm sizes** from the area are found in Appendix A. The Farm Income

*The Crop District is described in Chapter IV, pages 43-44.

**The representative farms are discussed in Chapter IV, page 45.

Statements for the three farms show net farm incomes of 3,088, 6,096 and 9,098 dollars for the small, medium, and large farms, respectively. These incomes parallel those found above and, again, cannot be termed acceptable.

While a comparison of the incomes of farm owners and non-farm owners and managers may not be strictly appropriate because of the differences in the nature of the respective businesses, it never-the-less provides an interesting perspective to the problem.

In 1968 and 1969 farm incomes of the special farm groups noted above, appear to fall into the lower levels of the average incomes of non-farm owners and managers as presented in Table 1.3. However, Table 1.3 was constructed from information which was included in the 1961 census (i.e., incomes for the year ended May 31, 1961). It is interesting to speculate how far behind farmers would be if 1968 or 1969 figures for non-farm owners and managers were available for direct comparison. It must be further pointed out that Table 1.3 gives only the payment for employment and management of the non-farm industry or service. The figures do not include any returns to capital. By comparison, the net farm income figures cited include returns to all components; farm family labor, capital, and management.

One can see that net farm incomes were low, both absolutely, in terms of returns to labor or investment, and relatively, when compared to managers and owners in other industries. In this study, a goal for net farm income attainment was chosen which would give farmers a specified return on labor and investment, and which could be used to evaluate the results of optimal farm organization patterns determined in this study.

Table 1.3

Average Income From Employment
Non-farm Owners and Managers

Owners and Managers in:	Average Income
	. . dollars . .
Retail trade	5,571.
Miscellaneous services	6,267.
Provincial administration	6,567.
Construction industries	7,089.
Furniture and fixture industries	7,321.
Education and related services	7,598.
Wholesale trade	7,798.
Non-metallic mineral products	8,258.
Metal fabricating industries	8,653.
Finance, insurance, real estate	8,908.
Transportation equipment	9,411.
Petroleum and coal products	9,516.
Knitting mills	9,760.
Service to business management	10,080.
Chemical and chemical products	10,303.
Paper and allied industries	10,547.

Source:

Derived from Table 4.12 in: Jenny R. Podoluk, Incomes of Canadians (Ottawa: Queen's Printer, 1968), pp. 76-78.

Farm Goals

For the farmer-decision maker who must operate within the context of the above income problem, there exists a multiplicity of courses for action. The response each farmer makes depends upon several factors; the levels of farm resources at his disposal, the line of credit at his command, his age, his level of management ability, and his aspirations for development of his farm unit. The last factor is most important. If the farmer's goals are well defined, he can make adjustments in the other factors to effect the most beneficial response to the problems faced.

It is most important that micro level goals be firmly established within the context of, and consistent with, those established under a national policy. As conditions change the basic economic questions of what, when, how, and for whom, as they are decided upon at the micro level, must be constantly re-evaluated concurrently with policy implementation at the macro level.

To develop this thesis consistent with the above declaration of the importance of specific goals, the goals set out in the T.E.D. Report were adopted. They provided a benchmark by which the performance of the representative farms (discussed later in the thesis) could be evaluated. The T.E.D. Report stated that by 1980 individual farms ought to earn 10,000 dollars of net farm income arising from 40,000 dollars of gross income. This income was to be generated from a farm base of 1,000 acres with a capital investment of 100,000 dollars [56, pp. 54-58]. Since the primary problem with which this thesis is concerned is one of low net farm income, the 10,000 dollar per annum net farm income goal specified by the T.E.D. Report provided a focal point for the study. It presented a challenge to determine the economic factors which must be changed to aid farmers in its attainment.

Objectives and Their Importance

The problem delineated above is basically one of growth. Farm net incomes were demonstrated to be deficient when one compared them to incomes earned by others in positions of management and ownership, or to the farm net income goal specified for 1980. The problem stated in this manner, required a normative solution (i.e., a solution specified in terms of what ought to be done to promote growth of the farm firm so that the above goal might be attained).

The objective of this study therefore became to analyze representative farm firms in order to determine effective organizational response patterns. The farm firms were examined over a period of time to determine whether optimum allocation of farm resources in the production of various farm commodities allowed the firm to achieve the growth rate necessary for the attainment of the earlier specified income goal.

A second objective of this study is a logical extension of the first. If the representative farms analyzed under objective one could not attain the 10,000 dollar net farm income goal with optimum allocation of given resources, what levels of resources optimally combined would allow its attainment?

Adequate investigation of future patterns of farm organization is most important. The whole effort expended in trying to help the farm firm attain its goals is wasted in conflict if programs developed do not harmonize interrelationships in the agricultural industry.

There are many groups and individuals in the industry that require information on the possible future organization of farm firms. Farm input suppliers must be able to determine in advance the quantities of inputs individual farm enterprises will use. From this can be predicted the aggregate supply of inputs required. Suppliers can integrate this information into their knowledge of their competitive position in the market, thereby obtaining estimates for their individual production units. If such plans and estimates are accurate, farm suppliers will be in a position to serve farmers' needs efficiently.

Farm management extension specialists require information on possible future optimum farm organization patterns and on methods of farm firm growth. It is their responsibility to help farm managers institute changes in farm organization which are designed to promote the attainment of farmers' objectives. When recommendations are made to many farmers in an area, advisors must be aware, not only of the immediate effects for the individual farmer, but also, of the aggregate effects which may occur when all farmers act on their advice.

Another group vitally interested in farm growth response patterns is comprised of the credit agencies, both public and private, which serve the farm community. Special attention is made here to the interests of this group, which could have been assumed to fall in the category of farm input suppliers above, because of the tremendous importance that capital has come to have in farming. As a result of the cost-price squeeze, farmers have been forced to expand their operations to maintain some positive level of aggregate income. The expansion process necessitates resorting to financing of additional land and equipment purchases. There has been a large measure of substitution of capital for labor in this expansion process. Lending agencies need to know if this trend is to continue. They are, therefore, always interested in studies which can help them plan in a rational way for the future capital requirements of the farming industry.

Of course, farmers themselves are most concerned about future organization of the farm firm. Such information aids them in formulating realistic goals when it is used in conjunction with their knowledge of current conditions. Based on information from this study, some farmers will accept the challenge to attain the net farm income goal specified earlier; others will prefer to settle for something less if the organizational changes required are too great. This may be especially true where the farm manager is approaching retirement age or where he combines farm and non-farm activities in such a manner as to satisfy his objectives. In considering any changes, the farmer might consult his area farm management specialist who can help him determine the optimum method of reaching desired results, or show him the costs associated with not using optimum resource allocation. The farmer, of course, must make the final decision, for it is he who must bear the full consequences of his decisions. The farm management specialist can only try to ensure that an informed decision is made.

The above discussion examined some of the important ways in which information on optimal future farm firm organization may be used. The examples presented are objective, empirical uses. There is another level at which such information could be used. This is in agricultural policy formulation. The implications to be derived from this study may not result directly in a specific new policy. More likely it could provide policy makers with very subjective or qualitative generalizations about the agricultural industry, which in conjunction with other socio-economic forces emanating from both the agricultural and non-agricultural sectors, will result in the development of over-all effective policy for the industry.

Analytical Approach

The analytical approach or technique used in this thesis is micro-economically oriented. Three representative farms were developed from a selected set of farm records from Crop District Number 10. These representative farms provided the initial resource restraints for the specification of a multiperiod linear programming model.

The coefficients comprising the activities specified in the program arose in three basic ways; (1) from technical requirements specified in other agronomic disciplines (i.e., engineering, plant science, soil science, or animal science), (2) from assumptions which relate the models as closely as possible to real farm situations, and (3) from functional requirements of the computing algorithm which provided for a flow of information through the model from one period to another.

The major problem in this thesis, as discussed above, is to determine if farms of different sizes can attain a net farm income goal of 10,000 dollars per annum by 1980. Because the goal is stated in terms of net farm income, the objective functions for the multiperiod linear programming models are constructed to reflect the effects of the various activities in the model on net farm income. The maximized net farm income as generated by the model can then be compared directly to the income goal. The effects of changes in one or more variables on net farm income can be readily evaluated by comparing the results from the different models. The function actually used is the discounted sum of annual net farm incomes, where net farm income is defined as the return to the farm family's labor, management, and investment. By using the present value of the future income stream a common point in time is determined for the comparison of the income earned in the model with the target income.

In Chapter II a review of a number of factors which have been put forward as affecting the growth of the farm firm is made. Some of these factors are incorporated into the model as will be seen in Chapter IV. Chapter III contains the development of some of the theoretical considerations required as a basis from which to build the programming model used for this study. As indicated above, Chapter IV presents the description of the functional aspects of the model. This chapter contains the keys to the appendices which contain most of the background analysis which was required in the construction of the programming models. In Chapter V some of the most significant findings of this research work are developed. Because of the extent of the numerical results which are generated in a computer oriented model, particularly a multiperiod linear program, it is necessary to draw out the highlights contained therein without overwhelming the reader with a myriad of figures. Chapter VI finalizes the study. The conclusions to be drawn from the study, and the implications thereof, are discussed.

CHAPTER II

FARM FIRM GROWTH FACTORS

Farm firm growth is a very complex phenomena. The complexity arises first due to the large number of characteristics of a farm firm which can be analyzed for growth. For example, one can use gross receipts, gross profits, net farm income, return to investment, net worth, or any of a number of other criteria as a "yardstick for growth."

Growth in terms of the chosen criteria may be measured as an absolute amount, or in terms of a rate per specified period. Whichever method is chosen, growth over the period of measurement is compared to some predetermined criterion and judged to be a "good" or a "bad" result on the basis of this comparison.

The ultimate purpose, of course, is not simply to determine the amount of growth which has occurred. Whether the result is positive or negative, the purpose of analyzing a firm's growth is to isolate the factors contributing to that growth. If it were positive, the manager could intensify his application of the growth factors, thus achieving even better results. Or, if the firm were not growing, then the analysis would hopefully indicate the misallocation of productive efforts, and identify potential avenues to growth.

In the second place, farm firm growth complexity is due to the many variable factors which may contribute to the process. Sahi [63, pp. 11-28] identified a larger number of factors potentially relevant to the growth process. These factors were identified in two distinct groups; economic factors and non-economic factors.

Size of the farm business in the initial year is one economic factor which contributes to farm firm growth. A large firm, whether measured in terms of value of production, total farm capital, or number of acres of improved land, has a better base from which to promote growth than a smaller one. There are several reasons for this. Most important is the fact that the broader base allows the larger farm to assume more risk, and thereby the opportunity to reap extra profits frequently attached to riskier enterprises. Also, the broader base of the larger farm is more attractive to lenders when the farmer attempts to borrow funds, whether short term, for operational finance, or long term for capital expansion.

If a farmer is short of funds, expansion of the farm firm may be expedited by borrowing capital. The important criterion when incurring liabilities is that the resources in which investment is made be capable of returning at least sufficient amounts to pay the interest and return the principal over the period for which the liability is effective. A further factor in taking on new liabilities is how they affect the relative financial strength of the farm firm. Care must be taken to achieve balance among short, intermediate, and long term liabilities so that the farm firm growth plan does not become vulnerable to excessive risk in any one of the categories.

Sahi [63] included as factors contributing to growth; use of fertilizer, decrease in summerfallow acreage, increase in wheat acreage, and disinvestment in cattle enterprises. These factors were peculiar to the time period which Mr. Sahi analyzed. A more appropriate way to discuss such factors would have been in terms of return or growth due to good management practices. Adoption of new technology and taking advantage of temporarily high marketing opportunities fall more within the purview of management efficiency than in generalizations about growth promoting factors.

The non-economic factors identified by Sahi as contributing to farm firm growth included attitudes toward risk and uncertainty, goal aspirations, educational level, age of the operator, and experience in farming.

Farmers' attitudes to risk and uncertainty are a composite of the many forces to which they are subject. Foremost among these is the innate reaction of the individual to risk situations. Some people are "born gamblers," others are conservative in their reactions. These basic reactions to risk are tempered by the remainder of the factors noted above, which accrue over time (i.e., aspirations, education, experience, and age). The organizational pattern adopted by a farm firm is subject to these attitudes in addition to the economic situation of the firm at any point in time. As Heady [8, pp. 500-501] notes, "Given an uncertainty setting, the optimum plan for any individual depends on his psychological makeup, his capital position, and the ends to be maximized."

The effects of factors such as farmers' aspirations, education, age and experience on the growth pattern of farm firms, are extremely difficult to measure. These factors are almost inextricably interdependent, but one can measure each of their separate effects by a cross-correlation analysis. The total effect of all non-economic factors can be determined. One has only to identify all the relevant economic factors, measure their effects accurately, and deduct them from the total growth amount. The balance must be the total effect of all non-economic variables.

It is almost redundant to explain that, as farmers age their aspirations change, and their experience enables them to make management decisions more easily than beginning farmers who have little experience on which to draw, and who may not have well established goals.

A beginning farmer may have an excellent educational background and a well defined set of goals. But, he may be prevented from engaging in certain risky enterprises because he cannot afford to take a chance on an uncertain return from the enterprise during the initial or establishment phase of its operation. Although a young farmer may have a promising long-run opportunity for a successful business, he could easily be "wiped-out" by adverse short-run situations.

Similarly, an older farmer approaching retirement age is unwilling to invest in some of the more risky farm enterprises even though he is very well established. Often farm families are caught for many years in a forced saving trap by goals which pressured them toward ensuring a debt-free farm by retirement age. This phenomenon prevents the older farmer from engaging in risky enterprises which, if they were to fail, might threaten his "retirement fund."

Not only is there a significant amount of interdependence among the non-economic variables affecting growth of the farm firm, but also an interdependence among the economic and non-economic factors when all are considered together. The "classic" example of this interaction is in the effects of farmers' attitudes to risk and uncertainty on their willingness to utilize efficiently capital resources available to the firm. Heady [8 , pp. 550-555] discusses the complete range of types of capital rationing, from the case of internal capital rationing to rationing by external lending firms.

The most efficient use of capital in a farm firm occurs when it is used to the point where its marginal cost and marginal return are equated. However, farm managers, due to their attitudes toward uncertainty, as determined by their age, education, family responsibilities, etc., tend to discount rather heavily the returns from additional use of available capital. Figure 2.1 depicts this action by farmers.

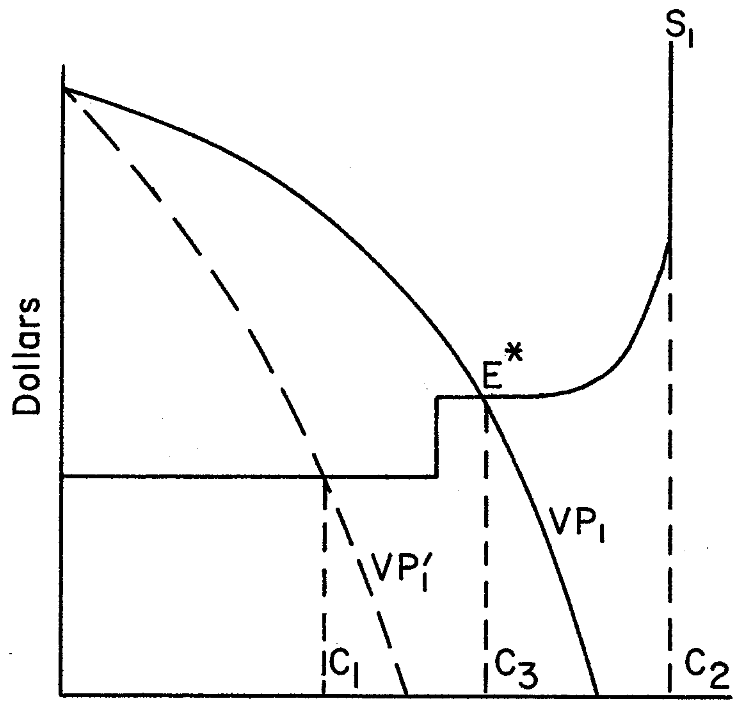

Figure 2.1 Effects of Risk and Uncertainty on Capital Use**

*Dotted line EC_3 added by author.

**Source: E. O. Heady, Economics of Agricultural Production and Resource Use (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1952), p. 552.

In Figure 2.1 the function S represents the supply of funds available from lenders at various rates of interest. It represents an unlimited supply in this case, because more funds are available than would be necessary for the farmer to equate marginal cost and marginal return, which condition would be satisfied at point E with quantity C_3 of capital.

In further regard to Figure 2.1, Heady [8 , p. 551] points out in his discussion that;

> Curve VP_1 . . . can be taken to indicate the marginal value productivity of capital on a particular farm, and while it can be viewed in an ex poste light, it more appropriately serves as the manager's expectation of the value productivity of capital. Curve VP_1' is the discounted marginal value productivity curve. It represents the return under VP_1 discounted because of uncertainty; . . . The latter curve thus serves as the borrower's effective demand curve since it indicates the amount of capital which would be used at any one interest rate were funds available at that price.

The same type of analysis as Heady made could be applied to each resource that might possibly be used in the operations of a farm firm. One would expect the same sort of discount due to subjective evaluations by the individual operator.

Others who have researched factors involved in farm growth have studied the effects of economic variables on the growth process. Martin and Plaxico [37] in their study, Polyperiod Analysis of Growth and Capital Accumulation of Farms in the Rolling Plains of Oklahoma and Texas, studied the effects of tenure situations (i.e., renting versus buying), starting farm size, capital rationing, and consumption levels.

Significant decreases in numbers of farms and increases in their size prompted Martin and Plaxico [37, p. 2] to ask such questions as:

> Who are the farm operators that can expand their farm size? What are their capital and equity characteristics? Under the existing policies and structure of real estate credit institutions, which farmers can borrow purchasing power for capital goods?

It is their contention [37, p. 2] that: "Answers to these questions may provide some insight as to the structural characteristics of the farm producing units of the future."

This thesis parallels the Martin and Plaxico study in that the question under consideration here is, "Who are the farm operators that can expand their net farm income to 10,000 dollars per annum by 1980?" And, "What organizational structure of the farm, including production and finance activities, is required to give such an income?" The studies are similar in other respects also. The concept of the representative farm as the basis for specification of the initial resource restraints is used in both. The adoption of multiperiod linear programming as the method of obtaining optimal solutions to several alternative problem specifications is a third similarity.

With these similarities in the two studies, the results determined by Martin and Plaxico [37, pp. ix-x] provided some indication of what might be expected for results in this study. They found that:

> Minimum starting equities ranged (sic) from a low of about $18,000. Differences in minimum starting equities for different farm growth situations were not large when all farmland could be rented; however, the difference in required growth rates over time was quite significant. Minimum starting equities increased substantially, from about $47,000. upward, when all farmland was purchased. The most relevant variable, with respect to minimum starting equity requirements, was tenure situations. However, growth objectives and annual consumption levels were important, especially for owner-operated farms. . . . Farm growth was maximum under a policy of renting all land operated for expansion purposes. Land acquisition through purchasing all land operated was one of the most limiting factors to farm growth. Different starting farm sizes also

> resulted in different growth rates. The effect of borrowed capital levels was significant, but different consumption levels had more effect on the growth process. An annual consumption function equal to $3,000. plus 75 percent of the net returns almost precluded growth.

The significance of these variables in the growth process of farms in Oklahoma and Texas indicated that they ought to be examined in relation to the problem in this thesis. Also, Sahi [63] found that these variables were important in growth of farms in the Newdale area of Manitoba, thereby concurring in the results found by Martin and Plaxico.

Martin and Plaxico recognized that there was a major drawback to their study. The physical operational activities of farming were represented in the model as one production activity. There was thus only one interface between the production activity and the financing and growth opportunity activities. The more realistic and appropriate concept, as included in this study, is to allow complete interaction of the various production, finance, consumption, and transfer activities.

Boehlje and White [43] presented, in a very concise argument, the reasoning for using either the single aggregate production activity or the completely interactive type of model. They said [43, p. 547] that:

> Treating the organization of production as an exogenus and irrevocable decision in a firm growth model seems reasonable if (1) linear relationships are assumed; (2) one is analyzing the firm in a long-run context where, by definition, all factors of production are variable; (3) all factors, including types of credit, are available in unlimited quantities or, if limited, are available in constant proportions; and (4) relative prices and technology are constant.

On the merits of designing a completely interactive model they noted [43, pp. 547-548] that:

> It is important to consider organization decisions or decisions concerning production and annual labor and capital acquisition as an integral part of the growth process when the above considerations are not a reasonable approximation of reality. The existence of resource fixities during specified periods of the planning horizon may cause the optimal production organization to change from period to period as the fixities change. Institutional restrictions may cause the relative availability of particular classes of resources to differ at any point in time and to change over time. . . . , the farmer's ability and willingness to manage hired labor may place a limit on the labor supply the firm will utilize. This limited labor utilization combined with an increasing supply of capital may allow substitution of capital for labor, resulting in changes in the optimum organization of the firm over time.

The latter arguments posed by Boehlje and White support the basis on which the model for this study was developed. In the model, there are institutional changes over time which cause changes in the optimum solution. This occurs in reference to the quota system, which changes from the old, specified acreage system to the new system based on assignment of acreage to specific crops for delivery purposes. Also, as the model progresses and long and intermediate debts are paid off, the opportunity to borrow for further land acquisition increases. This type of increase is analogous to the changes in resource fixity over time as noted by Boehlje and White in their argument above.

The above discussion serves to review two main approaches to the study of the growth process in farm firms. The work done by Sahi [63] could be described as positivistic. He examined the conditions which have been variously postulated as determinants of growth, and reported his findings on the growth of farm firms in the Newdale area of Manitoba over a period of five years, 1962-1966. Juxtaposed to this is the Martin and Plaxico study [37], which exemplifies the class of studies which are termed normative. This type of study attempts to determine what conditions ought to be in the future. Assumptions are made about the present state of the farm firm and about expected relationships among a number of critical variables. A solution to the problem, which specifies the activities that will yield the largest value of some criterion function, is then determined through the use of any one of a number of optimizing models. In the Martin and Plaxico study multiperiod linear programming was used.

In the above discussion a number of factors have been identified as being relevant and significant in the growth process of farm firms. These have been presented in relation to particular methodologies which applied to growth. Another economist, Warren R. Baily [42, pp. 3-4], discussed the "necessary conditions for growth of the farm business firm" in a very broad sense using five all-encompassing categories for the growth factors.

The first condition Bailey notes as being necessary for growth to occur is that there be an excess managerial capacity available. Management ability is one resource that is rarely identified in any quantitative respect. Most studies simply assume that "average management abilities" exist for the firm under consideration, without explaining what that term means. In problems solved by linear programming, the level of management ability must be assumed to be at least at the level required to implement all activities as specified in the solution. This does not quantify that level of ability very explicitly. But, perhaps no other way exists.

Bailey's second necessary condition is that the business be profitable. He says [42, p. 3] that; "Cash receipts on the average must exceed cash expenses. The firm need not be the most efficient firm in an area or group, nor even highly efficient." The main criterion here, as it relates to growth, is that there be some margin for reinvestment, some earned financial progress, even if production is at a very low level, with less than optimum combination of factors of production and enterprises.

Third, a minimum starting size is necessary. The farm firm must have a resource base large enough to generate the level of output necessary to support, in addition to the total production costs, the farm family living costs, plus ". . . some surplus cash for expanding the resources . . ." This condition, of course, is very closely related to the second. If the farm is extremely small it will not generate sufficient cash income for receipts to exceed expenses of production plus family living. If these expenses are covered, family consumption may be at an impoverished level with no funds available for growth.

Bailey's fourth consideration is attributed to Edith Penrose [12]. Bailey [42, p. 3] states:

> She observes that firms having opportunity for growth are often those that in effect find themselves with some unused production services - - a term she prefers over the term resources. A firm with some unused resources obviously is in a state of disequilibrium.

What Bailey implies here is that there exists another combination of resources which would yield a better outcome, a larger maximized profit for example, if a combination could be achieved which just used all the resources available. This might be the result of adoption of a new technology or through procuring additional complementary resources which would allow all resources to be used.

The last idea in the above paragraph gives Bailey's last necessary condition for growth to occur. That is, additional resources must be procurable. This is an important condition in that, as noted above, it allows the operator to utilize all his resources to the maximum. This includes his resources in terms of management ability. A farmer must be able to rent or buy more land, to purchase additional hogs, cattle or other livestock, and to obtain goods and services from agri-business in such quantities as allow him to just exhaust his management abilities. At such a point there would remain no opportunity for growth unless and until some change occurred in one or more of the underlying variables.

Chapter II has discussed some of the variables which have been found to have important implications for growth of farm firms. Some of these are considered later in this study in terms of their effects on growth and structural organization of farms in Crop District Number 10. Chapter III now presents some theoretical considerations of factors involved in growth, as well as a justification of the use of multiperiod linear programming in studying growth processes.

CHAPTER III

THEORETICAL CONSIDERATIONS

In Chapter I the problem for consideration in this thesis was outlined. Net farm incomes were shown to be deficient, in that they neither met the target level of 10,000 dollars per annum, nor compared favorably with incomes earned by owners and managers in other industries. The problem was thus determined to be one concerning farm firm growth, or more properly, a lack of growth, in net farm incomes. In examining the dimensions of the problem, important ramifications were indicated for interested parties in areas contiguous to the farm firm, as well as for the farm firm itself; for the agri-business area, which supplies the inputs so necessary to efficient farm production; for the agricultural policy area, where socio-political forces operate to develop programs designed to alleviate agricultural problems; for the extension-education area where ways and means are found to implement the programs through consultation with farmers.

In Chapter II a number of factors which have been found to influence the growth process were discussed. The effects of several factors were noted in a generalized way from the empirical results as presented by Sahi [63] and Martin and Plaxico [37]. To this point, no concise definition of the meaning of growth, as it applies to the farm firm, has been put forward in this study. Neither has there been any discussion of the theory involved in farm firm growth nor of a procedure to link the theory to the empirics of the problem as it has been defined. The purpose of Chapter III is to fill these voids.

Growth is simply defined as a gradual increase in size or as a process of growing. But this definition does not sufficiently relate the term to the context of the problem of this thesis. The problem being considered is one of deficiency of net farm incomes. Therefore, the investigation of the growth process in this thesis must be couched in terms of increase in net farm income.

The most important dimension of the growth process is, of course, that it is time dependent. The amount of growth depends on the rate of growth per unit of time, and on the number of units of time. For example, if a farm firm earns 2,000 dollars net farm income in the base year and income increases by 500 dollars per year for five years, then at the end of the fifth year income will be earned at the rate of 4,500 dollars per year, a growth in the rate of annual earning of 2,500 dollars. As noted in Chapter I, the objective in this thesis parallels the above discussion (i.e., to determine whether the annual net farm incomes of farmers in Manitoba Crop District Number 10 can grow from the annual income earned in the base year of 1968 to an annual income of at least 10,000 dollars by 1980).

Growth as an economic process adds greatly to the complexity of problem solution. The dynamics of a problem must be accounted for in attempting to find a solution. When time is a factor all of the parameters of that problem may change over time. For example, technological advancements make profound changes in the agronomic practices used by farmers in production. These advances very often cause important changes in the capital/labor ratio which places added emphasis on sound decision making and good financial management of the farm firm.

The other very crucial aspect of the effects of time in the growth process is, that prices of goods produced and costs of inputs used in production may change. This means that the producer is uncertain of the effects of market changes on both input and output sides over the course of the production period, which for agricultural products is a relatively lengthy time horizon when compared to many manufacturing processes. As above, these changeable factors have important implications, especially in the financial management of the farm firm.

Heady [8 , p. 382] characterizes the inclusion of the time dimension in an economic analysis of the farm firm in a very concise manner. He states:

> It is the time considerations in production which give rise to the real difficulties in decision-making. If production were instantaneous, decisions could be perfect, since the production function and the prices for factors and products would be known. This situation is far from reality in agriculture and, therefore, resource management must involve an immense amount of guesswork.

Even though the perfect knowledge situation, which is one of the main conditions included in the theory of firm under pure competition, abstracts from reality, it is still widely used in economic analysis to try to approximate real situations. Of course, the more closely the parameters of a problem parallel the conditions required for pure competition, the better the purely competitive model will be in estimating a solution to the problem.

To counter the effects of time in comparing amounts of income earned over a period of time, the process of discounting can be used. This procedure brings each amount of future revenue to a common denominator, in order that income of different periods can be put on a comparative basis in terms of present value. The discounting procedure can be accomplished by using the following formula to determine the present value, V, of a stream of revenue, R, earned over a period of n years with the market rate of interest equal to r:

$$V = \frac{R_1}{1 + r} + \frac{R_2}{(1 + r)^2} + \cdots + \frac{R_n}{(1 + r)^n}$$

This procedure is incorporated into the problem analysis of this thesis.

In discussing the growth of a farm firm in terms of the income earned by that farm, one could easily lose sight of the fact that a basic resource package or stock of capital assets exists for that firm. The size of this basic stock of assets, also its quality, is important in the determination of the growth possibilities of the firm. The amounts of land, machinery, buildings, livestock, grain, feed, and other supplies become used up at various rates in the production process. In a growth process, especially over a long period of time, changes in the quantities and qualities of all of these resources may occur. It is necessary to measure the growth in income generated by the farm "plant", keeping in mind the type and extent of these changes. Such organizational patterns, between the resources of the firm and the income earned by it, may be exploited, where identification of the involved factors is made, until the marginal conditions of added cost and added revenue are equated. To précis the above discussion would be to say that, changes in the farm firm's balance sheet must be accounted for in determining the real extent of income growth, not simply that displayed by the profit and loss statement.

Because the objective stated for this thesis is in terms of achieving a long run goal, there is no restriction on reducing current incomes in order to achieve a higher income in a future period. This relates to the last statement in the above paragraph. An example explains the meaning. A farm firm could borrow funds to purchase additional productive assets. However, in doing so, current income is reduced by the interest cost of the required debt. It may also be reduced because current working capital is removed from its application in purchasing inputs (e.g., fertilizer), which otherwise would have produced income. This enhancement of the future earning capacity of the firm has been effected by reducing current income, but the consequences of the decision may not be detected simply by considering the profit and loss statement.

In discussing the types of organizational response that can theoretically affect growth, one can note four basic types of adjustment. The firm may:

1. Produce a larger quantity of output from the same quantities of inputs thereby yielding a larger income. In this case the farmer must not have been combining the inputs in a proper proportion and must have left some resource idle. Or, the increase could be caused by some exogenous factor, for example, some technological change which allows the same resources to produce the larger output.

2. Produce the same quantity of output but use less of the input resources. This change reduces costs of production for that output and thereby increases income.

Items 1 and 2 can be described as being the technical efficiency criteria for the farm firm which may lead to firm growth. Further to these the firm may:

3. Procure additional resources that are in short supply, which would allow optimum use of all resources when obtained. A logical extension of this type of adjustment would be to procure additional resources of all types required for the production processes, in the proper proportions for optimal production at a new level of output. This condition, it may be noted, is the same as Bailey's fifth necessary condition for firm growth presented in Chapter II (page 24).

4. Allow smaller amounts of generated capital to be siphoned off into family consumption or savings. This factor, of course, acts as a direct spur to the capital resource use of the firm. Income generating variable inputs such as fertilizer may be purchased, or the funds may be utilized to procure longer term assets such as land or buildings.

The above are familiar concepts as applied in production economics to static analyses of the farm firm [1, 7, 8]. The same concepts are applicable in considering the growth of a firm over time; with one major addition. The equations of marginal rates of substitution and transformation in use of resources and production of outputs must be time dated and equated between all time periods. If, in the static marginal analysis of the firm, the relationship of two factors of production at equilibrium required that:

$$MRTS_{F_1-F_2} = \frac{P_{F_2}}{P_{F_1}}$$

then for a growth model which considers time explicitly, this equation must hold in every period and the equations between periods must hold.

That is:

$$MRTS_{(F_1-F_2)_{t_1}} = \frac{P_{(F_2)_{t_1}}}{P_{(F_1)_{t_1}}} = MRTS_{(F_1-F_2)_{t_2}} = \frac{P_{(F_2)_{t_2}}}{P_{(F_1)_{t_2}}}$$

$$= \ldots = MRTS_{(F_1-F_2)_{t_n}} = \frac{P_{(F_2)_{t_n}}}{P_{(F_1)_{t_n}}}$$

where MRTS = marginal rate of technical substitution,

F_1 = input factor one,

F_2 = input factor two,

P_{F_1} = price of factor one,

P_{F_2} = price of factor two, and

$t_1, t_2, \ldots, t_n$ = time periods.

This same type of analysis must also hold in the factor-product relationship and in the product-product relationship as regards the requirements over time.

When dealing with a large number of factors of production and many products from diverse production processes it becomes impossible to express the interrelationships in a single equation such as above. Since agricultural production is a very complex process requiring hundreds of different inputs and covering a large number of possible enterprises a large model is required to give even a very rough approximation of the operations of a farm firm.

A special form of marginal analysis was developed by G. B. Dantzig [4] which is capable of handling large problems in production economics, or problems in any field where a "best" solution is required to a model specified in mathematically linear functions. This is linear programming. In reading some works in which marginal problems were specified as a linear program, one is given the impression that linear programming is related to the marginality problem only as an empirical solution technique. The relationship is, of course, much closer than that. As noted by Dorfman, Samuelson, and Solow [5 , p. 133];

> It would be misleading to contrast the linear programming model with marginal analysis in general. Linear programming <u>is</u> marginal analysis, appropriately tailored to the case of a finite number of activities. "Traditional" marginal analysis is tailored to the case of a differentiable production function.

Linear programming is the theoretical model used in the determination of solutions to the problems posed at the beginning of this thesis. Before examining the component processes used in specifying the models for solution, linear programming will be more closely examined and defined.

<u>Linear Programming</u>

Linear programming is a relatively simple concept in terms of the way in which large and seemingly complex problems can be solved. The results of solving a linear program give a "best", or optimal solution to the problem. It is designed to solve problems in which some quantifiable objective is to be optimized, subject to certain constraints on the means of achieving the objective value. This may involve determining the best way to serve a family a balanced diet given the nutritive values of the foods available and the nutritional requirements of the human body, or the most efficient way to utilize several machines in a factory where there are a number of different types of machines, in terms of costs of operation, output capacity, etc. In presenting the above examples, the dimensions of a linear programming problem are used implicitly. Heady and Candler [9 , p. 2] give them explicitly.

> A linear programming problem has three quantitative components: an objective; alternative methods or processes for attaining the objective, and resource or other restrictions. A problem which has these three components can always be expressed as a linear programming problem.

This quote gives the full concept of a linear programming problem. An objective is required for optimization, whether it is stated in terms of maximization of some variable, such as income, or in terms of minimization of a variable, such as cost of production. There must be several alternative ways or processes for accomplishing the specified objective. The problem is to choose the best levels of a set of processes. The third component in the conception of a linear programming problem is that there must be some resource or other restriction. As is further pointed out by Heady and Candler [9 , p. 3]; "A linear programming problem does not exist unless resources are restricted or limited." Many examples of the types of restrictions found in linear programming of farm models are developed later in this thesis.

Reference is made above to the alternative processes or ways of doing things, and it is necessary to add a caution in the discussion of linear programming as to what is really optimized in such a solution. Every activity or process in a linear program is an expression of the combination of certain input resources to produce a given level of output in physical and/or monetary terms. Another process may produce exactly the same type of output (e.g., wheat), but the proportional combination of resources in the second process may be entirely different from that in the first. The amount of output obtained may or may not differ from that in the first process. The important point to observe, and one that is not often made clear in studies using linear programming, is that the choices made by a linear program involve levels of activities or ways of doing things, rather than the direct choice of amounts of inputs to use or outputs to be obtained. The optimum solution therefore expresses the maximum (or minimum) for an objective, given the activities established a priori as vectors of input-output coefficients or per unit resource requirements for a particular activity. Dorfman, Samuelson, and Solow [5 , p. 132] put it this way:

> Our point of view, then, will be that the essential choices made by a firm do not deal directly with levels of input and output, but rather concern the extent to which "different ways of doing things" are used.

The caution to be given here, which should appear in all linear programming studies, is that the optimum solutions specified for the study are only as good as the data used in formulating the vectors of input-output coefficients found in the programming matrix.

A quote from Dorfman, Samuelson, and Solow [5 , p. 8] introduces a more rigorous consideration of linear programming. This leads to a specification of the generalized model of a multiperiod linear program which is to be used in approximating real solutions to the growth problem as specified earlier in this thesis. They state by way of definition that:

> . . . linear programming is simple. It is the analysis of problems in which a linear function of a number of variables is to be maximized (or minimized) when those

variables are subject to a number of restraints in the form of linear inequalities.

In a mathematical notation the problem can be generalized as follows:

Maximize Z, where

$$Z = C_1 X_1 + C_2 X_2 + C_j X_j + \ldots + C_n X_n$$

subject to the resource inequalities,

$$\begin{array}{l}
a_{11} X_1 + a_{1j} X_j + \ldots + a_{1n} X_n \leq b_1 \\
a_{21} X_1 + a_{2j} X_j + \ldots + a_{2n} X_n \leq b_2 \\
\quad \vdots \qquad\quad \vdots \qquad\qquad\qquad \vdots \quad\; \vdots \\
a_{i1} X_1 + a_{ij} X_j + \ldots + a_{in} X_n \leq b_i \\
\quad \vdots \qquad\quad \vdots \qquad\qquad\qquad \vdots \quad\; \vdots \\
a_{m1} X_1 + a_{mj} X_j + \ldots + a_{mn} X_n \leq b_m
\end{array}$$

ensuring throughout that:

$$X_1 \geq 0,\ X_2 \geq 0,\ \ldots, X_n \geq 0.$$

In this generalized scheme, Z is the variable to be maximized, as for example in this thesis, where Z is the sum of the discounted annual net farm incomes. The $C_1 X_1$, $C_2 X_2$, . . ., $C_n X_n$ are the price times quantity (or level) relationships for each of the n activities or processes, X_j, which constitute the problem. The coefficients a_{ij} are input-output coefficients, specified as given for each activity, which indicate the amount added to or subtracted from the resource or restriction quantity b_i for a one unit operation of the activity X_j. The restrictions $X_1 \geq 0$, $X_2 \geq 0$, . . ., $X_n \geq 0$ are non-negativity restraints which ensure that no activity can come into the solution of the problem at a negative level. The usual assumptions of additivity and linearity, divisibility, finiteness, and single valued expectations apply to this specification of the problem [9, pp. 17-18].

The simple exposition on a general linear programming model presented above is capable of handling static monoperiodic problems. However, what is required in this study is a model which can take into account changes over time in the levels of resources, costs, and prices. As C. B. Baker [18, p. 144] noted in an article entitled, "Firm Growth, Liquidity Management, and Production Choices":

> What is required is a model that (a) incorporates the necessary production, consumption, marketing, and financing relationships, (b) is adaptable to variation in input, and (c) generates measureable output in terms relevant to questions on growth and liquidity.

Baker reviewed the types of models capable of handling problems with the above dimensions. He stated [18, pp. 144-145] his conclusions as follows:

> It is useful, therefore, to construct a model richer in its output structure than can be accommodated in a dynamic linear programming model, but more directly oriented to prescriptive results than may be the case with simulation models. Such an alternative exists in multiperiod linear programming.

Multiperiod linear programming can handle time-dated variables which is a prime requisite in the solution of the growth problem being studied. It cannot, in its formulation presented herein, handle the random forces which in reality must be taken into account. The problems of uncertainty in decision making, as noted in Chapter I, will not be removed by using this model. Recourse to stochastic models would be required in an effort to approximate solutions more realistically. However, despite these faults multiperiod linear programming is considered a realistic approach to solving the problem presented in this thesis.

Multiperiod Linear Programming

Multiperiod linear programming, as its name implies, is a model designed for the solution of problems which are characterized by changing parameters from one time period to another. That is, the model permits the time-dating of variables. By proper specification of the model, flows of information may be passed from period to period in chronological order, thereby representing the time sequence of effects of given variables as they occur in real situations. Contrast this to a monoperiodic or static linear programming model where activities specified in a solution are deemed to have occurred instantaneously (i.e., the model is timeless).

There are several advantages to having a model with the above noted facilities. In an economic model, such as is developed in this thesis, one can identify the source of flows of income generated by the model. The cash flow related to this income generation can also be monitored as it is passed from period to period through the model. Another advantage is that inventories of resources may be transferred from one period to another, the amount of each reflecting the effects of all operational activities on that inventory account during the period. With a sufficiently specified model all items of a firm's balance sheet may be effectively carried through the model.

The specification of a multiperiod linear program in its simplest form requires only a monoperiodic program repeated in a block diagonal system with the additional feature being several activities to provide for transfer of resources between periods. The model, of course, can be made as difficult as is required to represent the expected changes over time in levels of resource requirements or enterprise output. The generalized equational expression of a multiperiod linear program is presented below:

Maximize the function:

$$Z = C^1 X^1 + \ldots + C^k X^k + \ldots + C^t X^t,$$

subject to the following restraints:

$$\begin{array}{ccccccccc}
A_1^1 X^1 & + \ldots + & A_1^k X^k & + \ldots + & A_1^t X^t & \leq & B_1 \\
\vdots & & \vdots & & \vdots & & \vdots \\
A_l^1 X^1 & + \ldots + & A_l^k X^k & + \ldots + & A_l^t X^t & \leq & B_l \\
\vdots & & \vdots & & \vdots & & \vdots \\
A_t^1 X^1 & + \ldots + & A_t^k X^k & + \ldots + & A_t^t X^t & \leq & B_t, \text{ and}
\end{array}$$

$$X^1 \geq 0, \; \ldots \;, \; X^k \geq 0, \; \ldots \;, \; X^t \geq 0, \text{ where;}$$

Z = objective to be maximized, in this model the sum of discounted yearly net farm incomes,

C^k = a $(1 \times n_k)$ row vector consisting of gross returns and costs for the n_k activities in period k,

X^k = a $(n_k \times 1)$ column vector of period k activity levels,

A_l^k = an $(m_l \times n_k)$ matrix of coefficients indicating the amount of input i per unit of output j for activities of period k and restraints of period l,

B_l = a (m_l x 1) column vector of restraints for the m_l restraints in period l,

m_l = number of restraints in period l,

n_k = number of activities in period k,

l = 1, 2, . . . , t, and

k = 1, 2, . . . , t.

An important point to note about the construction of a multiperiod linear programming model is that all activities in every period are mutually dependent. That is, activities that enter the solution in the last period of the model depend on activities that entered in period one, and vice versa. This is not an unrealistic structuring for this problem, in that farmers do perform certain functions in the present time period on the basis of their expectations of enterprise requirements in the future. They are also bound to certain functions in the current time period because of decisions to commit resources to chosen enterprises in past periods.

The last important factor to be noted about a multiperiod linear programming model is in the nature of the solution derived for a given problem. Each solution is determined on the basis of very exact specification of the input-output coefficients, the right-hand sides, the C_j values, and the sign attached to each equation. To change so few as one of the above items may result in a drastic change in the solution results. There is, in effect, a knife-edge solution available to only one exact specification of the problem.

To this point, the problem has been identified, the literature reviewed for factors relevant in the solution of the problem, and a theoretical model proposed which will provide a vehicle for the analysis of the effects of those factors. In Chapter IV, the operational model is developed in terms of the types of activities that are required to represent the production, marketing, financial, and consumption functions characteristic of farm firms of Crop District Number 10.

CHAPTER IV

MODEL DEVELOPMENT

Each of the first three chapters presented a separate topic of discussion within the context of the over-all problem of growth. Some specifics of the nature of the problem were presented first, indicating that farm net incomes are low relative to the incomes being earned by owners and managers in other industries, and relative to the target income of 10,000 dollars per annum by 1980. It was indicated that the problem could be characterized as one requiring the application of the principles of firm growth.

Secondly, a number of factors were reviewed in terms of their relevance to the process of growth. It was determined that a number of factors, such as, size of the farm firm, ability of the farmer to obtain and use credit, and the availability of physical factors of production had an important bearing on whether growth occurs in farm firms.

Latterly, a theoretical model was proferred as being suitable for the study of farm firm growth, a multiperiod linear program. Its suitability arises primarily from the fact that the time element can be incorporated, a factor implicit in discussing growth. Multiperiod linear programming can be termed a dynamic certainty model; the structure allowing for a flow of information backward as well as forward through the model, and containing only coefficients with single valued expectations.

The discussion in this chapter acts as a catalyst to weld these diverse presentations into one cohesive unit. The theoretical framework is fleshed out with a body of empirical information which reflects the factors discussed in Chapter II, all of which is designed to solve the problem as presented in Chapter I. As implied by the title of this chapter, the developmental information regarding the study is presented, a description of the area selected for intensive study, the choice of the representative farm technique, and most important, an exposition on the restraints and activities included in the model.

The Area

As explained in the title of this thesis, the area selected for study is Manitoba Crop District Number 10 (Figure 4.1). Encompassed by this designation are thirteen Rural Municipalities, or two Federal Census Divisions, eleven and thirteen. The Crop District is situated in West Central Manitoba, bounded on the north by the northern edge of township 21 and the boundary of Riding Mountain National Park, on the east by the eastern edge of range 19, on the south by the southern edge of township 13, and on the west by the Saskatchewan border.

One of the primary reasons for the use of this area is the low variability of soil types throughout the area. Soils are characterized by the Newdale Soil Association, clay loams noted for high productivity. They rate mostly in the 7, 8 and 9 levels of the P.I. (productivity index) as determined by the Soils and Crops Branch of the Manitoba Department of Agriculture. Due to this high constancy of soil type it was not deemed necessary to divide the area on this basis for analytical purposes. To give a more precise description of the region,

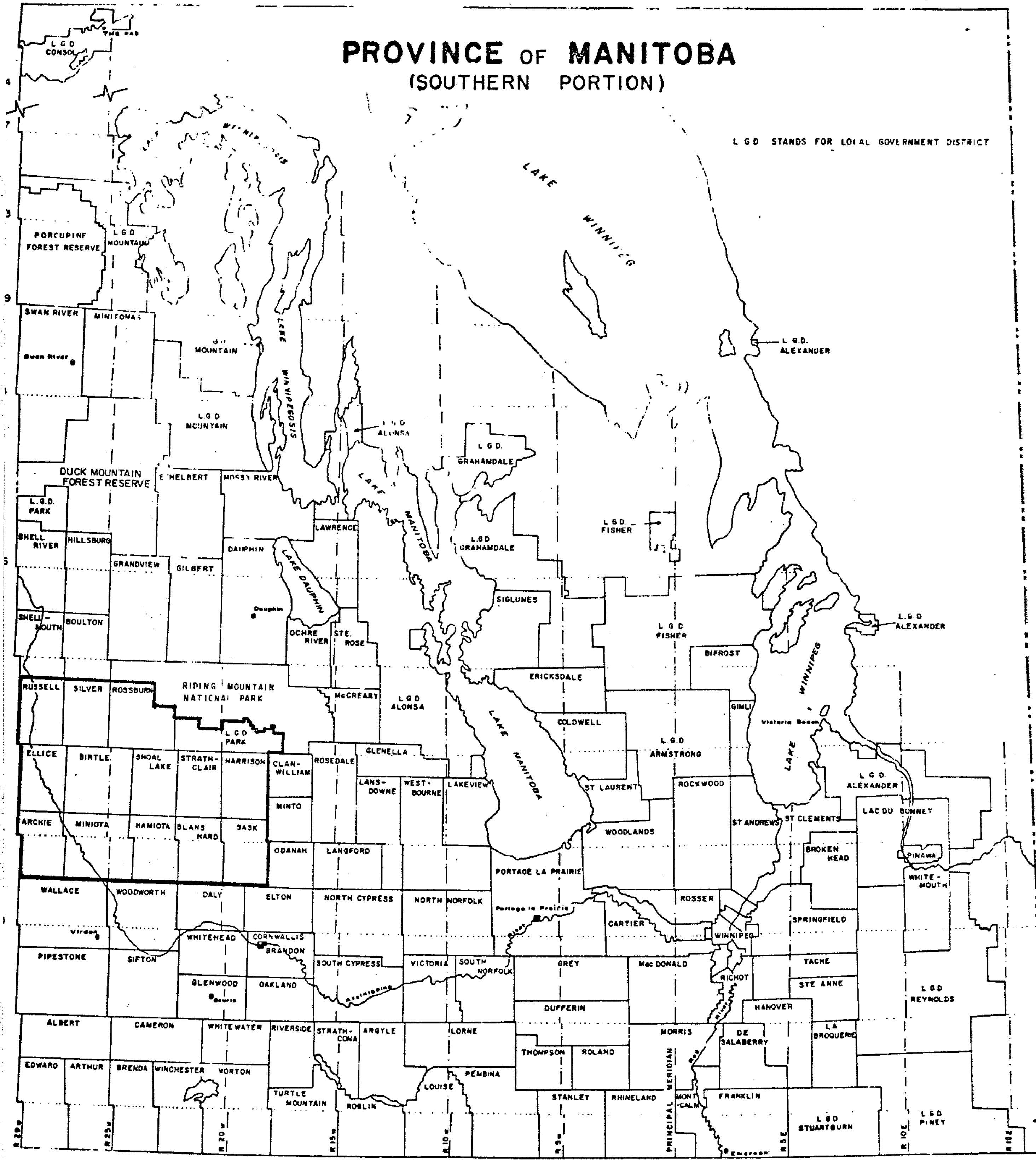

Figure 4.1 Map of Southern Manitoba Showing the Area Selected for Study in West-Central Manitoba

the following excerpt is taken from the Report of Reconnaissance Soil Survey of Rossburn and Virden Map Sheet Areas [24]:

> The Newdale association consists of medium textured soils developed on boulder till of mixed materials derived from shale, limestone and granitic rock sediments. These soils have developed under intermixed aspen grove and grassland vegetation. The influence of woods, together with a higher precipitation-effectivity due to a slightly cooler climate than prevails to the south, have resulted in some degradation in the soils. For this reason the soils of this area have been referred to as "Northern Black Earths" . . .
>
> The topography is generally undulating (irregular gently sloping) with innumerable undrained depressions varying in size from small "potholes" and sloughs to large meadows and intermittent and shallow lakes . . . As a result of this irregular relief pattern, surface drainage is quite variable and ranges from excessive runoff on the steeper slopes to prolonged inundation of the depressed areas. Internal or soil profile drainage has a corresponding range from good to very poor.
>
> The majority of the better drained Newdale soils were developed under grassland vegetation. However, the area as a whole lies within what has been designated as the "Park Belt" and islands of aspen occur in ever-increasing size from south to north. In the southern portion of the area, aspen occurs as rings of trees around the sloughs in the depressions. Towards the north the trees have crept farther up the slopes, particularly on the northern exposures, so that only the soils on the higher positions have not been influenced by this woodland invasion.
>
> Although glacial stones are present in all the Newdale soils, they do not constitute a serious problem to cultivation over most of the area. The exception is in areas adjacent to the major river channels where the boulder till was subjected to severe erosion during the post-glacial period. Here, the finer material was washed out of the surface layer, leaving a stony, water-worked till as the parent material from which the soils were subsequently developed.

Another important reason for choosing this area was the fact that good farm records were available from a fairly large group of farmers who had been members of the Western Manitoba Farm Business Association or the Farm Business Groups conducted by the Manitoba Department of

Agriculture. It was important to have a large number of good records for analysis to determine initial farm organization patterns for the three representative farm sizes used in the study. A discussion of the concept of the representative farm and the basis on which the representative farms used in this thesis were selected follows.

Representative Farms

The use of the concept of a representative farm firm is often used in the analysis of farm firms [15, 37,60]. The definition of what constitutes a representative farm varies greatly, however. For example, Martin and Plaxico [37] obtained their representative farm from the results of linear programming. Jeanneau [60], on the other hand, analyzed data for a Manitoba Municipality (R.M. of Morton), determined the size of farm which was most prevalent (three quarter section), then chose a farm of this size which had the most typical soil type for the area, and which appeared to reflect the typical farm in other respects. This farm was then analyzed intensively on a case farm basis.

In general, the procedure usually used is as follows: (1) collect data from a large number of farms on relevant resources, for example, acres of cropland and pasture, labor supplies, and capital of various types; (2) array the farms by two or three of the most important factors thought to affect production and set up a two or three-way frequency distribution or stratification; and (3) identify typical farms for each cell containing a significant number of farms. The object in following this procedure is to group farms so that their response patterns are likely to be similar and so that optimal plans if all were linear programmed individually might be similar.

In this study, representative farms of three sizes are analyzed. The size groupings are separated on the basis of total farm acreage. Small farms are considered as being less than 400 acres; medium farms, 400 - 760 acres; and large farms, greater than 760 acres. These representative farm sizes, which are to be investigated for growth potential, were chosen on the basis of an analysis of census data showing percentage change in numbers of farms in each of several size categories. Table 4.1 below gives the details.

Table 4.1

Percentage Changes in Numbers of Census Farms of Various Sizes from 1961-1966

Size of Holding (acres)	Percentage Change in Number of Farms in Each Size Group, 1961-1966	Farm Size Designation
70 - 239	-16.5	Small
240 - 399	-19.2	
400 - 559	- 7.1	Medium
560 - 759	4.1	
760 - 1,119	21.2	Large
1,120 - 1,599	37.1	
1,600 - 2,239	54.9	
2,240 - 2,879	93.3	
over 2,880	85.3	

Source:

Derived from Dominion Bureau of Statistics, 1966 Census of of Canada, Agriculture Manitoba. Catalogue No. 96-608, Vol. V (5-1), 1968.

The three farm size groups chosen for this study represent aggregations of smaller size divisions. The "small" farm group includes those sizes for which there is a large negative percentage change in numbers of farms from 1961 to 1966. The "medium" farm group includes those sizes for which there is a small negative or positive percentage change in numbers of farms. The "large" farm group covers the sizes of farms that show a large percentage increase in numbers.

To obtain data from which to specify the characteristics of each of these farm groups, a large number of records were required. These were provided by members of the Western Manitoba Farm Business Association and the members of Manitoba Farm Business Group Programs in the West-Central area of Manitoba. Fifty-one records were used in determining the characteristics of the farm size groups. The distribution was as follows: small farms, 5 records; medium farms, 20 records; and large farms, 26 records. A detailed analysis of these records appears in Appendix A. The information gleaned from these records, of course, provided the basic restraint levels for the specification of the multiperiod linear programming models which were developed for each of the three farm sizes. It is to the development of these models that the discussion now turns.

Multiperiod Linear Programming Models

Chapter III presented the theoretical model to be used in attempting to provide useful, empirical solutions to the problem of low net farm incomes. The model was displayed in a generalized form that abstracted from reality. The purpose of the following discussion is to inject that skeletal form with a body of material which describes the essential activities and restraints representative of realistic operations of a farm firm.

As stated earlier, the process of growth is most intimately related to the time factor. The first thing about the models to be specified, then, is the time span covered by them. (From this point onward the discussion of the models will be in the singular since their construction, in terms of activities and restraints, is the same.) When this study was started, the latest available records for the farms involved were for the year 1968. The starting point for the model is, therefore, January 1, 1969. Since the year at which the achieved level of net farm income (that income generated in the programming solutions) is to be compared to the target income level is 1980, the model spans twelve years.

Before looking at the detailed construction of the model, a few general comments should be made about the types of restraints and activities that will be encountered. The activities specified for this model can be broadly classified into the following types: production and marketing, whether for crops or livestock; financial, whether for borrowing various types of capital or paying farm overhead and family consumption; facilitative, primarily used to transfer end-of-period balances in supply rows to the next period; and lastly, a group of activities which can best be described as point-of-interest processes, those involved with outside investment, income tax payment scheme, land purchasing, and discounting of yearly net farm income.

The row restraints which govern the operation of the model are related in most instances to supplies of various resources available to the farm firm. The values attached to these row restraints (the right-hand-sides in programming terminology) indicate the amounts of various types of land, labour, capital, and inventory of saleable products - -

grain, livestock, and forage - - available for the operation of the farm. Added to these are types which ensure that certain activities enter the solution at prescribed levels; for example, restraints which ensure that farm cash overhead and family consumption expenditures are made, and that initial debt balances are reduced according to the relevant repayment schedules.

Model Dimensions

The over-all dimensions of the model are 1349 rows by 2200 columns for a basic run with no modifications. Each period within the model does vary in size due to the demands placed on it by institutional elements, especially the changing quota system over the first three years. Given that slight changes do occur, each period has from 110 to 115 rows and approximately 190 columns. Depending on the particular model being run, there are between 23 and 24 thousand elements in the programming matrix. A number of categories were described above in introducing the discussion of activities and restraints. The following list provides the approximate number of processes per period related to each category:

crop production (including forage and summerfallow)	27
marketing grain and forage	15
livestock production and marketing	25
least cost ration	65
transfers	25
miscellaneous (including financial and point-of-interest types)*	33

*Point-of-interest activities are those that have special significance in the model, such as, income tax, off-farm investment, and the discounting procedure.

In the same manner, row restraints were categorized; the numbers of rows falling into each of these are:

land use.	14
labour supplies and hiring maximums	16
capital transfers	8
inventories of crops and quota restrictions	16
inventories of livestock and ration restrictions.	45
financial	16

A more detailed explanation of the activities and restraints appears in the ensuing sections.

Activities

As can be discerned from the discussion of the dimensions above, the model developed for the investigation of the growth process is quite complex. It should be noted here, however, that only a representative few of each type of farming activity were included. To provide a much wider choice would have made the model too cumbersome.

The following discussion provides the general purposes and structure of the activities and restraints included in the model. At some points direct reference is made to specific coefficients for purposes of clarity. However, the development of individual coefficients and activity budgets, which comprise the greatest part of the programming matrix, is appended to the body of the thesis as Appendix B. As much as possible, the information found in Appendix B follows the exposition in this chapter.

Cropping. Five major crops were included in the model; wheat, oats, barley, flax, and rapeseed. Each of these could be grown on either summerfallow or stubble land. To determine whether fertilizer plays an important role in the farm plan, each crop could either be left unfertilized or fertilized according to minimum field crop recommendations for Manitoba [54]. Of course, the purpose of producing crops is to provide grain for sale or for use in feeding livestock. The grain produced by each of the crop activities (Table B.1) entered an inventory row for that crop, from which it could be drawn either by selling or feeding activities. Straw from wheat and oats filled bedding requirements of the livestock enterprise: none could be used in feeding. Land, labor, and capital in appropriate amounts were provided from their respective inventories (Tables A.2, A.6, A.3, and A.10). (See Tables B.2 to B.26 for labor and capital budgets for the cropping activities.)

Forage. Forage crops are grown as part of the crop rotation on most Manitoba farms for one, or more, of three reasons: (1) to provide high-quality feed for livestock; (2) to improve soil fertility and structure; and (3) where problems exist, to assist farmers in controlling weeds and soil erosion. In this study, the emphasis is on forage production as a source of livestock feed, although the opportunity is provided for its sale.

Forage growth was specified on a five year plan (Table B.22). In year one the stand was established with the aid of an oats nurse-crop. The oats were assumed to be harvested. In each of years two, three, and four, two cuts of hay were allowed, and in the fifth year one cut of hay was assumed, after which the land was sod-fallowed to prepare it for crop production the following year. Activities were specified in each period which allowed forage land to be broken in year two, three, or four of the production cycle. In the year of breaking, one cut of hay was again taken before sod-fallowing.

Summerfallow. The analysis of farm records for this study revealed one particularly important aspect of land use; the relatively high amount of land summerfallowed. The acreage averaged twenty-five percent of cultivated land. Since the annual rainfall in the area appears to be sufficient to grow a crop every year, it must be assumed that summerfallow is used to control weeds or improve soil fertility. These factors can be well controlled through use of chemicals for weeds, and fertilizer for crop nutrients. It would seem that an opportunity exists to increase incomes by reducing the amount of summerfallow. Despite these observations summerfallowing was specified in the basic model at 25 percent of cultivated acreage.

Wild hay and straw. Wild hay grows around the many sloughs and small lakes that characterize the Crop District Number 10 landscape. The hay can be cut and baled for livestock feed. An activity was entered into the model on a yearly basis to allow for this production alternative (Table B.25). In the same manner a straw baling activity was provided to supply bedding for the livestock enterprises when they entered a solution (Table B.26).

Grain selling. As stated above, the primary purpose in producing crops is to sell grain. The model developed for this study provided a complete range of grain selling activities. Of course, the overriding factor in all grain marketing is the quota and grain delivery system operated by the Canadian Wheat Board. This will be discussed presently. As well as marketing grain on quota, provision was made in periods one and two for selling grain outside the quota system. This practice was followed by many farmers during 1969 and 1970 when quotas were low and farmers developed pressing cash shortages. Selling prices for these activities were at much lower rates than were prices for quota grain. As well as the non-quota possibilities allowed, malting barley or oats of rolling quality could be sold. Malting barley sold at a premium of five cents per bushel over feed barley. Rolled oats obtained no such premium. Prices for all grains produced appear in Table B.27.

Periods one, two, and three coincide with years 1969, 1970, and 1971. Over these years the surplus supplies of grain in the Canadian marketing channel forced yearly changes in the quota and grain delivery system. In 1969 the old specified acreage quota system, introduced in 1953-54, was still in effect. For 1970 this system was replaced by "Operation Lift" which curtailed quotas on wheat for those who did not take wheat out of production and increase their summerfallow and/or forage acreage. Quotas for other grains were based on seeded acreage with the additional proviso that the farmer could allocate any or all of his acres qualified for wheat to any other crop. For 1971 and subsequent periods covered by the planning model, the "assignable acreage" quota system was specified. Under this system the farmer must assign eligible acreage to the particular grain he wishes to deliver. The amount he is allowed to deliver depends upon the acreage so assigned and on the level attained by the quota for that crop. All of the above quota restrictions were programmed into the model, including the payments system for Operation Lift, and they constitute the primary setting for all direct grain sales from the farm.

Cattle production. Cattle production is an integral part of the farming program in the West-Central area of Manitoba. Crop District Number 10 is usually second only to the Interlake area in terms of cattle numbers on farms at June 1 of each year according to the Yearbook of Manitoba Agriculture [49]. For example, in 1969, Crop District Number 12, which represents a major portion of the Interlake, had an inventory of 118,900 animals of all classes compared to 100,700 animals for Crop District Number 10. The figure for the Interlake is understated in that Crop District Number 12 does not include the lower portions of the area generally considered in discussions of the Interlake. This lower portion is represented by Crop District Number 4, which would add a further 35,700 head to the Interlake inventory. Making the appropriate calculations this gives the Interlake and West-Central Manitoba areas over 25 percent of the cattle population of Manitoba with 15.17 and 9.88 percent, respectively.

From the above description and comparison, it is obvious that cattle provide an important economic contribution to agriculture in West-Central Manitoba. To reflect this situation a number of cattle activities were included in the programming matrices for the model. The activities included allow maximum flexibility of the livestock production enterprise. Each farm size, in its initial specification, included some cow-calf units, as well as other classes of animals at varying stages of preparation for market. The program allows the cow-calf enterprise to grow or to cease through provision of a herd growth activity and a cow selling activity. In addition, opportunities exist to feed calves produced on the farm, or to sell them, to buy additional calves for feeding or stocker programs; to raise calves as stockers for sale to feedlots, or for placement in an on-farm feeder enterprise; and to buy feeder cattle for the production of slaughter beef (see Tables B.28 to B.30).

The production of beef cattle requires extra skills of the farmer over and above those needed for straight grain production. To reflect the quality of management applied to the cattle production activities, the following factors were considered in developing the model.

One of the most important factors in livestock management is herd maintenance or improvement. This is accomplished by culling poor performers out of the herd; those that fail to conceive, that calve very late for no apparent reason, or that produce a poor calf. Replacement animals are then chosen from the best heifers produced by the herd. In this project a culling rate of 20 percent is assumed. This is higher than the one in seven rate assumed in a study of beef-cattle production in West-Central Manitoba [61], but somewhat lower than the 25 percent rate suggested in the Manitoba Department of Agriculture Beef Manual [53].

The facility must be made available to allow a cow herd to grow if it is profitable to do so. To accomplish this an activity was introduced into the model which draws heifers from the supply of heifer stockers of the particular year. If it is profitable to increase the size of the herd, this activity forces the model to produce a heifer stocker animal from a weaned heifer calf or from a purchased stocker calf of the preceding period. The charge to the growth activity then becomes the cost of growing that stocker animal, or of purchasing and growing it, plus the additional costs incurred in advancing the growth and feeding rates, as compared to that for animals destined for feedlots; thus the heifer can be bred at about 15 months to calve as a two year old.

To increase the heifer's weight prior to breeding, she is fed a ration (Table B.37) designed to have her gain two pounds per day for 60 days, from May 15 to July 15, at which time she is bred. An additional one hour per head per month is added to the labor (Table B.32) which would ordinarily be used on the animal as a stocker. Cow-calf feeding and labor rates are used in the herd growth activity for the November-December production period.

The most critical period for a livestock manager is during calving time. With proper control of breeding dates, cows should have their calves before going on pasture. This enables the farmer to be on hand in case of problems - - especially for first calves coming from a two year old heifer. The calving rate for a cow herd is critical in terms of opportunity for a profitable enterprise. A low calving rate almost assures an unprofitable enterprise. Low calving rates, in an otherwise good quality herd, can usually be traced to poor management practices. In this project, a weaning percentage of 85 percent is assumed, which leaves room for some improvement. This assumption takes account of the possibilities that some cows do not conceive, that some miscarry, that some calves are stillborn, and that some deaths can occur due to disease or accidents between birth and weaning. Such a figure is quite realistic under average management. The ideal, of course, is to achieve a 100 percent weaning rate for maximum returns from investment in a cow-calf herd.

The 85 percent weaned calf rate is reflected in the model through the cow-calf production activity. Coefficients of -.43 and -.42 are placed in the weaned steer and weaned heifer rows, respectively, incorporating the assumption that half the calves produced are bulls and half are heifers. Any activity which requires a weaned animal then draws on either supply row.

Although a farm manager maintains a good cow herd and achieves the ideal in terms of weaning percentage, his over-all enterprise may still be unprofitable if he fails to achieve efficiency in his feeding program. This applies, as well, to the stocker and feeder enterprises that he may undertake. To provide for efficient feeding, the program for this project is specified so as to generate least cost rations for the various livestock feeding activities. Feed requirements (Tables B.33 to B.39) are based on the "net energy" concept, rather than requirements stated in terms of digestible nutrients. The coefficients used for this study can be found in <u>Net Energy Tables For Use In Feeding Beef Cattle</u> [32]. Net energy coefficients for various feeds (Table B.40) are taken from the same source. The types of feeds specified in the model are those readily available within the area, including tame forage and wild hay as roughage, as well as the normal feed grains. Supplements are assumed to be used to provide a balanced ration; the costs are included in the livestock budgets (Tables B.28 to B.31). Additional supplies of oats, barley, and forage can be purchased through an activity provided for each. Pasture can be rented as required.

In developing costs for the cattle activities, only those items which represent a direct expenditure on a particular enterprise are included. Overhead costs such as taxes, insurance, light and power are not included. No direct charges are included for feed. The feed used in any enterprise is charged to that enterprise indirectly by the use of transfer activities.

Costs associated with death loss are incorporated into the program indirectly as well. For the cow herd, the charge is made by reducing the proceeds from the sale-of-cull-cows activity. This activity is forced to operate at a level of 20 percent of the cow inventory. By showing a sale of the full 20 percent of the number of cows, the inventory numbers of cows is maintained at the correct level, while the reduction in the proceeds from the sale of the cull cows records the proper death loss charge.

For other cattle activities, the death loss cost is recorded in terms of an animal requirement from a supply row of the matrix. For example, to sell one beef animal for slaughter requires 1.01 animals from the supply row of that beef type. This effectively records a one percent death loss charge.

A full range of selling activities completes the livestock production and marketing complement within each annual period. The selling of cull cows was covered earlier in the discussion of herd improvement. The entire herd may be disposed of and the time and investment used in some other enterprise. A cow sold in period one, for example, would be removed from the inventory rows of all periods just as in the herd growth activity, the inventory was increased in each period from the year in which the activity functioned to the end of the model. It was assumed that cull cows and "disposal" cows were sold in October; costs were calculated for these activities on a ten month basis.

Weaned calves could be sold in October when cows were taken off pasture and stubble for the over-wintering period. Calves were assumed to have attained an average weight of 400 pounds. The return to selling steer and heifer calves was entered in the model net of shipping and selling charges.

Calves weaned in the fall could also be put directly on a high-gain ration and fed out to market weight of 1,000 pounds by June of the following period (Table B.29). It was assumed that the animals marketed sold as "good steers." For this activity costs of trucking and commission and yardage were included as production costs rather than being netted against the selling price. No difference occurred in the cash flow by using this method.

In the introduction to the cattle production activities, it was stated that calves could be reared in a stocker program. This enterprise absorbs weaned calves from the cow-calf activity; the calves are fed a maintenance or growing ration (Table B.34) over the winter which allows them to achieve a fairly large frame but with relatively little weight gain. The stocker animals are then placed on pasture the following summer, where they should gain weight to reach at least 800 pounds by September. At this point, the animals are ready for sale to a feedlot or for placement in an on-farm feeder enterprise, where they are finished to a market weight of approximately 1,100 pounds. Such an enterprise allows the farm manager some flexibility in his livestock management program. He can watch market developments and put stocker animals on full feed at any point in the program if he sees an advantageous situation arising. In this model, stockers are held in the program until September, when they can be sold as 800 pound feeders, or if it is profitable, they can, as pointed out above, be put on full feed, and marketed as slaughter beef in January at a weight of 1,100 pounds. A stocker program such as described above depends on a large supply of cheap roughage for over-wintering and on good pasture for the summer program. A pasture renting activity allowed the farm manager to supplement the pasture supply already available on the farm.

The last facility for beef production provided in this model is the alternative of purchasing feeders for a "short keep" type of enterprise. Feeders can be purchased (Table B.30) at 800 pounds for finishing to slaughter weight of 1,100 pounds. Such an enterprise requires assured supplies of high quality feed and extra management skills, especially in feeding. An enterprise such as this, of course, means that the farmer does not have to produce his own feeder animal input. Three such feeding periods (Table B.30) were assumed possible in this model: February to May; June to September; and October to January.

<u>Transfers</u>. Transfer activities in a programming model are the type described earlier as facilitative. They allow for the flow of information through the model. Of major importance in this area is the cash flow system, an integral part of the model. Maintaining a viable cash flow for a farm is one of the main problems for a farm manager. This results from the uneven inflow of proceeds from the sale of produce and outflow of expenditures for necessary factors of production or home use. To ease the pressure on a cash flow system a farm manager could have a "line" of short term credit with one of the financial institutions so that he can ensure that all obligations are met as they come due

whether he has cash on hand or not.

In this model, a supply of working capital is available at the beginning of period one (Table A.10). Each period is broken into quarters for the purpose of approximating a realistic cash flow. In quarter one, production activities draw on this cash supply. Any balance remaining is transferred to a row supply that combines this residual balance with cash proceeds of sales of produce assumed to have been made in that quarter. From this supply must be met all of the overhead commitments for that quarter of operation: farm cash overhead, such as light and power, automobile expenses, and miscellaneous expenses; family living expenses, food, clothing, health, and recreation; and farm debt repayment commitments. Another transfer activity then moves any excess funds forward to become the working capital of the second quarter. Short term borrowing activities are permitted to feed funds into the working capital supply rows up to a given maximum. This effectively approximates the operation of a line of credit concept mentioned above.

Other transfer activities operate in a similar manner. Inventories of grain, forage, and straw are forwarded from one period to another if all available supplies are not sold or used during that period. The maximum allowable use of credit is accounted for throughout the model by use of transfer activities. Each time a borrowing activity operates it reduces the maximum level of borrowing allowed. Repayments are added back into these restraints for each period and the resulting balance is transferred to become the binding factor on the operations in the next period.

Initial debt repayment. In many linear programming models, a farm operation is approximated and given an initial supply of capital plus the opportunities to borrow up to a given maximum. Such models fail to consider the on-going nature of the farming operation in that they never assume any beginning debt load. In this model, the initial debts of short, intermediate, and long term are accounted for by specifying a repayment schedule (Tables B.44 to B.58) for them and forcing the activities into the solution of the problem. The primary restriction imposed by these conditions, of course, are applied through the additional cash flow required to handle the payments as they fall due. Short term debt was required to be repaid on a yearly basis out of capital generated by the model. Intermediate and long term debts were repaid on schedules of three and twelve years in the basic model. Special runs were made on the model with repayment schedules of ten and twenty-five years, respectively, to determine the differential effects on income growth of the length of these schedules.

In the activities which provided for the repayment of initial debt balances, the restraint level maximums for each category of debt were reduced by the amount of debt outstanding. The operation of the activity to repay initial debts added back to these restraint levels an amount equal to the principal repaid in each period. Such a structure ensured that the true level of credit available was always reflected in the model.

Family consumption. Another activity that was forced into the linear programming model, is that which reflects the consumption function of a farm family (see Table A.9 for 1968 expenditure pattern) or provides the family with some minimum level of living. It is particularly important to account for this firm-household relationship in some manner, even if only a token recognition of its existence is made. This importance arises from two main points. If the model could be sufficiently disaggregated as to show a choice between, for example, a new deep-freeze for the house and a new cow for the beef herd, it would approximate the type of decision situation that arises in reality. The true value of the deep-freeze compared to the value of a cow to the farm firm cannot be specified in the model without resort to a subjective evaluation at the utility level. This is beyond the scope of this project. To give recognition to the fact that the household expenditure must be satisfied, a minimum requirement (Table B.59) is forced into each period of the model.

The second importance of the consumption expenditure is in its effects on the cash flow required to finance the total farm. In this project, the family expenditure must be accounted for in the cash flow system. It does not, however, enter the solution for net farm income. The expenditure is forced into the system by a cash requirement from generated capital in each quarter of an annual period. To determine the effects of varying the consumption function, three runs with levels of expenditure different from the basic model were made. The runs were made with zero consumption, with basic consumption plus 25 percent of net farm income, and with basic consumption plus 50 percent of net farm income. The zero level is obviously obtained by not forcing the family living activity to operate. The last two levels are attained simply by adding a coefficient of .25 or .50 to the activity column which transfers annual net farm income to the objective function. Each dollar so transferred causes 25 cents or 50 cents to be withdrawn from the generated capital row for the fourth quarter of each period.

Farm cash overhead expenses. The farm cash overhead expenses are paid by the model in a very straightforward and realistic way. Expenses that would normally be paid regularly by a farmer, such as, gas and oil, repairs, hydro and telephone, and miscellaneous items are charged against generated capital on a quarterly basis. Expenses that are normally paid yearly, such as, building and equipment insurance, land taxes, and depreciation are charged against generated income in the last quarter of each period (Tables B.60, B.61 and B.62). All these charges are made through a single activity, which is forced into the solution through the use of an equality restraint on the farm cash overhead control row of each period in the model. In this activity it can be noted that depreciation expense results in a direct reduction of cash balances. It is assumed that this expenditure goes directly into purchases of new machinery and buildings. The model was developed in this way to ensure that an up-to-date complement of machinery and buildings is maintained on the farm. In each year of the model, the expense recorded for overhead is increased according to the index of prices paid by farmers for goods and services [44]. It is assumed that this increase includes both outright price increases and increases in price due to technological innovations.

Land purchase. One of the most important factors deemed necessary to study for its effect on income growth is land purchasing. To allow purchases of land to be considered as a means to achieve income growth over time, entails certain assumptions that may not be valid for many farm managers who wish to use this method. First, it must be assumed that the farmer possesses the management skills to successfully integrate operations on a new, larger farm base. Second, it must be assumed that the farmer has the means to overcome other restraints which will inevitably become binding on the resources of the farm firm.

Capital, of course, becomes an immediate restraint in any farm expansion program. There are three main ways in which capital restrains the growth of a farm. The initial capital outlay for land and the repayment schedule affects the firm position for many years; sound planning and judgement are needed to keep the various debt ratios in a proper balance. Second, land actually acquired may be of a large enough parcel that the equipment complement on the farm is insufficient to ensure the farmer of being able to perform all his field operations in the restricted periods available to him, especially at seeding and harvest times. Such a situation requires that the farmer procure the necessary machinery capacity, either by purchasing more of the same size of equipment if he has a dependable source of labor other than his own, or by buying a larger more time-efficient line of equipment if he must operate alone. The latter procedure is probably forced upon most expanding farm units because of the general lack of dependable labor in agriculture. The last restraint is on operating capital. Each acre of land added to the farm unit calls for an infusion of capital for seed, fuel, fertilizer and other crop expenses. Returns from the additional land must be able to support the service costs of all these capital requirements.

Assuming that the required management skills are available on the representative farms and having the model determine the availability of capital, land buying activities were specified for inclusion in the model. Land could be purchased at the 1963-1968, six year average price of 70 dollars per acre (Table B.63). It is assumed that the appraised value for mortgage purposes is 80 percent of the purchase price and that 80 percent of the appraisal value is the maximum loan that can be obtained for land purchase. In terms of the market value of the property, then, the security value is .8 x .8 x \$70. = \$44.80 per acre. By deducting this value from the purchase price the amount of additional security per acre is determined, viz. \$70.00 - \$44.80 = \$25.20. In terms of market value, the additional security required is calculated as follows:

$$\frac{25.20 \text{ (security required)}}{44.80 \text{ (security value of 1 acre)}} \times \$70.00 = \$39.38 \text{ per acre purchased.}$$

Security for purchasing additional land is provided by the unencumbered market value of land and buildings already owned by the farmer (Table B.64).

The purchase of land is completely financed so that each acre purchased requires \$70.00 from the long term borrowing maximum restraint row. The debt is repaid on a 30 year amortized schedule (Table B.65) with payments made yearly out of capital generated by the model in the fourth quarter of each period. In each period subsequent to the year of purchase, the amount of the principal repaid in the previous period is added back to the balance of the long term borrowing maximum row and to the balance of the security row. If it were profitable to purchase more land at a later date these amounts would be available for financing.

Per acre overhead expenses are assumed to be the same for each new acre as for initial acreage and are charged against earnings quarterly. Each acre of land purchased is assumed to have the same percentages of each category of land (cultivated, pasture, wild hay) as was determined for the initial land base of each representative farm (Table A.2).

As discussed later, under the section on restraints binding the model, beyond a given level, any additional purchases of land require the acquisition of more machinery. There are, therefore, two land-buying activities per period of the model. The second differs from the first only by the inclusion of an amortization schedule for the purchase of new equipment. The equipment is assumed to be paid out over a five year period (Tables B.66, B.67, and B.68).

Off-farm investment. An investment activity is provided in the model to ensure that surplus funds not required for financing production activities or land purchases are not left idle. The activity also functions as a reservation price on the farmer's personal capital in that it would be chosen over any other activity that did not provide a return at least as large. Investment in Canada Savings Bonds was assumed to be a safe investment, being guaranteed by the Federal Government. These bonds are easily convertible into cash at any time so are available for investment in the farm business when the opportunity is profitable. The average rate of return used was calculated in Table 4.2 below:

Table 4.2

Interest Rates on Canada Savings Bonds Held for One Year
1962 - 1969

Year	Interest Rate
	percent
1962	4.50
1963	4.50
1964	4.50
1965	6.00
1966	5.00
1967	5.25
1968	5.75
1969	7.00
Average	5.30

Source:

Royal Bank of Canada Securities Department.

Income tax. Income taxes are an integral part of the financial management milieu in the same manner as costs of production. Taxes are seldom considered directly in farm management studies but are usually assumed to be paid by the farmer from his labor wage. Taxes are incorporated directly into this model. They are deducted before the net farm income is transferred to the objective function. The addition of this feature to the model is accomplished through the inclusion of two extra rows and seven extra activities per period. The first extra row, the income accounting equality row, determines the net income from the model before any exemptions for the farm family are deducted. The accounting equality row ensures that at least one of the tax activities is included in every period by placing a +1. in each of the tax activity columns, by setting the right-hand-side at a level of +1., and by specifying an equality for the row restraint. Since the objective is to maximize net after-tax income, the lowest level of tax activity or combination of two activities will be used. This technique of incorporating taxation into the farm decision-making model is patterned after the work of Vandeputte [51, pp. 521-523].

To provide a realistic set of tax deductions it was assumed that the farm family consisted of the operator, his wife, and two children. It was further assumed that additional deductible items aggregated with the farmer's personal exemptions for his family gave a non-taxable exemption of 3,000 dollars.

Taxes were calculated for the first several levels of taxation within the progressive tax structure. The amounts calculated included the Federal tax payable, the Provincial tax payable, and the deduction allowed for self-employed people who contribute to the Canada Pension Plan. Table 4.3 below gives the detailed amounts for each taxable income level considered.

Table 4.3

Income Taxes Payable on Given Levels of Taxable Income

Activity Name	Net Income	Taxable Income	Federal Tax	Provincial Tax	C.P.P.	Total
	. . . .		dollars			
Nontax	0.	0.	0.	0.	0.	0.
Taxfre	3,000.	0.	0.	0.	86.40	86.40
Txthre	6,000.	3,000.	468.00	163.50	169.20	800.70
Txfour	7,000.	4,000.	670.00	237.50	169.20	1,076.70
Txeght	11,000.	8,000.	1,511.00	611.80	169.20	2,292.00
Txtwel	15,000.	12,000.	2,486.50	1,119.30	169.20	3,875.00
Txfftn	18,000.	15,000.	3,286.50	1,287.30	169.20	4,743.00

Source:

Calculated using 1970 T1 General Individual Income Tax Return and Canada Pension Plan Return. 1970 tax rates are applied.

Discounting net farm income. The last activity to be discussed is probably one of the simplest yet most important in the model. The "Discnt" activity discounts and transfers net farm income of each period into the objective function of the model. The operation of the activity does the discounting rather than transferring an already discounted value. This is accomplished by placing a -1. in the row entitled "Cashrw," where all activities record their effects on net farm income, and a positive coefficient in the objective function row equal to the value of one dollar discounted from the particular period to the beginning of the model. The twelve positive coefficients registered in the "Discnt" activities of each period are the only coefficients in the objective function. The discount rate used was six percent.

Restraints

Programming restraints provide the bounds within which a model can operate; they are, as was stated in Chapter III, the third component required to conceptualize a linear programming problem. Earlier in this chapter the types of general restraints were categorized. A discussion of these problem bounds will clarify their importance.

Land use. Effective use of a limited land base is of major importance in maximizing returns to the farmer. Each year before planting, the farmer must determine which crops to seed, based on his knowledge of likely marketing conditions, rotation requirements for conservation of his soil, and his inventory position with respect to each crop. In the model, the land use pattern is part of the solution and depends on which crops yield the greatest profit considering all the restraints that bind crop production. To specify the initial land use restraints for this model, the 1968 records of the sample farms were examined. The results of this examination yielded the land use patterns for the three representative farm sizes (Table A.1). Since those figures include both owned land and rented land (land renting is decided within the model), it was assumed that owned land had the same distribution pattern as total land restraint coefficients used in the model (Table A.2). Operation of the model, of course, changes these values over time; summerfallow may be increased, forage land has to be broken and new land reseeded, and purchases of new land, as well as renting land, augments the available land supply.

In regard to land purchasing, some of the restraining factors involved were covered in the discussion of the activities specified in the model. However, a more complete explanation of all the restraints on land purchasing is required.

In delineating the ways in which capital restricts the decision to purchase land, the machinery complement and labor time relationship were mentioned. This relationship requires further explanation on a physical restriction basis, abstracting from the effects registered on the capital decision. There is, obviously, an upper limit to the amount of land which can be handled successfully with a given machinery complement. The upper limit is a function of the size of machinery, the speed at which it can be operated, the number of daily labor hours available for its operation, and the number of operating days. There is a very narrow range in speeds at which most field operations can be performed, and in man-hours of labor time available in a restricted period such as seeding time; therefore the amount of land that can be farmed effectively depends upon the size of machinery available. At some point in the process of adding to the land base of the farm, capital intensive inputs, in the form of newer, larger machinery, must be made in order to reduce per acre time requirements so that a larger total acreage can be handled. The basic question arises, "How much additional land can a farmer with a given complement of machinery handle before that complement would have to be augmented?"

In formulating an answer to the above question, with special reference to the three representative farms being considered in this study, the statistics on land base for the three farms were examined. Table 4.4 below gives these statistics. Considering the acreages that have to be worked on these representative farms, the knowledge gained from on-farm interviews about machinery use, and subjective evaluations of delays due to weather and machine down-time, it was estimated that these farms could be expanded to the extent of 50 percent of the present improved acreage before a larger line of equipment was required. Performing the necessary calculations for each farm indicates that they could expand by 167.38, 284.50, and 547.62 acres, respectively, in terms of total farm acreage.

Adjusting the above figures to sizes in which land parcels might likely be sold gives the restraints which are used in the farm models for maximum expansion of respective farm bases without equipment complement adjustment. They are as follows: small farms, 160 acres; medium farms, 320 acres; and large farms, 560 acres.

Table 4.4

Acreage of Land Operated
Small, Medium, and Large Representative Farms
Manitoba Crop District Number 10
For the Year Ended December 31, 1968

Farm	Size Class	Average Size of Sample Farms	Improved Acreage	Unimproved Acreage	Improved as a Percent of Total
	. . . .	. acres .	. . . .	.	. . percent . .
Small	<400	333	233	100	.699
Medium	400-760	569	400	169	.703
Large	>760	1,093	735	358	.672

If purchases of land exceed the above maximums, then machinery complements are required to be adjusted according to the following assumptions: the small farm must increase its machinery investment to the level initially specified for a medium sized farm; the medium sized farm must increase its machinery investment to the initial level of large farm investment; and a large farm must increase its machinery investment by 50 percent of its initial value. For the calculations of the investment requirements and the amortization schedules for the debt loads resulting from the added investment, see Tables B.66, B.67, and B.68.

Labor. The nature of the labor requirements in agriculture force a farmer to acquire many skills (i.e., plumbing, welding, mechanics, and accounting) in order to keep his farm operational. The application of these skills requires time. Currently, in agriculture, the farm manager relies on himself as the sole laborer as well as manager. His time is still supplemented by varying amounts of "unpaid" family labor, while good hired labor becomes more difficult to find.

A survey was conducted to determine the amounts of farm labor typically available in a number of critical time periods and in total during the year. Statistics were obtained for only part of the total sample of farms whose records were analyzed to yield the balance of the tables of Appendix A. The results of the survey are presented in Table A.6 as averages for the numbers of farms indicated in each representative farm size. Included in the figures are the hours of operator labor plus unpaid family labor.

Hired labor was assumed to be available to the same extent as operator labor; in total for the year, and on a distributional basis. An activity was specified to allow hiring of labor in each of seven intra-year time periods at $1.50 per hour.

Capital. The cash flow system specified in the model was discussed earlier. The initial value of short term capital for each of the representative farms was calculated by summing a number of current asset categories from the Net Worth Statements (Table A.3). These were: supplies, farm accounts receivable, stocks and bonds, personal accounts receivable and cash on hand and in bank. The value of personal debt was deducted from that sum. See Table A.10 for the calculations for each farm size. As noted earlier, the short term capital supply can be augmented through borrowing activities for each quarter of the year. The restraint on this type of capital borrowing is specified initially as 10,000 dollars less the beginning balance of short term debt.

Intermediate term debt was specified for use only in the land buying activities in which the machinery complement had to be increased. This type of credit could be obtained at an interest rate of 9 percent. As in short term, the maximum credit of this type that could be obtained was 10,000 dollars, less the initial balance of intermediate term debt.

Long term capital can be used in the model for only purchases of land. The interest rate was specified at 8 percent. In the basic solution of the model, the restraint on long term borrowing was also specified at 10,000 dollars. However, as the initial balance of this debt type is reduced the restraint level increases each period by the amount of principal repaid.

Crop inventory. Inventory rows in a multiperiod programming model act as holding accounts. The initial values specified as right-hand-sides for these rows record the amounts of grain of various types, forage, and hay held over from the previous year of operation of the representative farms to the initial year of the model. These amounts are held in account until they can be moved out through either a sales activity, a feeding activity, or a transfer activity which carries the inventory forward into the ensuing year. Grain and feed inventories for the three representative farms as of the beginning of the model are detailed in Table A.4.

Livestock inventory. In this model, only beef cattle were considered as a livestock alternative. Hogs were in evidence in small numbers on some of the sample farms, but from the Yearbook of Manitoba Agriculture [49, 1968, p. 21] it appeared that hogs in Crop District Number 10 constituted less than 5 percent of marketings for Manitoba in 1968 and had declined from 1967. Hogs were, therefore, not considered in the model. A full range of cattle production and selling activities were specified for the model. These activities operated from the initial inventory situation for each representative farm as presented in Table A.5.

The least cost ration system that supplemented the livestock production activities operated very simply. Each production activity indicated the total nutrient requirements of various types; energy for maintenance, energy for production, minimum protein, weight of feed, and so forth. These requirements were forced to be met by placing zero right-hand-sides on the rows as restraints. These restraints could be met by feeding various grains, forage, and wild hay, each providing a characteristic quantity of the required nutrients and contributing to the required weight of feed. The requirements for each class of cattle produced are given in Tables B.33 to B.39. The nutritional values of feedstuffs appear in Table B.40.

This concludes the discussion of the model development. The mass of detail that was required to specify the model has perhaps been given a cursory review; but to do otherwise would lead to a coefficient by coefficient discussion which would not likely reveal as much of the thread of the model as has been presented here. Much greater detail concerning the coefficients of the model are given in the Appendices. Chapter V presents the solution results for the models for each of the three farm sizes.

CHAPTER V

MULTIPERIOD LINEAR PROGRAMMING RESULTS

The scientific method, used in researching most problems of our world today, may be said to consist of five major steps. The first of these is the formulation of the problem. A problem may be easily stated, or it may require much observation of certain phenomena before one might recognize and be able to point out its dimensions. The second phase in researching a problem is to determine the full characteristics of the problem, by further observation of relevant phenomena, by reviewing contributions of others who may have isolated and studied the problem, and by deducing relationships between the characteristics of the problem and other known factors in the discipline under which the problem is categorized. The third step in the scientific method is to develop a theoretical model which sets out the relationships among the characteristics of the problem, and which allows one to develop an operational model or means of testing the theory proposed. The fourth part of the method calls for the researcher to operate his model and report the results. Lastly, the researcher must draw conclusions from the results and interpret their significance to society so that benefits derived from the process may accrue to all affected by the problem. To this writer, the last two phases are the most important, for they answer the two simply-worded questions, "What did the researcher find out?" and, "How can this information be put to use?" This chapter contains the "gist" of the answer to the first and Chapter VI the same for the second.

Organization of Results

The results of this study are organized and presented primarily on the basis of the three representative farm sizes; small, medium, and large, as discussed earlier. The initial computer "run" on each farm size, designated as the "Basic Model" for purposes of exposition, included all activities as described briefly in Chapter IV. Once these basic models were run, the process of experimentation was conducted by excluding one, or more, of the possible activities, thereby ascertaining the effects of that activity or group of activities on the sum of the discounted net farm incomes for the twelve periods of the model. A schematic diagram, indicating the type of variation from the basic model made for the several runs on each farm size, is presented for each farm size in Figures 5.1, 5.2, and 5.3. The program values for runs on each farm size are tabulated and presented in Table 5.1 for easy comparison of the net farm incomes generated by the three farm sizes. The balance of the Chapter is devoted to a presentation of detailed results for the basic models in each farm size and highlights of changes in the solutions for the experimental runs.

Small Farm

As will be recalled from Chapter IV, page 71, the small representative farm has the lowest level of land base from which to operate. Initially it had 256 total acres with 179 cultivated acres. Although the initial levels of available labor and operating capital were not dissimilar on the three farm sizes, the small farm never achieves the

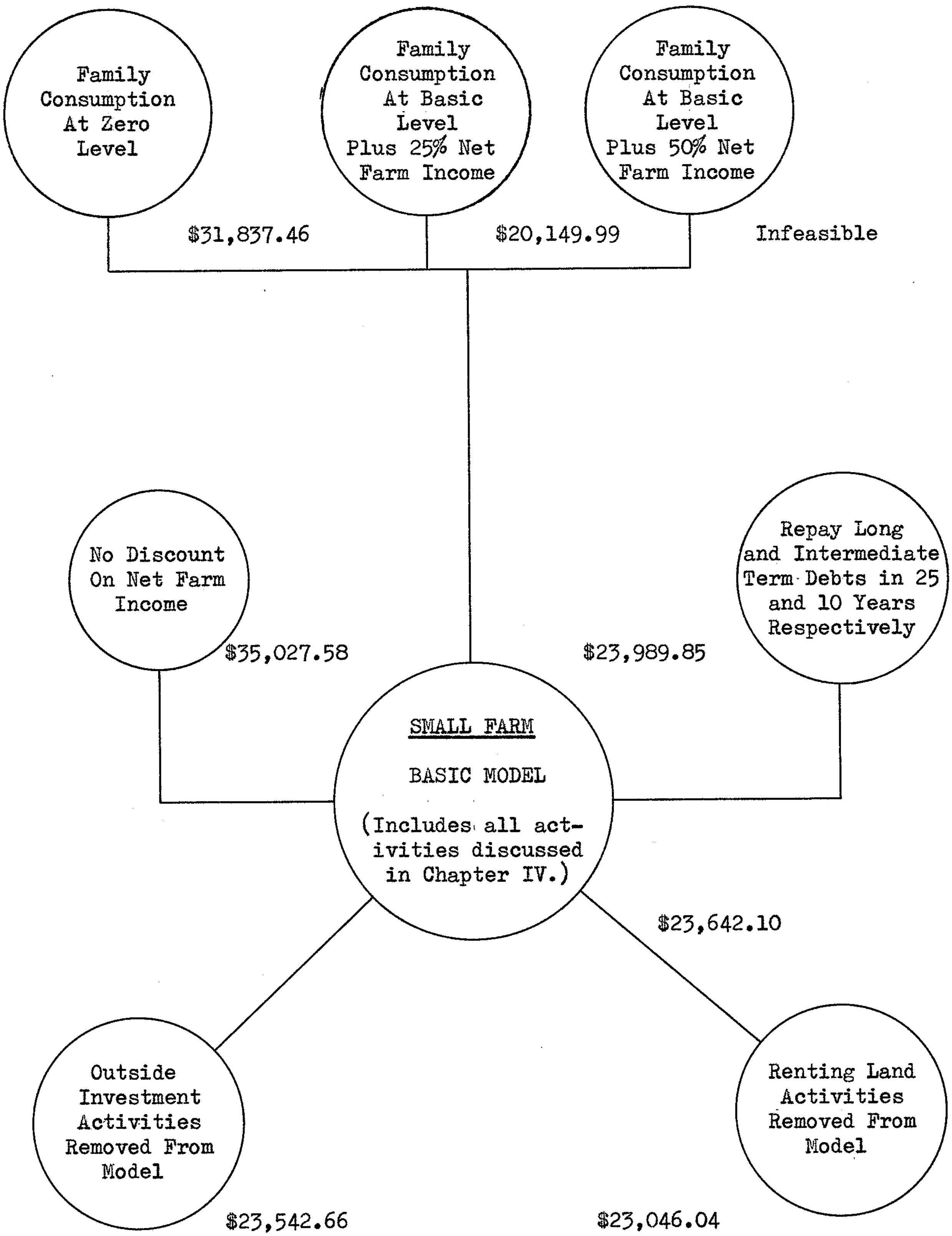

Figure 5.1. Schematic Diagram of Changes to "Basic" Model for Various Computer Runs - Small Farm.

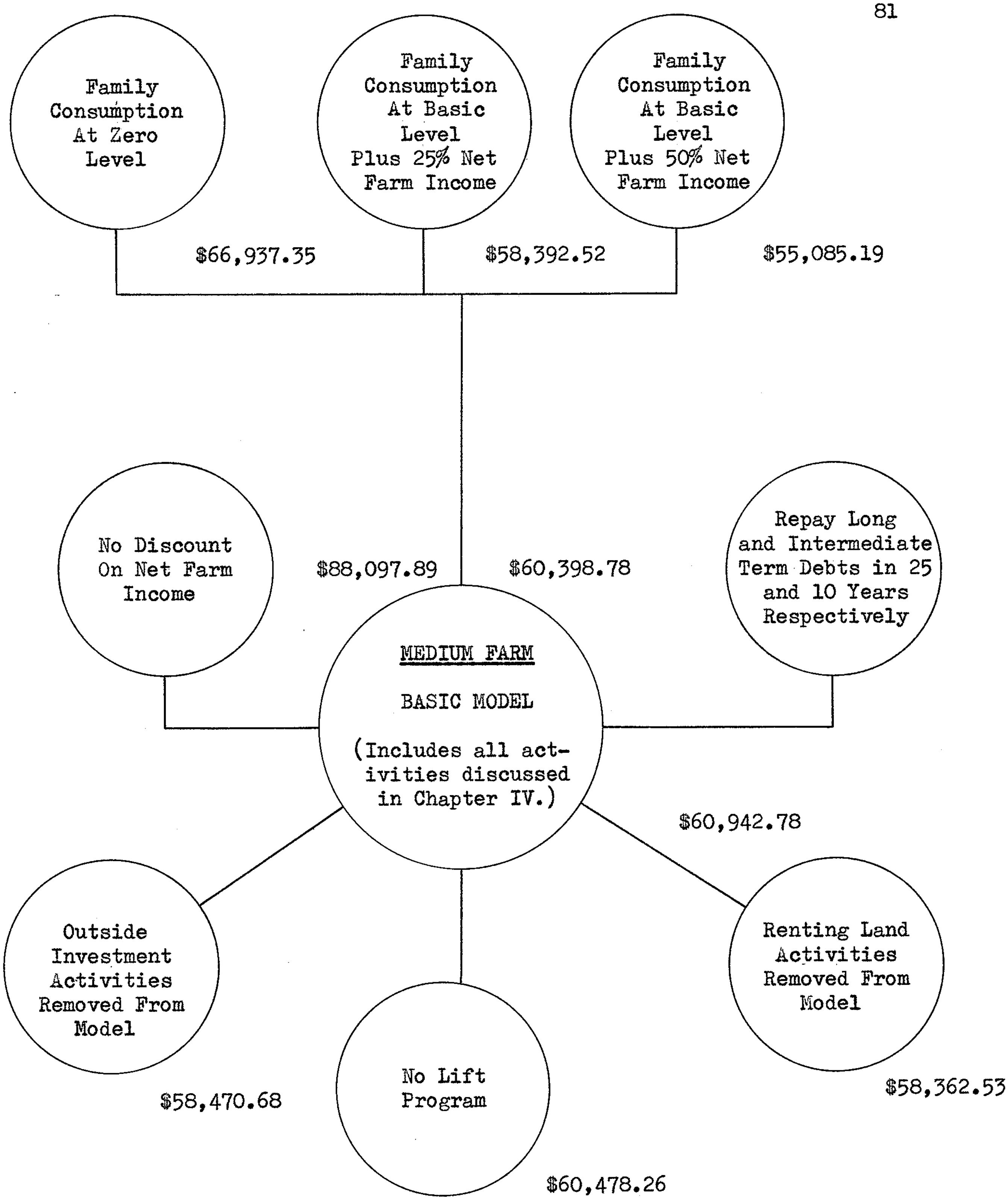

Figure 5.2. Schematic Diagram of Changes to "Basic" Model for Various Computer Runs - Medium Farm.

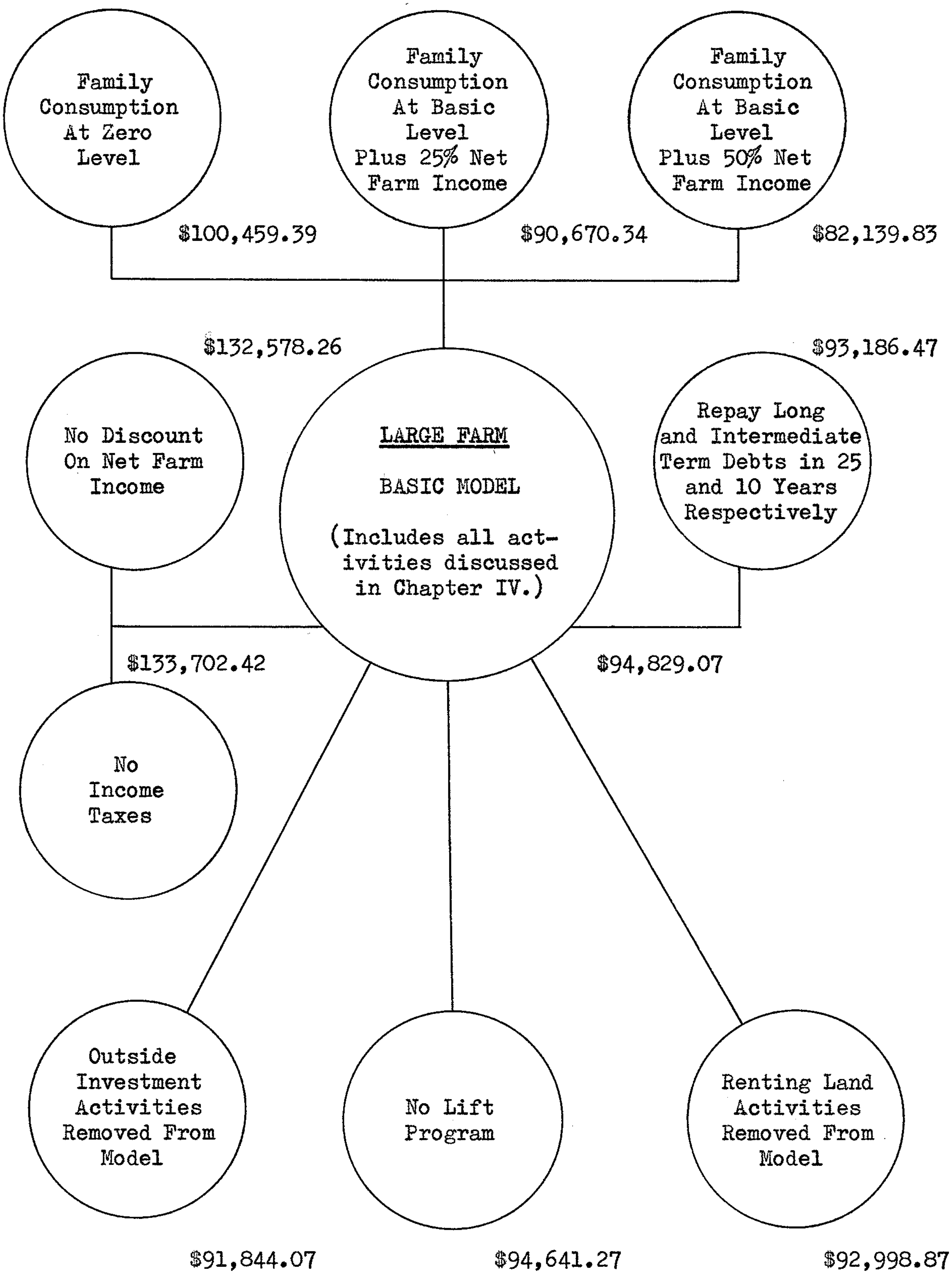

Figure 5.3. Schematic Diagram of Changes to "Basic" Model for Various Computer Runs - Large Farm.

Table 5.1

Sums of Discounted Net Farm Incomes for Given Model Runs on Small, Medium and Large Farms

Description of Computer Run*	Farm Size: Small	Farm Size: Medium	Farm Size: Large
	. . . . .	dollars	. . . . .
1) Basic Model	23,642	60,943	94,829
2) Repay initial long and intermediate term debts in 25 and 10 years respectively	23,990	60,399	93,186
3) No land renting activity	23,046	58,363	92,999
4) No off-farm investment	23,543	58,471	91,844
5) Net farm income not discounted	35,028	88,098	132,578
6) Family withdrawals at zero level	31,837	66,937	100,459
7) Family withdrawal at basic level plus 25 percent of net farm income	20,150	58,393	90,670
8) Family withdrawal at basic level plus 50 percent of net farm income	Infeasible	55,085	82,140
9) "Operation Lift" restrictions not included	**	60,478	94,641
10) Income not subject to Income Taxes	**	**	133,702

*Each run described represents a single change from the basic model. The changes are not cumulative as one moves down the table.

**No attempt was made to solve for this change in this farm size.

same level of income generated by either the medium or large farm, as is vividly demonstrated in Table 5.1. The limited land resource available is a key factor in the economics of this model, in that insufficient growth funds are generated to allow for a very extensive acquisition of additional cultivated land. This effectively blocks any major rise in net farm income.

The land use program, as determined in the basic model of the small representative farm, is given in Table 5.13.* Barley and rapeseed are the crops grown most consistently, with barley being grown "second crop", fertilized, and rapeseed on summerfallow, fertilized. Acreages in barley range from a low of 27 acres in period one to a high of 116 acres in period eight. A major crop of oats, 43 acres, is grown only in period one, with small amounts occurring in several other periods. Wheat does not appear in the solution until period three and it is grown on fallow, fertilized, in periods three through seven. Acreages are small, ranging from only four acres in period four, to 33 acres in period five. Forage is of little consequence in this basic model, except in period three where 67 acres are grown. Land in summerfallow in every period is forced to a level of one quarter of the total owned land base, 64 acres. This restriction was introduced into the model to approximate the "normal" management factor applied to land use in Crop District Number 10.

An important facet of the results in terms of land use, besides the dependence on large acreages of barley and rapeseed, is the relatively

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*Note: Data from the basic solutions of all three farm sizes are found in Tables 5.13 to 5.27 at the end of this chapter, starting at page 123.

stable solution in each period after number seven. Up to this period, there are several changes in crops included from period to period, and also changes in the levels of each one included in the plan. However, after period seven, fertilized barley is grown on stubble at approximately 115 acres per period, rapeseed on fallow at 64 acres per year, and oats on stubble at approximately 15 acres per period. This type of stabilization of a solution in later periods of multiperiod programs has been encountered in other studies (see especially the work of Boyko [59]).

Labor use for the small farm basic model is given in the second half of Table 5.13. It can be noted that a low total labor level is required in period one. This results from the small numbers of livestock produced. Livestock brought into the small farm model in the initial resource restrictions did not require major amounts of labor. Purchases of stock heifers do not occur until the fourth quarter of the first period (see Table 5.14) when 48 head come into the plan. A relatively stable number of stockers is found over the whole time span of the model, and, since labor requirements for the crops included in the model do not vary greatly, the total labour requirements in each period of the model stabilized in the 1400 to 1500 hour range. Management labor, which only the farmer himself can perform, is shown separately but is included in the amounts for each intra-year time period and in the figures for Total Labor use. Increases in labor requirements over periods seven to twelve reflect the extra labor required to operate rented and purchased land. The decrease in total labor use in period twelve masks the increase in crop labor and is due to the sale of all livestock in period twelve.

As can be noted in Table 5.13, hired labor does not constitute a major restriction to the growth of farm income. It was assumed throughout the model that hired labor could be found to match the number of hours of operator labor available, but only 68 hours were required over the winter cattle-feeding months from November through March of periods two and three for the small farm operation.

Grain sales in this model, as might be expected, follow closely the results of the cropping program determined in the solution. They are also very closely restricted by the quota system in its three forms, the old unit quota plus specified acreage in 1969, the "LIFT" quota program for 1970, and the new assignable acreage quota system for the years 1971 through 1980.

The details of grain sales are found in Table 5.14. These include the sales of inventory on hand at the start of the model and all grain produced for sale by the various activities. Wheat is sold in all periods except eight, nine, ten and twelve; with the exception of periods one and five, quantities are small. Oats are sold only in periods one and two. As will be noted under the discussion on cattle feeding, oats is the main grain fed to cattle. Barley and rapeseed are sold in every period of the model and constitute the primary source of income from grain production. An allowance of one 2,500 bushel lot of malting barley was programmed into the model and, since it sells at a five cent per bushel premium over regular quota barley, advantage of this provision is exercised in every period. Barley is also sold in all periods except three, four, and five on a regular quota basis. Maximum barley sales occur in period eight, when 5,457 bushels are sold. Sales of barley are close to this level over periods eight through twelve.

Maximum sales of rapeseed occur in period seven, when 2,496 bushels are sold. Sales range down to a low of 942 bushels in period three.

An interesting point to note is that no flaxseed production or sale comes into the solution for the small farm model. This probably occurs because of the low yield-times-price ratio of flax as compared to other crop production alternatives.

Livestock production is an integral part of the solution in all periods for the small farm model. Stocker steers or heifers are purchased in the last quarter of each period, except twelve, and sold as feeders after being rough fed over the winter and pastured for the summer. The stocker program operates fairly constantly at between 45 and 50 head, with a high of 56 stock heifers purchased in period two.

Cows included in the initial inventory, plus calves, are sold in periods one and two. The cow-calf enterprise appears not to be profitable, as it does not enter the solution at any point after the initial herd is sold.

In the feeding program required by the numbers of livestock coming into the programming solution, oats is the main source of energy for both maintenance and production in the livestock ration. Barley is fed in five periods to supply energy for maintenance and production of stockers, with the maximum amount being 451 hundred weight in period six. The maximum amount of oats fed to stockers occurs in period three, the period in which stocker inventory was highest, when 990 hundred weight of oats are used. Consumption of oats is more normal at approximately 900 hundred weight in other periods except one and twelve. Forage is used in every period of the model, providing roughage for the ration as well as energy for both maintenance and production. Maximums of approximately

600 hundred weight are fed to stockers in period four to satisfy the requirement for net energy for maintenance, and in period five to satisfy the requirement for net energy for production. Wild hay is available throughout most of Crop District Number 10 in varying quantities and is used for stockers in several periods. The maximum is in periods nine and ten when 568 hundred weight is fed. Only feed for stockers has been discussed here because of the small part that other classes of beef play in the total program. For complete details on the feeding program see Table 5.15.

The crop program does not supply all the feed supplies required by the livestock activities in this model. Significant quantities of oats are purchased in all periods except one and twelve, ranging from a low of 658 bushels in period three to over 3,100 in period two. The average for the ten years in which purchases are made is just over 1,700 bushels. As well as the additional oats required, owned pasture land is in short supply in all periods. The "rent pasture" activity operates at a level varying from 10 to 49 acres to fulfill the requirements for grazing stockers over the summer months. Details of both oat purchases and pasture renting are shown at the bottom of Table 5.15.

One of the features of this model is an attempt to program a cash flow system into the farm plan. While success is achieved in having cash flow from period to period with a system that allows one to see the net transfer of capital, the model does not show the gross amounts paid out of capital for production activities, nor the gross amounts of capital generated by various selling activities. These additional aspects could be added to the model in any future work with it. Details of net transfers of capital between periods is shown in

Table 5.16, along with the amounts of short term capital borrowed in each period. Notice especially the large transfers of generated capital of the third quarter (CGENCP) to the operating capital of the fourth quarter (ONDCAP). This results from the sales of the stockers, which have been pastured all summer, as feeders.

Table 5.17 gives the operational results for those activities which are described earlier in the thesis (Chapter IV, page 49) as point-of-interest activities. Each of these types of activity are withdrawn from the model to determine their effects on net farm income, which effects are discussed presently. Table 5.17, however, gives the levels achieved by each of these activities as included in the basic model.

The first of these activities provides one means of increasing the land base on which to generate larger farm income, by allowing for the renting of land. The "rent land" activity comes into the programming solution in each of periods seven through eleven at a level of 112 acres. No good reason has been found to explain why lesser acreages of land are not rented in earlier periods, nor to explain why such a large acreage appears in the solution so suddenly in period seven.

A second method of acquiring land is to purchase it. As explained in Chapter IV, two land purchase activities are possible in each period of the model. In this basic model solution of the small farm, the first type of activity enters the solution, that is, purchase land with no requirement for additional machinery. In period twelve, 112 acres of land are purchased. The reason for purchasing at this point, instead of renting, is that the purchase activity C_j cost is less than the rental activity C_j cost on a per acre basis.

Every farm firm may from time to time have surplus funds available which cannot be utilized within the farm business, or on which the return within the farm business is deemed unacceptable. Such funds may be invested profitably off the farm. Activities are included in the model to allow this investment, and in the programming solution for the basic small farm plan 2,467 dollars are invested in period one and 3,372 dollars in period two. Off-farm investment is assumed to be in Canada Savings Bonds at 5.3 percent interest. It appears that on-farm opportunities in periods one and two cannot pay more than this return into the objective function. No further off-farm investment occurs in periods three through twelve.

Activities to force the payment of income taxes on any taxable income are programmed into the model. In the results for the small farm model these are of little consequence, as most of the income falls in the non-taxable category. No actual tax on income is paid until period nine, when one percent of the income for the year is taxed in the category of "taxable income less than 3,000 dollars". In earlier periods only a contribution to Canada Pension Plan is made. The maximum tax paid comes in period twelve, when 58 percent of taxable income is taxed in the category "taxable income less than 3,000 dollars", and 42 percent in "taxable income from 3,000 to 4,000 dollars".

The last item of information appearing in Table 5.17 is the activity levels for the discounting activities. The amounts shown, when discounted by the appropriate factor for the particular period and summed, give the value of the program as detailed in Table 5.1. These amounts represent the undiscounted net farm income per period, after payment of income tax on any taxable income. The value of the program for the small farm basic model is 23,642 dollars, comprised of contributions from the various periods according to the figures given in Table 5.17 when multiplied by the appropriate discounting factor. The discounting factors are given directly below the income figure for each period.

Medium Farm

The "medium farm" label applies to the second size category of farms grouped for analysis (see Chapter IV, page 46). This size group has an average total land base of 506 acres, of which 341 are cultivated. Compare this to the 256 total acres and 179 cultivated acres initially available on the small farm. As pointed out earlier, levels of capital and labor available on the three farm sizes are similar. The medium farm has several more head of cattle than does the small farm for the first period (Appendix A, Table A.5). As might be expected, inventories of other assets are generally higher for the medium farm than for the small farm. Since this is the case, one might expect a better performance record for the medium farm as compared to the small farm. The following results are presented to enable one to make such a comparison.

The land use pattern for the medium size farm is given in the first section of Table 5.18. Two additional oat crops are grown in some periods as compared to the small farm basic model, oats on fallow-fertilized, and oats on stubble-unfertilized. The acreages sown to oats in any period remain small, the maximum being 24 acres of fertilized, second-crop oats. Wheat is grown in six periods in this model, instead of five as in the small farm basic model. Acreages range from a low of two in period two, to a high of 95 in period four. Again here, as in the small farm basic model, the major acreages go into barley on stubble and rapeseed on fallow. Barley enters the solution in every period, at a low of 20 acres in period two, and ranging up to 282 acres in periods eight, nine, and ten. Rapeseed acreage varies somewhat less than that for barley, the range being from 39 acres in periods three and four to 186 in period seven.

The overall pattern of land use for the medium farm basic model follows generally that of the small farm with the same crops coming into the plan in similar periods in each. This result should be expected since prices for all crops are identical, as are yields. Costs of production, as well as labor requirements, do differ between the two models. However, the variation in these factors is not large, and apparently does little to influence the choice among production alternatives.

Labor use in the medium farm model reflects the increased land base that must be operated. Total labor use varies from 1,152 hours in period one to 2,241 in period three. This figure stabilized at approximately the 2,100 hour level over the last half of the time span. Labor that must be performed by the farm manager averages 412 hours per period over the whole time period covered by the model. These hours are included in the "Total Labor Use" figures in Table 5.18.

Hired labor enters the solution to a much greater extent in the medium farm basic model than in the small farm basic model. Some labor is hired in every period except one, three, and four. The maximum levels hired are in periods eight and nine, when 167 hours come into the solution. As for total hired labor use, hours stabilize over the last six years of the model in the 125 to 160 hour range.

Grain sales in the medium farm solution are concentrated in barley and rapeseed, as follows from the cropping program choices. Wheat sales in some periods go as high as 2,848 bushels with lowest marketings in period six at 374 bushels. A small inventory of flax on hand at the outset of the model is sold in period one and flax does not enter the solution as a production alternative at any point in the model. Oats is sold only in the "LIFT" year, period two - 828 bushels. The balance of the oats produced is used for feed. One carload of malting barley is allowed, and as in the small farm model, advantage of this choice is taken. Under the regular quota sales of barley a maximum of 9,468 bushels is sold in period eight with sales in this class over 9,100 bushels in each of the last five periods of the model. Rapeseed sales reach a maximum in period seven at 5,474 bushels and average from 4,100 to 4,300 bushels per period over the last five periods. Details of all grain marketings appear in Table 5.19.

Increases in the amount of land used, the quantity of labor consumed, and levels of grain produced continue if one looks at the livestock production figures in Table 5.19. Carrying stockers through for sale as feeders again constitutes the major livestock alternative chosen, with numbers of head involved up approximately 150 percent over the numbers produced on the small farm. Maximum production of feeders again occurs over the winter between periods two and three; seventy-seven head are sold as feeders in that period. Also in June of period two, 22 head of cattle are sold for slaughter at the light weight of 1,000 pounds - as compared to 1,050 pound animals sold through other slaughter-beef selling activities. Production of feeders throughout most of the model averaged in the 60 to 70 head range, as compared to 45 to 50 head per period in the small farm model.

In the feeding activities for the medium farm basic model, barley takes a more prominent role in the ration, relative to oats, than it did in the small farm model. It is used primarily to provide energy for production. Oats still is used in every period and, in aggregate amounts, at greater levels than in the small farm model. Forage is used here exclusively to provide energy for maintenance. It is not used to provide energy for production. Wild hay again enters the solution at significant levels, ranging from approximately 450 hundred weight to 750 hundred weight. Table 5.20 provides full information on the feed for all classes of cattle produced in the model.

A significant variance from the levels of oats purchased and pasture rented in the small farm model occurs on the medium farm model. It appears that the medium sized farm is more nearly self-sufficient in livestock feed than is the small sized farm. Notice by comparing levels at the bottom of Tables 5.20 and 5.15 that the medium sized farm in fact purchases less grain in almost every period than does the small farm. The same is true for rented pasture.

Table 5.21 indicates the kind of cash flow generated by the medium sized farm. As expected, the magnitude of transfers for this farm size are greater than those for the small farm model. Note especially the large transfers from generated capital of the third quarter to operating capital for the fourth quarter in each period, rising to a maximum of 15,132 dollars in period eight. Another important aspect of the transfers section of Table 5.21 is the much smaller number of instances where zero funds are transferred, relative to the small farm.

Along with the results noted in the paragraph above, the necessity to borrow funds is seen to be all but eliminated. Capital is borrowed in only three quarters throughout the whole model, as shown in the second section of Table 5.21. The greatest amount borrowed is 2,530 dollars in the fourth quarter of the first period.

The last series of important results for the medium size farm's basic model are contained in Table 5.22. They constitute levels of activities previously described as "point-of-interest" activities. The "rent land" activity is the first of these. For this model, 320 acres of land are rented in each of periods seven through twelve. This differs slightly from the small farm basic model, in which land was purchased in period twelve rather than rented. The 320 acre figure represents the maximum additional land that can be rented or purchased without acquiring additional equipment. It should again be pointed out the anomaly which keeps additional land resources out of the solution until period seven, a result which also occurred in the small farm basic model.

Off-farm investment is of much greater consequence in this basic medium farm model than in the basic small farm model. Funds are invested off the farm in every period, starting with 6,535 dollars in period one, sinking to a low of 67 dollars in period five, then rising in every period to a maximum of 33,133 dollars in period twelve. Since the rate of return on off-farm investment is only 5.3 percent, this result indicates the low rate of return on funds invested internally in the farm business.

As may be obvious from the results of Table 5.1, where the values of all programs are recorded, the income tax situation for the medium farm differs from that for the small farm, in that the medium farm value is 60,943 dollars compared to the 23,642 dollar value of the program for the small farm. As can be noted by comparing the tax portions of Tables 5.22 and 5.17, a greater percentage of annual incomes for the medium farm model appear in the taxable income rows, rather than in the non-taxable rows as occurs for the small farm model. Only in periods three and four does income fall into the non-taxable category, with only five percent of period four income coming into this class. In period twelve, 95 percent of taxable income is taxed in the category "taxable income $12,000. - $15,000.".

The last item of interest in Table 5.22 is the series of undiscounted net farm incomes generated by the medium farm basic model. Note how the amount rises from period one to period two, plummets in period three, then rises steadily to a maximum of 13,039 dollars in period twelve. The big jump in value in period twelve occurs because no purchase of livestock is made with which to carry on the livestock production program past the end point of the model. If this purchase were deducted from the income indicated in Table 5.22, it is not likely that the target income of 10,000 dollars per annum would be achieved in this medium sized farm basic model.

Large Farm

The large farm designation applies to the group of farms which showed a large percentage increase in numbers of census farms from 1961 to 1966 (see Chapter IV, page 46). In Crop District Number 10, twentysix farms were analysed to provide a representative farm for this size of operation. The land restraint coefficients for this model show a total owned acreage of 924 acres, of which 610 acres is improved land (see Appendix A, Table A.2). This latter figure compares to 341 acres for the medium sized farm and 179 acres for the small farm. It would appear from this comparison that if the same margin of net income per acre can be attained on this size of farm as on the medium or small farm, then the total net income generated will be greater and this size of farm may provide the greatest opportunity for a farm manager to attain the target income of 10,000 dollars annual net farm income by 1980. This is, in fact, the result, as will be seen when Table 5.27 is discussed. First, however, the general results from the linear programming solution of the large farm basic model are given.

Having seen the results for the small and medium farm basic models and examined the tables of solution figures for them, one can see by looking at the tables for the large farm basic model that these results follow very much the same pattern. They vary primarily in the magnitude at which activities enter the solution. First of all, the land use pattern is similar, major cropping activities being fertilized barley on stubble and rapeseed on summerfallow - fertilized. Some forage is grown and some broken up early in the model. Also, minor acreages of wheat and oats appear in various periods (see Table 5.23 for details of acreages entering the solution).

Labor use in the large farm basic model appears to be much more stable from period to period, as compared to the small and medium sized farms. Exceptions are periods one and twelve, in which livestock are kept to much lower levels than in the remaining periods. Total labor use ranges from a low of 1,462 hours in period twelve to a high of 2,734 hours in period three. Period three labor is at a high level due to the large acreage of forage. Management labor is also at its lowest level in period twelve and highest in period three. Again, in the large farm model, major amounts of hired labor enter the solution, especially in the August 16 - September 15 time period; the maximum for this period is 226 hours for year eight of the model.

Grain sales in the large farm basic model follow the same pattern as in the other farm sizes. The magnitude of sales in the large farm model is much greater than in either of the other models. Malting barley is again sold to the maximum of one carload with very large balances of barley inventory being sold through the Board quota system. As expected from the results noted for land use, rapeseed sales are also extensive, the maximum being 8,415 bushels in period seven. Full details of all grain sales are given in Table 5.24.

Table 5.24 also gives the livestock activities which enter this basic solution. As was the pattern for the smaller two farm sizes, emphasis in livestock production and sales rests on the stocker program. Although numbers of head appear to be greater for the large farm, on an individual year by year comparison of Tables 5.24 and 5.19, the average for the full twelve years is only a fraction of one head higher than for the medium farm. As in the other models, the cow-calf enterprise ceases to function after the first two periods.

Table 5.25 presents the feeding program used for the various livestock enterprises that enter the linear programming solution for the large farm basic model. Since growing stockers is the main livestock enterprise for this farm size, the most important part of the table reflects the quantities of feed used in that enterprise. Oats, barley, tame forage, and wild hay are all used to provide energy for both maintenance and for production. The tame forage and wild hay provide roughage for the ration as well.

Table 5.25 also indicates the levels of feed oats purchased and pasture rented. Purchases of feed are considerably less than for either the small or medium farms, ranging from zero in several periods, to a maximum of 3,684 bushels in period two. Rented pasture for the large farm model is somewhat higher than for the medium farm model but less than the amounts rented for the various periods in the small farm model. Acreages involved range from a low of five acres in period twelve to a high of 54 acres in period three.

The cash transfer record for the large farm basic model is contained in Table 5.26. It is characterized, as were the results for the small and medium farm models, by the large transfers of cash from third quarter generated capital to the October-November-December operating capital. This record also shows approximately the same number of instances for which no cash is available for transfer as does the medium farm. Borrowing of short term capital is also minimal for this model, funds being borrowed in only six quarters throughout its span to a maximum of 889 dollars.

Moving to the last table of results for the large farm basic model, Table 5.27, the programming solution levels for the "point-of-interest" activities are presented. First, it is found that only land renting is used as a means of enlarging the acreage base of the farm, again only in periods seven through twelve. Three hundred and eighty-six acres are rented in each of these periods, the maximum allowable for this farm size being 996 acres, 560 of which could be handled without additions to the machinery complement.

Off-farm investment is of great significance in this model, the fund being invested reaching just over 50,000 dollars in the final year of the model. It is quite amazing that this volume of cash can be made available in the model in addition to the requirements for paying operating and overhead charges. As will be noted later, the value of the program is not significantly diminished by removing the opportunity for off-farm investment.

As to be expected from the previous discussion, income taxes are an important factor on this large farm model. Taxes are paid in every period for the large farm model, the maximum amounts being in periods seven, and ten through twelve. Some income is taxed in the over fifteen thousand dollar tax bracket in every period except three and four. Details of percentages of taxable income taxed in the various brackets appear in Table 5.27.

Lastly, Table 5.27 gives the levels of net farm income for each period of the large farm basic model. In eight of the twelve periods, income surpasses the target income of 10,000 dollars per annum. However, that is on an undiscounted basis. The yearly contributions of discounted income to the total value of the program are shown as the last item of the table. When these amounts are summed, they total 94,827 dollars, the value of the program for the large farm basic model shown in Table 5.1. The last row of income figures shows the drastic effect that discounting has on incomes arising in future periods.

This concludes the presentation of detailed results for the basic models of each farm size. The discussion which follows reports the effects on farm organization and net farm income caused by varying the make-up of the model. Specifically, different types of activities are removed, one at a time, from the model; for example, off-farm investment alternatives. Such changes are made in all twelve periods, not just one period. Only highlights of changes from each separate run are given, since five tables per farm size per model change would be required to present details such as are given for the basic model. The discussion is presented in the same order as the value-of-program figures given in Table 5.1.

Comparison of Results Between Basic Models and Models With Adjusted Repayment Periods on Initial Long and Intermediate Term Debts

In the basic model of each farm size, initial intermediate and long term debts were forced to be paid off in three and twelve years, respectively. These terms are probably very close to those into which many farmers tend to lock themselves. However, through prudent shopping longer terms can be found (for example, through the Manitoba Agricultural Credit Corporation). To approximate the repayment period available through such an agency, initial intermediate and long term debts were rescheduled to pay-out periods of ten and twenty-five years, respectively. The purpose in this restructuring was to determine its effects on farm organization and net farm income.

The impact on net farm income arises in two ways from such a change. First, the interest paid on farm debt is the only part of the payment that influences net farm income. Therefore, one would expect net farm income to decrease in every period subsequent to the first, since a lower payment on principal is made each period thereby leaving a higher balance on which to calculate interest. However, a second factor may offset this effect. The annual payment over a longer period of time is lower than over the shorter period, therefore an extra amount of working capital is available in each period, on which the farmer may realize a return.

Table 5.1, items 1 and 2 compare the gross results for the longer repayment period to those for the basic model, which includes the shorter repayment period. Lengthening the repayment period does not appear to have a significant effect on the gross value of the farm plans. For the small farm, the total gross return rises by only 348 dollars, while for the medium and large farms, the totals decrease by 544 and 643 dollars, respectively. From this result, it appears that the additional working capital only pays off in increased net farm income in the small farm model, where it is in short supply. In the medium and large farm models, the surplus of generated cash simply increases by 8,212 and 15,116 dollars, respectively. The lower returns accrue to the medium and large farms since the excess cash not going into repayment of debt is lent out at a lower rate of interest than the rate charged on borrowed capital.

The physical organization of each farm size remains relatively constant for the change to the longer repayment period, with the exception of the amount of land rented or purchased over the last six years of the models. In the small farm basic model, 112 acres of land are rented over periods seven through eleven. This acreage is then purchased in period twelve. However, with the changed repayment period, 101 acres are rented in periods seven to ten with that acreage purchased in period eleven. For the medium size farm, the average rented over periods seven to twelve of both the basic model and the model incorporating a longer repayment schedule is 320 acres. This is the maximum that could be rented or purchased without acquiring additional machinery. For the large farm, additional acreage is rented in periods seven through twelve, 386 acres for the basic model and only 384 for the model incorporating the longer repayment schedule.

Of further interest in regard to the change to a longer repayment schedule are the changes in amounts of capital invested off the farm. Table 5.2 shows these differences, for medium and large sized farms, between the basic models and the models with longer debt repayment schedules for initial intermediate and long term debts. The increases are attributed to the lower total payment on debt, which leaves surplus funds which do not pay a sufficiently high rate of return when invested internally within the farm compared to the 5.3 percent interest rate earned on funds invested off the farm.

<u>Exclusion of Land Renting Activities</u>

Renting land is one method of acquiring control over income generating assets. It may be accomplished by investing very small amounts of capital, such as under a share-crop rental, or by paying a definite sum on a cash rental basis. The cash rental system involves a higher degree of risk for a tenant but it enhances his opportunity for profit when yields are high. The cash rental scheme is incorporated into the basic model of each farm size.

Table 5.2

Off-Farm Investment Per Period - Medium and Large Farms
Comparison Between Basic Models and Models With
Extended Repayment Schedules for Initial
Intermediate and Long Term Debts

	Medium Farm Models		Large Farm Models	
Period	Basic	Long Repayment Schedule	Basic	Long Repayment Schedule
	. . . . dollars			
1	6,534	6,534	2,435	2,322
2	6,643	7,116	1,221	3,198
3	1,716	2,658	1,554	7,073
4	123	2,125	3,643	12,587
5	66	2,783	6,011	15,384
6	2,020	5,258	8,561	18,244
7	5,137	9,073	13,244	23,092
8	10,883	15,389	19,951	30,377
9	16,469	21,716	26,151	37,919
10	22,187	28,062	32,380	44,828
11	27,325	33,779	40,137	52,168
12	33,133	40,401	50,483	63,546

To explore the effects of closing off this avenue to greater returns, the activities providing for land rental were removed from one run of the model. As expected, the net farm income decreased for all three farm sizes from that earned in the basic model. The losses in income were 596, 2,580, and 1,830 dollars, respectively. The medium sized farm appears to have suffered most from loss of the land renting alternative.

The lower levels of income earned are due primarily to the decreased acreage of land that can be brought under control in each farm size. In the basic small farm model, 112 acres are rented in periods seven to eleven and the land is then purchased in period twelve. When renting is excluded as an alternative, 79 acres are purchased in period seven. This constitutes a loss of the net income from 33 acres over a six year period. The same effect is found in the medium and large size farms. In the medium farm basic model, 320 acres are rented in periods seven to twelve, whereas only 146 acres can be brought under operation through purchase in period seven - a decrease of 174 acres. For the large farm, 130 acres is the difference in total acreage controlled over each of the last six years of the model due to the removal of land renting alternatives.

Although the total net income generated for each farm is less with no land renting opportunities, the distribution of income is more stable. Stability of annual income is something that farmers would generally prefer, however, with a higher total value rather than lower. The undiscounted values of net farm income for each of the farm sizes, comparing the basic model to the "no rented land" model are shown in Table 5.3.

Since the incomes generated by the models with no land renting alternatives are lower, there is less capital funnelled into off-farm investment in later periods of each farm size. This effect is caused by the drain of capital funds into land purchasing. The comparisons are given in Table 5.4 for the medium and large farms. Off-farm investment only occurs in periods one and two of the small farm models, decreasing

Table 5.3

Undiscounted Net Farm Income Per Period -
Small, Medium, and Large Farms
Comparison Between Basic Models and Models
With No Land Renting Activities

	Small Farm Models		Medium Farm Models		Large Farm Models	
Period	Basic	No Rented Land	Basic	No Rented Land	Basic	No Rented Land
	. . . .	. . dollars				
1	1,554	1,405	5,199	5,199	10,106	10,102
2	2,913	2,913	6,323	8,072	12,151	13,257
3	1,399	2,178	2,913	5,199	5,923	7,392
4	693	1,522	5,085	4,705	6,579	7,735
5	2,913	2,766	5,923	6,196	8,895	9,507
6	2,913	2,727	5,923	6,183	9,583	8,810
7	2,913	2,913	8,708	7,137	13,257	11,187
8	2,913	2,913	8,069	6,485	12,781	10,954
9	2,942	2,913	8,617	6,515	13,035	10,936
10	2,953	2,913	8,708	6,551	13,257	11,458
11	4,548	3,432	8,708	7,635	13,257	13,257
12	5,506	3,767	13,039	11,135	13,257	13,257

by 231 and 294 dollars for these periods in the "no rented land" model, as compared to the basic model. One can see in Table 5.4 that off-farm investment for the medium farm size is larger than for the large farm.

Other minor effects of the removal of the land renting alternative were noticed. In the cropping program, there tended to be a shift out of wheat and oats into barley or rapeseed in early periods. Acreages of forage also decreased.

Table 5.4

Off-Farm Investment Per Period - Medium and Large Farms
Comparison Between Basic Models and Models With
No Land Renting Activities

	Medium Farm Models		Large Farm Models	
Period	Basic	No Rented Land	Basic	No Rented Land
	. . . .	dollars	. . . .	
1	6,534	6,581	2,435	2,799
2	6,643	7,779	1,221	2,016
3	1,716	5,450	1,554	3,989
4	123	6,746	3,643	6,021
5	66	8,571	6,011	9,482
6	2,020	10,380	8,561	12,724
7	5,137	13,208	13,244	16,461
8	10,883	15,369	19,951	20,966
9	16,469	17,033	26,151	23,307
10	22,187	18,584	32,380	25,598
11	27,325	18,436	40,137	28,436
12	33,133	19,549	50,483	32,488

Off-Farm Investment Excluded From Model

As noted in the discussion on types of activities included in the basic models, the off-farm investment activity was designed to ensure that no funds were left idle and to act as a reservation price on the farms' capital funds.

The effects on the value of the programs when off-farm investment is excluded, range from a negligible amount for the small farm (99 dollars), to fairly substantial amounts for the medium and large farms. The values of the plans for the medium and large sized farms decreased by 2,472 and 2,985 dollars, respectively. The effect is small in the small size farm because of the low level of off-farm investment that occurred in the basic small farm model solution. Since investment levels were higher in the medium and large size farms, greater effects are to be expected.

One of the most noticeable effects of this change was the higher levels of capital transferred from period to period in most years of the model. Capital borrowings also decreased. For example, in period one for the small farm, borrowing October-November-December capital decreased from 3,485 to 1,016 dollars. In the medium sized farm, the same activity dropped from 2,530 dollars to zero.

As expected, physical changes in farm organization, in terms of crop or livestock activities, were minimal. Most important was an increase in the acreage rented in the small and large farms; from 112 to 119 acres for the small farm, and from 386 to 414 acres for the large farm.

The last important effect of removal of off-farm investment activities from the three farm models relates to the level of the cash fund generated by the end of the twelfth year. The funds generated in the basic models of each farm size were 3,112, 44,722, and 61,029 dollars, respectively. With no off-farm investment opportunities these funds are significantly decreased, except for the small farm which shows a small increase. The new amounts are 3,343 dollars for the small farm, 37,558 dollars for the medium farm, and 53,417 dollars for the large farm.

Net Farm Income Not Discounted

Allowing net farm income to flow into the objective functions without discounting has fairly major consequences for the physical organization of each of the farm models. This is especially true in the first few years of the models, before the solution results of each year stabilize.

The changes that occur in farm organization, from year to year within one model, or in a comparison between the basic model of a particular farm size and the model for that same farm size with net farm income not discounted, although they are many, do not have a large effect on the overall results of the operation from a financial point of view. One crop increases several acres, another crop decreases; a few head of cattle, more or less, are bought, fed, and sold. The net effects on the objective function are small. The only physical change that has a significant effect, in comparing the basic models to the models with no discount on net farm income, is the increased acreage of land brought under control by renting in later periods of the small and large farms. The increase obviously occurs because of the greater impact that net farm incomes from these later years of the models have on the objective function with the discount factor removed.

On the financial side, the gross values of the programs are naturally much increased due to the removal of the discount factor on transfers of net income to the objective function (see Table 5.1 for the figures). In addition, cash funds generated by the end of the last period of the models are much increased, the small farm rising from 3,112 to 5,911 dollars, the medium from 44,722 to 46,129 dollars, and the large farm rising from 61,029 to 63,017 dollars. The off-farm investment patterns differ between the basic model and the model with no discounting as can be noted in the columns of Table 5.5.

Family Consumption at Zero Level

Family consumption activities were placed in each model to approximate the type of firm-household decision that must be made on every farm (see Chapter IV, pages 62-63). In these models, however, no choice was allowed. The activities were forced to enter the solution at levels deemed sufficient to satisfy basic requirements, as determined from an analysis of actual farm records in Appendix A, Table A.9. The actual coefficients used in each of the three basic farm models are set out in Appendix B, Table B.59. To determine the effects on the programming solutions in terms of potential income growth, or likely income decline, the models were run with varying levels of family consumption. Following are the results of using a zero level of consumption out of farm capital. (This situation is probably quite common where the farm wife provides the family consumption funds out of earnings from off-farm work.)

For all three farm sizes, the gross values of the plans increase substantially over those found in the basic models. The small farm value goes from 23,642 up to 31,837 dollars. The value of the medium farm plan rises from 60,943 to 66,937 dollars. The large farm run with zero family consumption increases in value from 94,829 to 100,459 dollars.

Along with these increases in the sum of discounted net farm incomes, there is a tremendous change in the cash funds accumulated by the end of each model run. These are due, of course, to the lower with-

Table 5.5

Off-Farm Investment Per Period - Small, Medium, and Large Farms
Comparison Between Basic Models and Models With
Net Farm Income Undiscounted

	Small Farm Models		Medium Farm Models		Large Farm Models	
Period	Basic	Undiscounted N.F.I.*	Basic	Undiscounted N.F.I.*	Basic	Undiscounted N.F.I.*
	. . . .	. . . . dollars	. . . .	. . . .	. . . .	. . . .
1	2,467	2,731	6,534	6,142	2,435	1,525
2	3,372	3,753	6,643	6,179	1,221	-
3	-	-	1,716	1,367	1,554	-
4	-	-	123	2,178	3,643	-
5	-	-	66	3,289	6,011	3,219
6	-	-	2,020	5,426	8,561	3,473
7	-	-	5,137	8,607	13,244	7,097
8	-	-	10,883	14,046	19,951	13,607
9	-	-	16,469	21,214	26,151	21,478
10	-	-	22,187	27,683	32,380	29,239
11	-	-	27,325	29,621	40,137	40,112
12	-	-	33,133	34,579	50,483	51,520

*N.F.I. = Net Farm Income

drawals of cash from each farm. The small farm fund rises from 3,112 to 41,763 dollars, or an over twelve fold increase. In the medium farm model, the fund more than doubles, moving from 44,722 dollars up to 92,784 dollars. For the large farm, the fund accumulates to 108,573 dollars; up 47,544 dollars. As could be expected, the capital transfer activities operate at higher levels in each model and borrowing of short term capital decreases.

One of the major contributions to the increase in net farm income is the increased level of off-farm investment of capital. Table 5.6 gives the details.

This section of the results has indicated the types of changes that can occur when capital withdrawals from a farm firm are decreased. The next two parts will give the results of adding given percentages of net farm income to the withdrawals considered as basic requirements.

Family Consumption Including Twenty-Five Percent of Net Farm Income

The most important physical change that is encountered as a result of this change in the model requirements, is that renting of land occurs earlier in the small farm model. Forty-seven acres are rented in period six. This is the first instance of additional land base being acquired in any period earlier than period seven.

More important than the physical adjustments, are the monetary effects of adding 25 percent of net farm income from each period to family consumption. The value of the objective function drops considerably for all farm sizes, 3,492, 2,550, and 4,159 dollars, respectively, going from small to large farm size. Perhaps more important

Table 5.6

Off-Farm Investment Per Period - Small, Medium, and Large Farms
Comparison Between Basic Models and Models With Zero
Family Consumption

Period	Small Farm Models		Medium Farm Models		Large Farm Models	
	Basic	Zero Consumption	Basic	Zero Consumption	Basic	Zero Consumption
	. . . . .dollars					
1	2,467	2,714	6,534	7,309	2,435	2,861
2	3,372	5,089	6,643	8,904	1,221	3,092
3	-	2,707	1,716	9,571	1,554	10,277
4	-	2,055	123	13,196	3,643	15,974
5	-	4,041	66	16,255	6,011	20,615
6	-	5,384	2,020	21,073	8,561	28,831
7	-	8,563	5,137	26,518	13,244	33,931
8	-	13,658	10,883	37,677	19,951	45,876
9	-	18,791	16,469	48,483	26,151	57,003
10	-	24,053	22,187	58,941	32,380	70,882
11	-	29,301	27,325	68,203	40,137	84,909
12	-	33,391	33,133	79,248	50,483	98,780

than this, is the decrease in the cash funds at the end of each model. The small farm fund drops from 3,112 dollars to zero; the medium farm fund declines by over 20,000 dollars, from 44,722 to 21,666 dollars. The large farm cash fund shows the greatest decrease, plummetting from 61,029 to 23,804 dollars.

Naturally, the transfers of capital from quarter to quarter through the model are reduced as a result of the above decreases. At the same time, borrowing of short term capital is up in periods in which borrowing occurred in the basic models and new borrowing activities enter the solutions for other quarters of various periods.

A comparison can be made between the basic models and models with additional family withdrawals, in terms of contributions of undiscounted net farm income and off-farm investment by scrutinizing Tables 5.7 and 5.8.

Family Consumption Including Fifty Percent Net Farm Income

With the family consumption withdrawal at such a high rate, no solution could be generated for the small farm model. Indications from the program output were, that the capital supply ran out in period six. No attempt was made to determine if the model would run with a higher level of borrowing allowed to offset the drain of funds into consumption.

For the medium and large farm models, the decreased amount of available capital is readily apparent. Transfers of funds through each model is reduced and borrowing of short term capital increased, a trend that was evident in the previous section when only 25 percent of net

Table 5.7

Undiscounted Net Farm Income Per Period - Small, Medium, and Large Farms
Comparison Between Basic Models and Models With Family Consumption
Including Twenty-Five Percent of Net Farm Income

	Small Farm Models		Medium Farm Models		Large Farm Models	
Period	Basic	Consumption With 25 Percent N.F.I. Added*	Basic	Consumption With 25 Percent N.F.I. Added*	Basic	Consumption With 25 Percent N.F.I. Added*
	. . . .		. . dollars . . .		. . . .	
1	1,554	691	5,199	5,112	10,106	8,708
2	2,914	2,914	6,323	5,902	12,151	13,257
3	1,400	732	2,914	2,914	5,923	5,923
4	694	125	5,085	3,564	6,579	6,345
5	2,914	2,914	5,923	5,923	8,895	8,708
6	2,914	2,914	5,923	5,895	9,583	8,726
7	2,914	2,914	8,708	8,059	13,257	11,512
8	2,914	2,914	8,069	7,826	12,781	11,662
9	2,943	2,914	8,617	8,292	13,035	12,131
10	2,954	3,005	8,708	8,708	13,257	12,787
11	4,548	2,918	8,708	8,708	13,257	13,257
12	5,506	4,254	13,039	13,139	13,257	13,257

*N.F.I. = Net Farm Income

Table 5.8

Off-Farm Investment Per Period - Small, Medium, and Large Farms
Comparison Between Basic Models and Models With Family
Consumption Including Twenty-Five Percent of
Net Farm Income

	Small Farm Models		Medium Farm Models		Large Farm Models	
Period	Basic	Consumption With 25 Percent N.F.I. Added*	Basic	Consumption With 25 Percent N.F.I. Added*	Basic	Consumption With 25 Percent N.F.I. Added*
	dollars					
1	2,467	2,772	6,534	5,092	2,435	2,197
2	3,372	3,367	6,643	3,856	1,221	748
3	-	-	1,716	-	1,554	-
4	-	-	123	-	3,643	-
5	-	-	66	-	6,011	-
6	-	-	2,020	-	8,561	-
7	-	-	5,137	949	13,244	-
8	-	-	10,883	4,294	19,951	4,520
9	-	-	16,469	7,680	26,151	7,709
10	-	-	22,187	10,188	32,380	9,707
11	-	-	27,325	11,610	40,137	12,215
12	-	-	33,133	14,407	50,483	16,742

*N.F.I. = Net Farm Income

farm income was added to consumption. The cash funds that were generated in the basic models of the medium and large farms are further reduced, the medium farm fund to 3,087 dollars, the large fund to zero.

Perhaps the most important indicator of the restrictiveness of the adjustment made for this run, is in the value of the objective functions for the medium and large farms. The decreases from the basic models are greater than for any other type of adjustment tried. The medium farm value declines from 60,942 to 55,085 dollars, while the large farm value decreases from 94,829 to 82,139 dollars.

Another factor which reflects the low amount of available capital is the level of off-farm investment activities. These activities enter the solution for this particular run of the three models in only periods one and two. For the medium farm, the amounts are 4,893 dollars in period one and 3,354 dollars in period two; for the large farm, the respective amounts are 2,412 and 1,308 dollars.

One of the most interesting results of this change occurs in the large farm, where a significant amount of land is rented in very early periods of the model. As noted before, this kind of activity rarely occurred before period seven of the model. Table 5.9 gives the details.

There are few major changes in the physical organization of the large farm due to the increased withdrawal of consumption funds as compared to the basic model. The crop plan tends to stabilize in period seven, with acreages at slightly different levels than the basic model due to a lower level of land rented over periods seven to twelve.

Table 5.9

Levels of Land Renting Activities in Large Farm Model
Family Consumption Including Fifty Percent Net Farm Income

Period	Acres
1	-
2	366
3	88
4	-
5	64
6	6
7	293
8	293
9	293
10	293
11	293
12	293

"Lift" Program Excluded From Basic Model

The Lower Inventory for Tomorrow program involving periods two and three, was included for the three farm size models. A run was made on each farm size excluding the details of this program. The results of making this change were quite insignificant, as can be noted in Table 5.1 by looking at the values of these programs as compared to the basic models. As further evidence of the small change that took place, the values of the cash funds generated at the end of the medium and large farm models are compared to those in the basic models in Table 5.10.

Although the monetary effects of the "Lift" program are not significant, the cropping program does change in periods two and three when the "Lift" program activities and restraints are removed from the basic model. As expected, acreages of forage and summerfallow decreased and acreages put into crop activities increased.

Table 5.10

Value of Cash Funds Generated in Medium and Large Farms
Comparison Between Basic Models and Models With
No Lift Program Activities or Restraints

Farm Size	Basic Model	No "Lift" Program Model
	. . . . . .dollars	. . . .
Medium	44,722	46,727
Large	61,029	60,050

Income Tax Activities Excluded From Basic Model

Most people would prefer to be relieved of the burden of paying income taxes. It is difficult to avoid them however, except in an experimental model such as this. As noted in Chapter IV, page 68, most studies of this type make the assumption that income taxes are paid out of the labor return to the farmer. Income taxes are, however, one of the liabilities attached to any business enterprise and as such should be considered directly in evaluating the returns to that business. Results of other studies, in terms of net income returns may be overstated by this failure to consider taxes directly. Consideration of the results presented in Table 5.11 gives an indication of the levels that this overstatement might reach.

All runs of all models have the income tax system operating in them, as described in Chapter IV, page 68, except this particular run.

Table 5.11

Undiscounted Net Farm Income Per Period - Large Farm
Comparison Between Basic Model and Model With
No Income Taxing Activities

Period	Basic Model	Model With No Income Taxes
	. . . . . dollars	. . . .
1	10,106	12,444
2	12,151	21,797
3	5,923	3,573
4	6,579	5,717
5	8,895	14,127
6	9,583	12,919
7	13,257	19,450
8	12,781	18,148
9	13,035	18,196
10	13,257	18,743
11	13,257	17,189
12	13,257	26,533

This experiment was made on the large farm because it paid the greatest amounts of tax, comparing the three models.

The results were found to parallel very closely those of the run in which family consumption was reduced to the zero level. Since income taxes were deducted in calculating net farm income, the value of the objective function increases tremendously over the value in the basic large farm model, from 94,829 up to 133,702 dollars. Looking at the cash fund generated by the end of the model, it rises by an even larger amount, from 61,029 to 119,732 dollars. Of course, transfers of capital through the model are much greater and credit requirements much less.

Table 5.11 outlines the contributions of each period to the net farm income. The values are not discounted so that if summed they would not equal the value of the objective function.

Since not all of the funds available in this model are required in financing production activities, relatively large sums become available for investment off the farm. These funds are much greater than in the basic large farm model, a comparison which can be made in Table 5.12.

Table 5.12

Off-Farm Investment Per Period - Large Farm
Comparison Between Basic Model and Model
With No Income Taxing Activities

Period	Basic Model	Model With No Income Taxes
	. . . . . . dollars	. . . .
1	2,435	2,799
2	1,221	4,061
3	1,554	13,162
4	3,643	12,408
5	6,011	14,959
6	8,561	22,550
7	13,244	30,658
8	19,951	43,994
9	26,151	56,315
10	32,380	68,675
11	40,137	81,509
12	50,483	95,612

The above discussion concludes the presentation of the results of the various trial runs made with these multiperiod linear programming models of the three representative farm sizes. The results for the basic models were covered in quite great detail, so as to provide a basis for the later comparison with results of adjusted models. The latter part of the chapter presented the comparative highlights of the adjusted models in relation to the basic models.

These results are used as grounds on which to base the conclusions about the total project. Chapter VI presents these conclusions and the summary of the thesis.

Table 5.13

Linear Programming Solution - Small Farm - Basic Model
Land and Labour Use

	Period											
	1	2	3	4	5	6	7	8	9	10	11	12
Land Use:	acres											
Wheat on fallow - fertilized	-	-	9	4	33	8	22	-	-	-	-	-
Wheat on stubble - unfertilized	-	-	-	-	-	-	-	-	-	-	1	-
Oats on stubble - fertilized	43	-	5	8	-	-	12	12	14	15	16	8
Barley on stubble - fertilized	27	72	28	42	42	106	75	116	115	114	112	121
Rapeseed on fallow - fertilized	45	54	33	33	59	37	85	64	64	64	64	64
Rapeseed on stubble - fertilized	10	-	-	-	-	-	-	-	-	-	-	-
Summerfallow land	64	64	64	64	64	64	64	64	64	64	64	64
Break forage land	12	-	12	79	-	67	-	-	-	-	-	-
Grow forage	-	12	67	-	-	-	-	-	-	-	-	-
Labour Use:	hours											
January, February, March	51	368	368	368	368	359	330	363	368	368	368	226
April 1 - May 15	53	199	237	184	200	194	197	206	209	209	209	146
May 16 - June 15	58	121	136	101	118	123	133	139	140	140	140	114
June 16 - August 15	129	162	190	335	164	143	189	195	197	197	197	147
August 16 - September 15	83	124	139	107	121	127	154	158	158	158	158	144
September 16 - October 31	126	104	149	144	194	135	199	168	171	174	178	82
November, December	242	269	245	245	239	220	242	245	245	245	151	-
TOTAL LABOUR USE	754	1357	1459	1488	1383	1307	1431	1476	1490	1493	1402	908
Management labour (included above)	141	309	337	320	306	291	302	317	320	321	298	178
Hired Labour (included above):												
January, February, March	-	-	53	-	-	-	-	-	-	-	-	-
November, December	-	15	-	-	-	-	-	-	-	-	-	-

Table 5.14

Linear Programming Solution - Small Farm - Basic Model
Grain Sales and Livestock Production

	Period											
	1	2	3	4	5	6	7	8	9	10	11	12
Grain Sales:	. . . .					bushels						
Wheat - unit quota	400	-	-	-	-	-	-	-	-	-	-	-
- specified acreage	496	-	-	-	-	-	-	-	-	-	-	-
- outside quota	656	-	-	-	-	-	-	-	-	-	-	-
- "LIFT" quota	-	241	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	259	120	987	233	661	-	-	-	26	-
Oats - "LIFT" YEAR seeded acreage	-	319	-	-	-	-	-	-	-	-	-	-
- rolling quality	2500	-	-	-	-	-	-	-	-	-	-	-
Barley - Malting	2500	2500	1288	1935	1430	2500	2500	2500	2500	2500	2500	2500
- extra quota	272	1580	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	-	-	-	1472	640	2957	2925	2892	2819	2827
Rapeseed - seeded acreage quota	1465	1516	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	942	949	1707	1080	2496	1906	1921	1936	1950	1965
Livestock Production:	. . . .					head						
Feed calf - own steer	1	1	-	-	-	-	-	-	-	-	-	-
Buy stocker steers	-	-	36	-	49	45	-	50	-	50	31	-
Sell feeder steers	2	-	-	35	-	47	43	-	48	-	48	29
Sell light slaughter beef - June	5	2	1	-	-	-	-	-	-	-	-	-
Feed calf - own heifer	1	-	-	-	-	-	-	-	-	-	-	-
Buy stocker heifers	48	56	14	50	-	-	49	-	50	-	-	-
Sell feeder heifers	-	46	54	13	48	-	-	47	-	48	-	-
Increase herd	1	-	-	-	-	-	-	-	-	-	-	-
Sell cows	2	1	-	-	-	-	-	-	-	-	-	-

Table 5.15

Linear Programming Solution - Small Farm - Basic Model
Feed Fed to Livestock and Feed Purchased

		Period											
		1	2	3	4	5	6	7	8	9	10	11	12
		. . . .	. . . .	. . . .	. . . .	. . . .	hundred weight	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Cow - calf													
Oats	- NEM	15.1	9.3	-	-	-	-	-	-	-	-	-	-
	- NEP	3.4	-	-	-	-	-	-	-	-	-	-	-
Forage	- NEM	43.2	21.6	-	-	-	-	-	-	-	-	-	-
Stockers													
Oats	- NEM	62.0	539.1	484.0	190.8	335.2	356.5	330.9	529.8	261.8	285.2	233.6	112.8
	- NEP	188.6	373.8	505.3	712.7	309.4	53.2	334.3	364.4	641.8	618.4	569.4	65.2
Barley	- NEM	-	-	-	-	252.5	-	168.5	-	-	-	-	-
	- NEP	43.2	-	-	-	-	451.4	-	-	-	-	-	216.8
Forage	- NEM	189.7	103.8	259.3	601.8	-	-	50.6	99.6	34.0	-	30.1	39.3
	- NEP	-	-	-	-	597.6	182.7	-	-	-	34.0	-	-
Wild Hay	- NEM	-	-	-	-	-	390.9	26.8	-	567.8	567.8	504.6	223.5
	- NEP	-	504.4	399.6	-	-	-	478.0	496.0	-	-	-	-
Feeders - up to 800 pounds													
Oats	- NEM	22.3	8.3	3.4	-	-	-	-	-	-	-	-	-
	- NEP	-	19.6	8.5	-	-	-	-	-	-	-	-	-
Barley	- NEP	57.4	-	-	-	-	-	-	-	-	-	-	-
Forage	- NEM	25.2	9.3	3.8	-	-	-	-	-	-	-	-	-
Molasses	- NEP	-	1.4	-	-	-	-	-	-	-	-	-	-
Feeders - 800 to 1,050 pounds													
Oats	- NEM	18.0	6.2	3.1	-	-	-	-	-	-	-	-	-
	- NEP	49.6	14.7	8.6	-	-	-	-	-	-	-	-	-
Forage	- NEM	21.4	7.4	3.7	-	-	-	-	-	-	-	-	-
Molasses	- NEP	-	2.6	-	-	-	-	-	-	-	-	-	-
Purchase Feed - Oats (bushels)		-	3175	658	2187	1896	1205	1252	1873	1810	1719	1365	-
Rent pasture (acres)		10	28	49	38	38	39	36	38	38	34	34	34

Table 5.16

Linear Programming Solution - Small Farm - Basic Model
Cash Flow Transfers and Short Term Capital Borrowings

		Period											
		1	2	3	4	5	6	7	8	9	10	11	12
		. . . . dollars											
Initial capital - $4,073.													
Transfer -	JFMCAP to AGENCP	1516	899	2814	326	821	1828	2085	1442	2273	2321	2436	2602
	AGENCP to AMJCAP	1544	1406	2557	-	-	-	-	-	-	-	-	-
	AMJCAP to BGENCP	474	191	1176	326	755	1218	431	883	872	924	968	1628
	BGENCP to JASCAP	1680	1080	1118	-	-	-	-	-	-	-	-	-
	JASCAP to CGENCP	914	-	-	-	-	-	-	-	-	-	-	-
	CGENCP to ONDCAP	1304	5058	5938	2874	5267	4131	4101	6675	6215	6566	6792	5999
	ONDCAP to DGENCP	-	712	3338	-	3248	2988	770	3374	2610	2788	2728	5855
	DGENCP to JFMCAP	1926	-	470	976	1899	2266	849	2488	2540	2659	2044	-
Borrow -	JFMCAP	-	-	-	-	-	109	-	802	-	-	-	738
	AMJCAP	-	-	-	1131	1779	2664	2056	2797	2827	2918	2988	3654
	JASCAP	-	-	-	1072	1210	1154	1521	1497	1531	1558	1586	1387
	ONDCAP	3485	3374	2813	3527	4087	4143	2458	2974	2637	2413	-	-

Table 5.17

Linear Programming Solution - Small Farm - Basic Model
Miscellaneous Activities

	Unit	Period 1	2	3	4	5	6	7	8	9	10	11	12
Rent land	acres	-	-	-	-	-	-	112	112	112	112	112	-
Buy land (no additional equipment required)	acres	-	-	-	-	-	-	-	-	-	-	-	112
Off-farm investment	dollars	2467	3372	-	-	-	-	-	-	-	-	-	-
Income Taxes													
Non-taxable-no contribution to C.P.P.	per cent of income taxed in given category	.47	-	.52	.76	-	-	-	-	-	-	-	-
Non-taxable-contribution made to C.P.P.		.53	1.00	.48	.24	1.00	1.00	1.00	1.00	.99	.98	.28	-
Taxable income less than $3,000		-	-	-	-	-	-	-	-	.01	.02	.72	.58
Taxable income $3,000-$4,000		-	-	-	-	-	-	-	-	-	-	-	.42
Undiscounted Net Farm Income	dollars	1554	2914	1400	694	2914	2914	2914	2914	2943	2954	4548	5506

Table 5.18

Linear Programming Solution - Medium Farm - Basic Model
Land and Labour Use

	Period											
	1	2	3	4	5	6	7	8	9	10	11	12
Land Use:	. . . . acres											
Wheat on fallow - fertilized	-	2	21	95	37	12	93	-	-	-	-	-
Oats on fallow - fertilized	-	17	-	-	-	-	-	-	-	-	-	5
Oats on stubble - fertilized	4	-	8	-	-	-	-	-	-	-	24	-
Oats on stubble - unfertilized	-	-	-	-	-	-	-	-	-	-	-	12
Barley on stubble - fertilized	133	81	20	58	106	201	144	282	282	282	258	266
Rapeseed on fallow - fertilized	93	78	39	39	113	73	186	141	141	141	141	141
Rapeseed on stubble - fertilized	14	-	-	-	-	-	-	-	-	-	-	-
Summerfallow land	81	59	29	29	85	55	141	141	141	141	141	141
Break forage land	16	-	106	120	-	-	-	-	-	-	-	-
Grow forage	-	104	120	-	-	-	-	-	-	-	-	-
Labour Use:	. . . . hours											
January, February, March	129	458	458	458	458	458	458	458	458	458	458	458
April 1 - May 15	95	278	313	230	244	251	282	287	287	270	270	270
May 16 - June 15	105	198	190	149	171	183	231	234	234	227	227	227
June 16 - August 15	213	237	513	533	238	214	322	331	329	316	320	301
August 16 - September 15	212	253	237	218	247	262	262	262	262	262	262	262
September 16 - October 31	75	135	232	274	244	180	345	218	218	209	254	166
November, December	266	331	305	305	312	320	331	331	305	305	305	-
TOTAL LABOUR USE	1152	1864	2241	2154	1891	1882	2196	2120	2093	2047	2097	1758
Management labour (included above)	221	421	498	437	404	408	470	468	461	340	446	366
Hired Labour (included above):												
January, February, March	-	-	122	-	-	11	22	38	38	-	-	-
April 1 - May 15	-	-	14	-	-	-	-	-	-	-	-	-
August 15 - September 15	-	-	-	-	-	8	117	129	129	125	127	125
November, December	-	95	-	-	-	-	-	-	-	-	-	-

Table 5.19

Linear Programming Solution - Medium Farm - Basic Model
Grain Sales and Livestock Production

	Period											
	1	2	3	4	5	6	7	8	9	10	11	12
Grain Sales:	bushels											
Wheat - unit quota	400	-	-	-	-	-	-	-	-	-	-	-
- specified acreage	935	-	-	-	-	-	-	-	-	-	-	-
- outside quota	1721	-	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	686	2848	1112	374	2823	-	-	-	-	-
Oats - "LIFT" YEAR seeded acreage	-	828	-	-	-	-	-	-	-	-	-	-
Barley - Malting	2500	2500	912	1466	2500	2500	2500	2500	2500	2500	2500	2500
- outside quota	36	-	-	-	-	-	-	-	-	-	-	-
- extra quota	1324	6466	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	-	-	1404	5028	2273	9468	9396	9324	9253	9181
Rapeseed - seeded acreage quota	2897	2207	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	1098	1107	3252	2124	5474	4180	4212	4244	4277	4310
Flax - seeded acreage quota	19	-	-	-	-	-	-	-	-	-	-	-
Livestock Production:	head											
Feed calf - own steer	12	1	-	-	-	-	-	-	-	-	-	-
Buy stocker steers	-	-	62	-	-	-	-	-	-	-	62	-
Sell feeder steers	1	-	-	60	-	-	-	-	-	-	-	60
Sell light slaughter beef - June	5	22	2	-	-	-	-	-	-	-	-	-
Feed calf - own heifer	11	1	-	-	-	-	-	-	-	-	-	-
Buy stocker heifers	45	77	-	62	64	65	67	67	62	62	-	-
Sell feeder heifers	-	43	74	-	60	61	62	65	65	60	60	-
Increase herd	2	-	-	-	-	-	-	-	-	-	-	-
Sell cows	16	2	-	-	-	-	-	-	-	-	-	-
Sell slaughter beef - January	2	-	-	-	-	-	-	-	-	-	-	-

Table 5.20

Linear Programming Solution - Medium Farm - Basic Model
Feed Fed to Livestock and Feed Purchased

	Period											
	1	2	3	4	5	6	7	8	9	10	11	12
	. . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	hundred weight	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .
Cow - calf												
Oats - NEM	148.3	18.5	-	-	-	-	-	-	-	-	-	-
Forage - NEM	128.5	16.1	-	-	-	-	-	-	-	-	-	-
Wild Hay - NEM	217.4	27.2	-	-	-	-	-	-	-	-	-	-
Stockers												
Oats - NEM	62.6	577.9	787.6	544.2	321.2	318.0	252.0	344.6	335.9	375.4	415.9	227.6
- NEP	222.4	409.4	535.4	-	335.3	-	-	269.0	178.6	-	444.2	65.1
Barley - NEM	-	-	-	-	-	253.7	75.6	-	-	-	264.4	
- NEP	-	-	-	580.3	475.6	587.3	862.6	605.4	677.3	749.1	-	507.2
Forage - NEM	177.5	118.3	143.1	302.9	96.7	278.0	151.5	114.7	121.8	127.5	72.4	87.4
Wild Hay - NEM	-	-	-	-	657.5	-	641.4	697.3	672.0	514.5	16.3	445.1
- NEP	-	539.6	738.1	446.2	-	494.1	-	-	-	107.1	660.4	-
Feeders - up to 800 pounds												
Oats - NEM	65.2	90.4	6.5	-	-	-	-	-	-	-	-	-
- NEP	138.9	214.3	17.2	-	-	-	-	-	-	-	-	-
Barley - NEP	12.2	-	-	-	-	-	-	-	-	-	-	-
Forage - NEM	68.2	103.4	7.5	-	-	-	-	-	-	-	-	-
Molasses - NEP	-	22.6	-	-	-	-	-	-	-	-	-	-
Feeders - 800 to 1,050 pounds												
Oats - NEM	18.0	83.0	6.2	-	-	-	-	-	-	-	-	-
- NEP	49.6	195.0	17.2	-	-	-	-	-	-	-	-	-
Forage - NEM	21.4	98.5	7.4	-	-	-	-	-	-	-	-	-
Molasses - NEP	-	33.9	-	-	-	-	-	-	-	-	-	-
Purchase Feed - Oats (bushels)	-	4344	-	1503	1930	935	741	1805	1513	1104	1000	-
Pasture rented (acres)	-	31	36	32	32	31	27	30	30	30	30	16

Table 5.21

Linear Programming Solution - Medium Farm - Basic Model
Cash Flow Transfers and Short Term Capital Borrowings

		Period											
		1	2	3	4	5	6	7	8	9	10	11	12
		dollars											
Initial capital - $7,568													
Transfer -	JFMCAP to AGENCP	775	713	4288	3771	854	453	-	441	539	1107	1174	714
	AGENCP to AMJCAP	1961	2607	4098	4453	2316	1889	3028	3907	3986	4536	4583	4104
	AMJCAP to BGENCP	-	-	2109	3187	408	198	-	-	-	482	448	-
	BGENCP to JASCAP	1915	7118	1810	1889	1856	1584	3004	2869	2912	2898	2993	2995
	JASCAP to CGENCP	521	5664	-	-	-	-	-	-	-	-	-	-
	CGENCP to ONDCAP	2183	12636	13384	11528	12304	12501	14868	15132	15107	14171	14146	14121
	ONDCAP to DGENCP	-	1885	7122	4290	4621	5295	7450	7000	7666	6984	7013	13780
	DGENCP to JFMCAP	1551	326	2313	1039	2828	3382	6365	6006	6349	5541	5486	-
Borrow -	JFMCAP	-	-	-	-	-	-	-	-	-	-	-	-
	AMJCAP	-	-	-	-	-	468	-	-	-	-	-	-
	JASCAP	-	-	-	-	-	247	-	-	-	-	-	-
	ONDCAP	2530	-	-	-	-	-	-	-	-	-	-	-

Table 5.22

Linear Programming Solution - Medium Farm - Basic Model
Indicated Activities

	Unit	Period 1	2	3	4	5	6	7	8	9	10	11	12
Rent land	acres	-	-	-	-	-	-	320	320	320	320	320	320
Off-farm investment	dollars	6535	6644	1716	124	67	2020	5138	10884	16470	22188	27326	33133
Income Taxes													
Non-taxable-contribution made to C.P.P.	per cent of income taxed in given category	-	-	1.00	.05	-	-	-	-	-	-	-	-
Taxable income less than $3,000		1.00	-	-	.95	-	-	-	-	-	-	-	-
Taxable income $3,000-$4,000		-	1.00	-	-	1.00	1.00	-	.23	.03	-	-	-
Taxable income $4,000-$8,000		-	-	-	-	-	-	1.00	.77	.97	1.00	1.00	.05
Taxable income $12,000-$15,000		-	-	-	-	-	-	-	-	-	-	-	.95
Undiscounted Net Farm Income	dollars	5199	6323	2913	5085	5923	5923	8708	8069	8617	8708	8708	13039

Table 5.23

Linear Programming Solution - Large Farm - Basic Model
Land and Labour Use

	Period											
	1	2	3	4	5	6	7	8	9	10	11	12
Land Use:	acres											
Wheat on fallow - fertilized	-	-	9	82	34	-	87	-	-	-	-	-
Wheat on stubble - unfertilized	-	-	12	-	-	-	-	-	-	-	-	54
Oats on fallow - fertilized	-	18	-	-	-	-	-	-	-	-	-	-
Oats on stubble - fertilized	-	13	13	-	-	-	-	-	-	5	55	24
Barley on stubble - fertilized	239	179	114	176	222	341	277	434	434	429	379	287
Rapeseed on fallow - fertilized	151	165	116	116	201	153	287	217	217	217	217	217
Rapeseed on stubble - fertilized	37	-	-	-	-	-	-	-	-	-	-	69
Summerfallow land	142	125	88	88	153	116	217	217	217	217	217	217
Break forage land	41	-	110	148	-	-	-	-	-	-	-	-
Grow forage	-	110	148	-	-	-	-	-	-	-	-	-
Labour Use:	hours											
January, February, March	182	489	489	489	489	489	489	489	489	489	408	214
April 1 - May 15	148	336	397	273	287	318	338	343	321	319	285	205
May 16 - June 15	166	270	276	205	232	253	292	292	292	291	276	239
June 16 - August 15	367	331	630	630	314	297	393	397	381	376	353	281
August 16 - September 15	324	324	324	324	324	324	324	324	324	324	324	324
September 16 - October 31	120	194	301	334	283	210	423	264	253	260	263	103
November, December	289	363	326	326	363	358	363	329	326	272	143	-
TOTAL LABOUR USE	1670	2263	2734	2570	2264	2264	2586	2439	2385	2334	2056	1462
Management labour (included above)	312	518	614	514	476	501	558	538	508	494	420	270
Hired Labour (included above):												
January, February, March	-	27	204	-	-	56	48	56	4	-	-	-
April 1 - May 15	-	-	20	-	-	-	-	-	-	-	-	-
May 16 - June 15	-	-	-	-	-	-	9	10	-	-	-	-
June 16 - August 15	-	-	-	59	-	-	-	-	-	-	-	-
August 16 - September 15	28	78	74	34	68	99	216	226	221	221	212	177
November, December	-	154	-	-	-	-	-	-	-	-	-	-

Table 5.24

Linear Programming Solution - Large Farm - Basic Model
Grain Sales and Livestock Production

	Period											
	1	2	3	4	5	6	7	8	9	10	11	12
Grain Sales:						bushels						
Wheat - unit quota	400	-	-	-	-	-	-	-	-	-	-	-
- specified acreage	1689	-	-	-	-	-	-	-	-	-	-	-
- outside quota	4584	-	-	-	-	-	-	-	-	-	-	-
- "LIFT" quota	-	523	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	486	2487	1040	-	2662	-	-	-	10	1044
Oats - rolling quality	2500	-	-	-	-	-	-	-	-	-	-	-
Barley - Malting	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
- extra quota	2390	15341	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	2657	3673	5943	10576	7417	15898	15788	15678	15552	11254
Rapeseed - seeded acreage quota	5311	4648	-	-	-	-	-	-	-	-	-	-
- assigned acreage system	-	-	3298	3325	5818	4442	8415	6425	6475	6525	6575	7804
Flax - seeded acreage quota	66	-	-	-	-	-	-	-	-	-	-	-
Livestock Production:						head						
Feed calf - own steer	17	2	-	-	-	-	-	-	-	-	-	-
Buy stocker steers	-	-	27	66	-	73	-	-	-	-	-	-
Sell feeder steers	5	-	-	26	64	-	70	-	-	-	-	-
Sell light slaughter beef - June	5	31	4	-	-	-	-	-	-	-	-	-
Feed calf - own heifer	15	2	-	-	-	-	-	-	-	-	-	-
Buy stocker heifers	44	91	39	-	74	-	74	67	66	55	29	-
Sell feeder heifers	-	42	87	38	-	71	-	71	64	64	53	28
Increase herd	5	-	-	-	-	-	-	-	-	-	-	-
Sell cows	20	5	-	-	-	-	-	-	-	-	-	-

Table 5.25

Linear Programming Solution - Large Farm - Basic Model
Feed Fed to Livestock and Feed Purchased

	Period											
	1	2	3	4	5	6	7	8	9	10	11	12
	. . . . hundred weight											
Cow - calf												
Oats - NEM	-	46.4	-	-	-	-	-	-	-	-	-	-
Barley - NEM	185.4	-	-	-	-	-	-	-	-	-	-	-
Forage - NEM	86.5	40.2	-	-	-	-	-	-	-	-	-	-
Wild Hay - NEM	345.9	67.9	-	-	-	-	-	-	-	-	-	-
Stockers												
Oats - NEM	199.1	327.8	897.5	-	346.9	11.8	-	-	166.8	112.6	503.9	222.9
- NEP	87.6	717.7	621.6	307.0	48.9	-	-	257.0	-	-	361.2	150.9
Barley - NEM	-	-	-	669.0	-	876.4	796.0	454.8	267.6	194.9	-	-
- NEP	97.8	-	-	224.6	844.2	443.4	527.9	588.8	773.5	836.1	-	-
Forage - NEM	-	-	130.2	146.8	142.7	-	200.3	-	-	160.2	32.4	13.9
- NEP	-	39.6	-	-	-	200.1	-	167.5	163.8	-	-	-
Wild Hay - NEM	82.3	657.1	54.3	-	683.3	-	-	698.8	640.8	601.5	95.8	33.8
- NEP	142.7	-	827.2	653.0	-	686.9	681.6	-	-	-	447.9	201.1
Feeders - up to 800 pounds												
Oats - NEM	-	131.7	16.3	-	-	-	-	-	-	-	-	-
- NEP	-	312.5	43.1	-	-	-	-	-	-	-	-	-
Barley - NEM	52.2	-	-	-	-	-	-	-	-	-	-	-
- NEP	189.1	-	-	-	-	-	-	-	-	-	-	-
Forage - NEM	87.6	150.2	18.8	-	-	-	-	-	-	-	-	-
Molasses - NEP	36.5	31.2	-	-	-	-	-	-	-	-	-	-
Feeders - 800 to 1,050 pounds												
Oats - NEM	10.7	117.4	16.7	-	-	-	-	-	-	-	-	-
- NEP	42.2	276.2	41.9	-	-	-	-	-	-	-	-	-
Barley - NEP	5.8	-	-	-	-	-	-	-	-	-	-	-
Forage - NEM	21.4	139.5	9.3	-	-	-	-	-	-	-	-	-
Molasses - NEM	8.9	-	-	-	-	-	-	-	-	-	-	-
- NEP	-	48.0	-	-	-	-	-	-	-	-	-	-
Wild Hay - NEM	-	-	9.2	-	-	-	-	-	-	-	-	-
Purchase Feed - Oats (bushels)	-	3684	-	464	1164	35	-	756	491	-	-	-
Pasture rented (acres)	12	25	54	36	36	41	36	37	32	31	24	5

Table 5.26

Linear Programming Solution - Large Farm - Basic Model
Cash Flow Transfers and Short Term Capital Borrowings

		Period											
		1	2	3	4	5	6	7	8	9	10	11	12
		dollars											
Initial capital - $3,238.													
Transfer -	JFMCAP to AGENCP	364	-	2943	267	-	-	-	7	1181	180	-	-
	AGENCP to AMJCAP	2629	4346	4329	2719	3662	3717	5338	6081	7232	6208	5908	5996
	AMJCAP to BGENCP	-	-	645	-	88	-	290	-	1058	-	-	872
	BGENCP to JASCAP	3485	12659	2999	2416	3011	3612	4460	4248	4239	4271	5808	6756
	JASCAP to CGENCP	981	10083	-	-	-	530	-	-	-	-	1555	2575
	CGENCP to ONDCAP	5722	23003	17304	7090	15285	17055	18771	18813	17569	17441	17064	13505
	ONDCAP to DGENCP	942	11143	10518	-	6974	9549	11063	11270	10239	11493	13712	13020
	DGENCP to JFMCAP	-	4977	2595	2524	2738	4765	6621	6851	5553	6558	8648	-
Borrow -	JFMCAP	-	-	-	-	-	-	-	-	-	-	-	-
	AMJCAP	889	-	-	81	-	731	-	-	-	88	-	-
	JASCAP	-	-	-	698	-	-	-	-	-	38	-	-
	ONDCAP	-	-	-	-	-	-	-	-	-	-	-	-

Table 5.27

Linear Programming Solution - Large Farm - Basic Model
Indicated Activities

	Unit	Period 1	2	3	4	5	6	7	8	9	10	11	12
Rent land	acres	-	-	-	-	-	-	386	386	386	386	386	386
Off-farm investment	dollars	12436	1222	1555	3644	6011	8562	13245	19951	26151	32380	40138	50484
Income Taxes													
Taxable income $4,000-$8,000	per cent of income taxed in given category	-	-	1.00	.76	-	-	-	-	-	-	-	-
Taxable income $8,000-$12,000		.69	.24	-	.24	.96	.81	-	.10	.05	-	-	-
Taxable income $12,000-$15,000		-	-	-	-	-	-	-	-	-	-	-	-
Taxable income $15,000-$18,000		.31	.76	-	-	.04	.19	1.00	.90	.95	1.00	1.00	1.00
Undiscounted Net Farm Income	dollars	10106	12151	5923	6579	8895	9583	13257	12781	13035	13257	13257	13257
Discounted Net Farm Income	dollars	10106	11463	5271	5524	7046	7160	9346	8499	8178	7847	7403	6984

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this final chapter, as indicated by its title, is to present a brief overview of the discussion which comprises the preceding five chapters and to state the conclusions from the study which appear to be justified on the basis of the results found in chapter five. The intention is also to refresh the reader's memory about the problem being considered in the thesis and to re-emphasize the stated goals and objectives of this study as they relate to that problem. In developing the conclusions of the study, certain of its limitations will be pointed out, areas which require further analysis will also be outlined.

In developing the introduction to this thesis, it was pointed out that the Agricultural Industry is constantly in a state of crisis. New situations develop which add to the problems already faced by the farmer, the agri-business sector, and the various agricultural departments of governmental bodies. Old problems, which have been identified and much researched, resist attempts at their solution. One of the most persistent of these old problems, and perhaps the most important, if the list presented on page two is re-examined, is the problem of low net farm incomes. It is to that problem that the research effort in this study was directed.

Establishment of a reasonable goal or objective, or a set of goals, was stated as being of utmost importance when working on a farm problem, especially if there is a direct contact with the farmer in an extension situation. In line with this approach, an objective was set forth for this study. Simply worded, it was to determine the possibility of various sized farms reaching a net farm income target of 10,000 dollars per annum by 1980, or period twelve of a model with a starting date of January 1, 1969. The use of multiperiod linear programming was chosen as the analytical technique, since it is capable of handling time dated variables and maximizing a given objective function. This last feature was deemed important, since the maximum values thus generated could be compared to the stated criterion and evaluated as to whether or not it was surpassed. (In this study, the criterion was 10,000 dollars net farm income per annum.)

Through study of several other reports and theses, a number of important factors relevant to income growth were discovered which supported some of the ideas initially formulated about the thesis subject, and which supplied additional information which facilitated the development of the basic models used in the study. The review of these factors comprised Chapter II of the thesis. The discussion covered such variables as; the initial size of the farm unit in terms of acres of land base, the availability of capital for the operation of the farm unit, and the tenure situation related to the farm unit. These factors are strongly featured in the models used in this thesis.

Chapter III provided a cursory review of some of the theoretical considerations that formed the basis upon which the study rests. The term growth, as used in this thesis, was defined as income growth within the firm, rather than as growth of the size of a farm in a physical sense. The necessity of incorporating the time factor into any model dealing with growth was stressed and the discounting procedure that was utilized to bring the streams of income to a present value for comparison was introduced. The basic types of firm adjustment that allow for growth were discussed. The first two consisted of the technical efficiency criteria for a farm firm; the third was the adjustment of the total size of the resource base, and four was covered by the idea of allowing smaller levels of funds to be withdrawn from the farm firm, so that the fund available within the firm could be utilized to generate higher income levels. Lastly, the chapter covered the theoretical concepts of linear programming and multiperiod linear programming, marginal analysis concepts "tailored to the case of a finite number of activities."

Once the theoretical aspects of the study were developed, the operational structure and details to be included in it had to be specified. Elements discussed were as follows: the area selected for study, Manitoba Crop District Number 10; the concept of a representative farm, which was used to guide the analysis of several farm businesses from the selected area; and the activities and restraints specified for the model, which constitute the bounds within which solutions to the problem as outlined in Chapter I were to be determined.

Chapter V records the results found in the multiperiod linear programming solutions of the model. These results were discussed in two distinct sections. In the first, the solutions for the basic models of the three representative farm sizes were presented in great detail, much of it provided in tabular form and keyed to the discussion. The following physical factors were given much attention: land use patterns over the twelve periods of the model; labor use for each specifically segregated time period in each year of the model, as well as total labor use and hours of labor hired; grain sales of each crop, broken down as to the system under which it moved; numbers of head of livestock produced, purchased or sold; and the least cost ration specifications in terms of type and amount of feed. Of greater interest were the results which involved the financial operations of each of the basic models. Since the models are completely interactive, a requirement in a later period could initiate a sequence of activities through each of the preceding periods and this sequence could be followed forward or backward through the model. Such observations could be made especially in the capital transfer system. Activities which were described earlier in the thesis as "point-of-interest" activities gave the most important results in the solutions, since these were to be manipulated so as to try to determine possible solutions to the problem as set out in Chapter I.

The second section of the results incorporated the discussion about the effects of varying the structure of the basic models. Specifically, activities which were thought to have a significant effect on growth in net farm income, were removed from the basic model, one at a time, in a non-cumulative procedure, to produce a new solution. These solutions were then compared to the solution for the basic model to determine the net effects of that factor on the model. All of the experimental runs were related directly to financial management strategies. A general remark about these changes would be that those management decisions which called for removal of large sums of capital from the model made the greatest impact on net farm income and on the cash funds generated by the end of the last period of the model.

The above exposition completes the summary of this study. The balance of this chapter consists of the specific conclusions that may be drawn from each of the individual model changes reported upon in Chapter V and an overall statement of general conclusions from the study. A number of suggestions for future work with the model developed for this study are also cited.

Lengthening of the repayment schedules for initial intermediate and long term debts failed to produce a startling response in terms of increased net farm income. It would appear that for this type of change to be effective in bolstering income levels, capital must be in very short supply and there must be some highly profitable activities available on the farm into which the capital could be invested. Since an increase in off-farm investment occurred at an interest rate of only 5.3 percent, on at least the medium and large sized farms (see Table 5.2) it can be concluded that alternative high return activities were not available in the model as it was specified.

As had been determined in other studies (see for example, the work of Martin and Plaxico [37]), the renting of land is a profitable method by which to gain control over larger acreages of land. If acquisition by purchase is the only means of increasing the acreage in a farm unit, the growth in both income and final equity positions are decreased as compared to the alternative of being able to rent.

The off-farm investment activities used in this study basically provided a reservation price for the farm capital resource. These funds were quite liquid, moving out of farm capital one year and back into it the next year. However, the net effect on net farm income was not large, if the opportunity for off-farm investment was removed. The reason for this, one can conclude, is that there are internal investment opportunities which return very close to the rate attached to the off-farm investment activities (in this model, 5.3 percent).

It is questionable whether funds available on most farms, in reality, have the liquidity engendered in the assumptions used in the development of this model. More likely, one would find that when excess funds become available, they tend to become locked into investment in a farm enterprise which, at the time, may be paying a good return but which forces the farmer to maintain that investment long after the favorable returns have disappeared.

As noted above, in the general remark about the effects of the various changes made in the model for experimental runs, the activities which have the most pronounced influence on net farm income and on the levels of cash funds generated by the end of the last period of each model, are those which involve sizeable withdrawals of cash from, or additions of cash to, the capital flow. The results of reducing the requirement of farm funds for family consumption to zero most effectively emphasizes this conclusion. The only other experimental change, in which the income was also discounted, to give a larger increase in value of the program was removal of income taxes. Since income taxes must always be paid where taxable income is earned, the windfall effects registered by removing them for one run of the model may be disregarded for purposes of this comparison. However, it is not at all inconceivable that family requirements, <u>out of farm generated funds</u>, could be reduced to zero. The example of a working farm wife providing these funds was mentioned in reviewing the results of the run with zero family consumption. Many others could be provided.

Despite the beneficial increases in net farm income arising out of reduced consumption, only the large and medium sized farms consistently provide income above the 10,000 dollar level by the end of the model, the target income as set out in Chapter I. If the incomes are discounted for comparison as at the beginning of period one, none of the incomes would surpass the target income level, as evidenced by the results under item six in Table 5.1. The large farm would approach this target quite closely.

It appears from the results of this study that, unless some major source of additional income can be generated, for example, through highly subsidized prices for farm commodities, payment of supplemental income to small farmers, or highly increased production which can all be marketed, the trend to much larger farm units with small farmers getting out of farming will be continued, since the income return to the small farmer does not provide the growth potential to allow him to achieve the desired income level.

As expected, the net farm incomes and generated cash funds were much reduced when twenty-five percent of annual net farm income was added to the basic yearly consumption withdrawals, details of which appear in Appendix B, Table B.59. Since the basic consumption levels range from only 2,511 dollars in period one for the small farm, to a maximum of 4,157 dollars in period twelve of the large farm, the total withdrawals in any period for any of the farms is not extravagantly high if compared to the income from employment of non-farm owners and managers (see Table 1.3). Since many farm families may be induced to expend the higher levels on consumptive uses, either because of family numbers or through poor management, their growth potential becomes much reduced, as can be deduced from the results shown in Tables 5.7 and 5.8. As the level of net farm income withdrawn for consumption increases, the conclusion that larger numbers of farms will fail to reach the target income level follows directly.

Much literature in farm income policy refers to the existence of the forced savings trap which characterizes agricultural firm-household relationships. This phenomenon is very real and will continue to exist if the growth potential of farm firms is to become real growth. The evidence from this study supports such a conclusion.

The model developed for this study, it may be redundant to say, has many limitations. Perhaps the most serious is the cost involved in constructing it and making it work initially. Once a multiperiod model is working it remains difficult to switch from one set of farm restrictions to another without a wholesale change in coefficients. Since production coefficients from one farm to another vary considerably, this necessitates almost a complete rebuilding of the model to work with a different farm. Many of the coefficients for the three farm sizes used for this study are the same in all three models. Through increased sophistication in computer techniques, such as mixed integer programming, a facility not presently available at the computer installation on which this model was developed, the scope of activities and variations in internal coefficient manipulation will be much broadened.

However, such development does not preclude further study through adaptation of the present models. Many activities can be specified and included in the models; many should be removed. Especially important should be a concentration on activities that provide higher risk returns. Coupled with these developments an attempt at sensitivity analysis should be made, even though this is a difficult procedure with a multiperiod model. A first set of changes that could be considered, would be a much greater restrictiveness in the quota levels over the later years of the models. With an expanded choice of activities in the livestock enterprises including hogs, sheep, and poultry, along with inclusion of other cash crops, there exist infinite possibilities of cropping and livestock combinations.

Perhaps more important than the increased choices in physical production activities would be a broadened set of financial management strategies in terms of borrowing activities and variable types of repayment schedules. A more sophisticated income tax calculation and payment system is also required.

Others who utilize the multiperiod linear programming technique as a decision making system for farm firm analysis should find this study a useful basis as a take-off point. It constitutes only a first step in providing a positive approach to the solution of agricultural production and farm adjustment problems.

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APPENDIX A

RESULTS OF ANALYSIS OF FARM RECORDS

Table A.1

Average Land Use: Small, Medium, and Large Representative Farms: Manitoba Crop District Number 10

Land Description	Small (5 farms)	Medium (20 farms)	Large (26 farms)
	. . . .	.acres	. .
Owned	256	506	924
Rented	77	63	169
Total	333	569	1,093
Unimproved	100	169	358
Improved	233	400	735
Summerfallow (incl. new breaking)	58	104	178
Wheat	71	118	235
Oats	14	31	65
Barley	64	58	112
Flax	-	11	18
Rapeseed	-	-	19
Other	10	43	45
Forages	16	18	48
Wild Hay	-	20	30
Pasture (incl. tame, wild)	-	51	94
Waste, Farmstead, Other	100	115	250

Table A.2

Land Restraint Coefficients: Small, Medium, and Large Representative Farms: Manitoba Crop District Number 10

Description	Small	Medium	Large
	. . . .	acres	.
Unimproved Land	77.0	165.0	314.0
Improved Land	179.0	341.0	610.0
Total Land	256.0	506.0	924.0
Summerfallow Land	45.0	93.0	151.0
Stubble Land	122.0	232.0	418.0
Forage Land	12.0	16.0	41.0
Pasture Land	28.0	45.0	79.0
Wild Hay Land	12.0	18.0	25.0
Waste, Farmstead, and Other (not included in model)	37.0	102.0	210.0
Total Land	256.0	506.0	924.0

Table A.3

Farm Net Worth Statements: Small, Medium, and Large Representative Farms: Manitoba Crop District Number 10: As at December 31, 1968

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
	. . . .	dollars	. . . .
Assets			
Land	18,148.	33,058.	53,889.
Buildings	6,724.	8,556.	10,785.
Machinery	9,804.	14,171.	23,731.
Livestock	3,608.	7,218.	10,989.
Grain and Feed	4,904.	8,805.	18,045.
Supplies	312.	357.	529.
Farm Accounts Receivable	57.	461.	196.
Total Farm Assets	43,556.	72,626.	118,164.
House (Personal Share)	1,673.	3,362.	3,978.
Car (Personal Share)	372.	632.	828.
Non-Farm Real Estate	-	765.	79.
Life Insurance	-	2,423.	1,064.
Stocks and Bonds	1,712.	4,458.	1,219.
Personal Accounts Receivable	1,617.	346.	4.
Cash on Hand and in Bank	375.	2,004.	1,361.
Furnishings	2,450.	2,140.	2,677.
Total Personal Assets	8,199.	16,130.	11,210.
Total Assets	51,755.	88,756.	129,374.
Liabilities			
Long Term Loans	9,234.	12,144.	23,137.
Medium Term Loans	2,096.	3,136.	8,029.
Short Term Loans	952.	2,149.	4,481.
Total Farm Debt	12,282.	17,399.	35,647.
Operator's Equity in Farm	31,274.	55,227.	82,517.
Personal Debt	5.	58.	71.
Total Debt	12,287.	17,457.	35,718.
Operator's Net Worth	39,468.	71,299.	93,656.

Table A.4

Grain and Feed Inventories: Small, Medium, and Large Representative Farms: Manitoba Crop District Number 10: As at December 31, 1968

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
Wheat (bushels)	1,793.	3,056.	7,196.
Oats (bushels)	1,042.	1,854.	3,499.
Barley (bushels)	2,610.	3,268.	5,038.
Mixed Grain (bushels)*	-	566.	414.
Rye (bushels)*	-	36.	73.
Flax (bushels)	-	19.	66.
Forage Seed (pounds)*	-	-	6.
Rape (pounds)	-	-	16,869.
Other*	-	56.	5,896.
Other*	-	-	1,446.
Silage (tons)	-	-	33.
Legume Hay (tons)	2.	24.	26.
Mixed Hay (tons)	4.	2.	3.
Wild Hay (tons)	0.2	21.	23.
Straw (tons)	3.	23.	27.

*Not included in model as restraints on supply rows.

Table A.5

Livestock Inventories: Small, Medium, and Large Representative Farms: Manitoba Crop District Number 10: As at December 31, 1968

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
	. . . .	head	
Beef Cows	2.0	16.0	20.0
Heifers	-	2.0	5.0
Calves	2.0	9.0	15.0
Stockers	1.0	1.0	5.0
Feeders (calves)	5.0	5.0	5.0
Feeders (yearlings)	-	2.0	-
Bulls	-	1.0	1.0

Table A.6

Labor Supply by Specified Time Period: Small, Medium, and Large Representative Farms: Manitoba Crop District Number 10

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
		. . . . hours	
January	122.0	153.0	158.0
February	123.0	153.0	159.0
March	123.0	152.0	172.0
Total	368.0	458.0	489.0
April	147.0	181.0	247.0
May 1-15	122.0	132.0	150.0
Total	269.0	313.0	397.0
May 15-31	122.0	132.0	149.0
June 1-15	113.0	130.0	143.0
Total	235.0	262.0	292.0
June 15-30	113.0	130.0	143.0
July	231.0	268.0	320.0
August 1-15	124.0	135.0	167.0
Total	468.0	533.0	630.0
August 15-31	124.0	135.0	168.0
September 1-15	121.0	127.0	156.0
Total	245.0	262.0	324.0
September 15-30	122.0	127.0	157.0
October	198.0	218.0	266.0
Total	320.0	345.0	423.0
November	147.0	163.0	196.0
December	122.0	168.0	167.0
Total	269.0	331.0	363.0
Yearly Total	2,174.0	2,504.0	2,918.0

Table A.7

Farm Income Statements: Small, Medium, and Large Representative Farms: Manitoba Crop District Number 10: For the Year Ended December 31, 1968

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
	. . . . dollars		
Receipts			
Beef & Feeder Cattle Sales	185.	3,485.	4,487.
Hog Sales	4,634.	3,719.	3,208.
Crop Sales	3,552.	5,069.	9,700.
Total Major Sales Accounts	8,371.	12,273.	17,395.
Other Livestock & Livestock Product Sales	-	313.	916.
Labor & Custom Work Income	11.	191.	248.
Wheat Board Payments	1,042.	1,952.	3,011.
Other Miscellaneous Crop Receipts	79.	255.	423.
Total Miscellaneous Receipts	1,132.	2,711.	4,598.
Total Operating Receipts	9,503.	14,984.	21,993.
Inventory Increase (Decrease) Crops	1,089.	1,078.	4,184.
Inventory Increase (Decrease) Livestock	686.	948.	628.
Gross Returns from Landlord Livestock	-	(32.)	-
Value of Products Used in Home	115.	228.	172.
Total Receipts Adjustments	1,890.	2,222.	4,984.
Adjusted Gross Farm Receipts	11,393.	17,206.	26,977.
Livestock Purchased	(952.)	(1,876.)	(1,355.)
Grain & Hay Purchased	(655.)	(524.)	(770.)
Prepared Rations Purchased	(512.)	(130.)	(299.)
Gross Profit	9,274.	14,676.	24,553.

Table A.7 (continued)

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
	. . . .	dollars	.
Less: Cash Operating Expenses	4,094.	5,676.	10,434.
Returns Above Operating Expenses	5,180.	9,000.	14,119.
Less: Depreciation - Buildings & Machinery	1,573.	2,184.	3,571.
Net Farm Earnings	3,607.	6,816.	10,548.
Less: Interest Paid on Farm Debt	519.	720.	1,450.
Net Farm Income	3,088.	6,096.	9,098.

Table A.8

Farm Expense Statements: Small, Medium, and Large Representative Farms: Manitoba Crop District Number 10: For the Year Ended December 31, 1968

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
	. . . .	dollars	. . . .
Car - Fuel	170.	179.	230.
- Repairs and Other	156.	144.	208.
Truck - Fuel	144.	121.	200.
- Repairs and Other	133.	189.	227.
Tractor - Fuel	187.	348.	520.
- Repairs and Other	158.	296.	336.
General Cropping Machinery Repairs	96.	145.	285.
Haying Equipment Repairs	1.	30.	30.
Combine & Swather Operating Expense	28.	127.	249.
Livestock Equipment Repairs	30.	45.	47.
Small Tools and Miscellaneous Equipment	68.	105.	150.
Special Crop Machinery Repairs	-	14.	2.
Total Machinery and Equipment Operating Expense	1,171.	1,743.	2,484.
Farm Buildings - Crops	33.	118.	208.
- Livestock	64.	34.	63.
Fence Repairs	21.	51.	75.
Total Building and Improvement Operating Expense	118.	203.	346.
Crop Insurance	61.	195.	443.
Sprays	159.	335.	625.
Fertilizer	811.	878.	1,929.
Custom Work	243.	84.	350.
Other Direct Crop Expense	6.	87.	136.
Total Crop Operating Expense	1,280.	1,579.	3,483.

Table A.8 (continued)

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
		dollars	
Cow-Calf-Supplements and Minerals	2.	36.	88.
-Veterinary and Medicine	16.	65.	60.
-Other Direct Livestock Expense	12.	121.	170.
Feeders-Supplements and Minerals	4.	8.	16.
-Veterinary and Medicine	-	1.	-
-Other Direct Livestock Expense	1.	6.	5.
Hogs-Supplements and Minerals	579.	477.	486.
-Veterinary and Medicine	58.	50.	32.
-Other Direct Livestock Expense	73.	12.	20.
Other Livestock-Supplements and Minerals	1.	15.	60.
-Veterinary and Medicine	8.	4.	10.
-Other Direct Livestock Expense	1.	4.	64.
Total Direct Livestock Expense	755.	799.	1,011.
Overhead Expenses:			
Hydro and Telephone	148.	181.	225.
Miscellaneous Overhead Expense	37.	71.	95.
Farm Cash Rent	279.	3.	434.
Land Taxes	291.	564.	924.
Building and Equipment Insurance	39.	80.	77.
Farm Rental Shares-Crops	-	166.	306.
-Livestock	-	(32.)	-
Hired Labor Plus Board	61.	154.	427.
Total Overhead Expenses	855.	1,187.	2,488.

Table A.8 (continued)

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
	. . . .	dollars	. . . .
Total Current Expenses	4,179.	5,511.	9,812.
Supplies Inventory (Increase) Decrease	(85.)	165.	622.
Total Cash Operating Expense	4,094.	5,676.	10,434.
Depreciation Buildings and Machinery	1,573.	2,183.	3,571.
Total Expenses (excluding interest)	5,667.	7,859.	14,005.

Table A.9

Household Expenditures, Personal and Non-Farm Receipts: Small, Medium, and Large Representative Farms Manitoba Crop District Number 10: For the Year Ended December 31, 1968

	Small (5 farms)	Medium (20 farms)	Large (26 farms)
	. . . .	dollars	
Household and Personal Expenses:			
Food	915.	961.	1,126.
Household Operations	258.	493.	495.
Personal	579.	1,127.	1,180.
Clothing	263.	342.	378.
Health	208.	187.	215.
Furniture and Appliances	115.	83.	204.
Education	153.	90.	82.
Investments	1,196.	665.	252.
Old Debt	-	9.	51.
Total	3,687.	3,957.	3,983.
Personal and Non-Farm Receipts			
Off-Farm Labor Income	3,108.	606.	314.
Off-Farm Investment Income	245.	291.	95.
Other Non-Farm Receipts	353.	1,229.	359.
Total Non-Farm Receipts	3,706.	2,126.	768.

Table A.10

Current Assets Considered as Cash for Calculation of
Initial Value of Short Term Capital -
Small, Medium, and Large Farms

Current Assets	Farm Size		
	Small	Medium	Large
	. . . . . .	dollars	. . . . . .
Supplies	312.	357.	529.
Farm Accounts Receivable	57.	461.	196.
Stocks and Bonds	1,712.	4,458.	1,219.
Personal Accounts Receivable	1,617.	346.	4.
Cash on Hand and in Bank	375.	2,004.	1,361.
Sub Total	4,073.	7,626.	3,309.
Less: Personal Debt	5.	58.	71.
Initial Value of Short Term Capital for Programming Models	4,068.	7,568.	3,238.

Source:

See Table A.3 for Net Worth Statements of each farm size.

APPENDIX B

COEFFICIENT SPECIFICATIONS FOR MULTIPERIOD LINEAR PROGRAMMING MODELS

Table B.1

Fertilizer Requirements and Application Rates, Gross Grain Yields, Seeding Rates, and Net Grain Yields - Specified Crops

Crop	Fertilizer Requirements*		Fertilizer Applied		Gross Yield**	Seed Required	Net Yield***
	Pounds-N	Pounds-P_2O_5	Pounds	Analysis			
	. . . . per acre	. . . .					
Wheat-Fallow-U	0	0	0	0	27.26	1.50	25.76
Wheat-Fallow-F	4	20	42	11-48-0	31.20	1.50	29.70
Wheat-Stubble-U	0	0	0	0	19.46	1.50	17.96
Wheat-Stubble-F	39	20	42	11-48-0	21.44	1.50	19.94
			105	33.5-0-0			
Oats-Fallow-U	0	0	0	0	58.08	2.25	55.83
Oats-Fallow-F	4	20	42	11-48-0	68.88	2.25	66.63
Oats-Stubble-U	0	0	0	0	43.81	2.25	41.56
Oats-Stubble-F	39	20	42	11-48-0	60.40	2.25	58.15
			105	33.5-0-0			
Barley-Fallow-U	0	0	0	0	42.31	2.00	40.31
Barley-Fallow-F	4	20	42	11-48-0	50.54	2.00	48.54
Barley-Stubble-U	0	0	0	0	32.72	2.00	30.72
Barley-Stubble-F	39	20	42	11-48-0	46.62	2.00	44.62
			105	33.5-0-0			
Flax-Fallow-U	0	0	0	0	15.16	.67	14.49
Flax-Fallow-F	40	0	125	33.5-0-0	16.86	.67	16.19

Table B.1 (continued)

Crop	Fertilizer Requirements* Pounds-N	Fertilizer Requirements* Pounds-P_2O_5	Fertilizer Applied Pounds	Fertilizer Applied Analysis	Gross** Yield	Seed Required	Net*** Yield
	per acre						
Flax-Stubble-U	0	0	0	0	10.75	.67	10.08
Flax-Stubble-F	40	0	125	33.5-0-0	12.75	.67	12.08
Rape-Fallow-U	0	0	0	0	17.42	.12	17.30
Rape-Fallow-F	4	20	42	11-48-0	27.87	.12	27.75
Rape-Stubble-U	0	0	0	0	14.32	.12	14.20
Rape-Stubble-F	49	20	42	11-48-0	20.25	.12	20.13
			135	33.5-0-0			

*Derived from recommendations in "1969 Field Crop Recommendations for Manitoba."

**Grain yields for wheat, oats, barley, and flax were derived from a regression analysis of yield and fertilizer application data relevant to Crop District Number 10. The data covered the years 1964 to 1968 and were obtained from the Manitoba Crop Insurance Corporation. A quadratic equation, with yield regressed on nitrogen and phosphorus fertilizer applications (including an interaction term) provided the best results for each crop.

***Net yields are shown in the above table for the base year-Period 1 of the model. Yields for subsequent periods in the model were determined by applying the long-run trend (1939-1965) to the above yields.

Table B.2

Crop Labor Requirements*
By Seasonal Periods
Small Farm

Crop-Labor Periods	Unfertilized Fallow	Unfertilized Stubble	Fertilized Fallow	Fertilized Stubble
	. . . .	hours	. . . .	
Wheat				
September 15-October 31 (Previous Year)	-	.37	-	.37
April 1-May 15	.33	.25	.33	.25
May 15-June 15	.36	.37	.37	.37
June 15-August 15	.06	.06	.06	.06
August 15-September 15	.53	.49	.54	.51
Total	1.28	1.54	1.30	1.56
Management**	.18	.20	.17	.19
Oats				
September 15-October 31 (Previous Year)	-	.36	-	.36
April 1-May 15	.22	.18	.22	.20
May 15-June 15	.36	.37	.37	.37
June 15-August 15	.07	.03	.07	.03
August 15-September 15	.62	.55	.67	.62
Total	1.27	1.49	1.33	1.58
Management**	.17	.19	.18	.21
Barley				
September 15-October 31 (Previous Year)	-	.36	-	.36
April 1-May 15	.22	.18	.22	.20
May 15-June 15	.37	.37	.37	.37
June 15-August 15	.07	.03	.07	.03
August 15-September 15	.55	.53	.58	.56
Total	1.21	1.47	1.24	1.52
Management**	.16	.19	.16	.20
Summerfallow				
June 15-August 15		1.08		
August 15-September 15		.23		
September 15-October 31		.23		
Total		1.54		
Management**		.20		

*Crop labor requirements were determined by using the assumptions and computer programs developed for: W. J. Craddock, Interregional Competition in Canadian Cereal Production, Special Study No. 12, Economic Council of Canada (Ottawa: Queen's Printer, 1970).

**Quantities of management labor appear as separate restrictions in the model but are included in the "Total" labor requirements for each activity as calculated in this table.

Table B.3

Crop Labor Requirements*
By Seasonal Periods
Medium Farm

Crop-Labor Periods	Unfertilized Fallow	Unfertilized Stubble	Fertilized Fallow	Fertilized Stubble
	. . . .	hours	. . . .	
Wheat				
September 15-October 31 (Previous Year)	-	.25	-	.26
April 1-May 15	.13	.15	.13	.13
May 15-June 15	.33	.34	.33	.34
June 15-August 15	.06	.06	.06	.06
August 15-September 15	.68	.65	.69	.66
Total	1.20	1.45	1.21	1.45
Management**	.16	.19	.16	.19
Oats				
September 15-October 31 (Previous Year)	-	.25	-	.26
April 1 - May 15	.10	.15	.12	.13
May 15-June 15	.30	.34	.33	.34
June 15-August 15	.05	.06	.06	.06
August 15-September 15	.76	.75	.91	.85
Total	1.21	1.55	1.42	1.64
Management**	.16	.20	.19	.21
Barley				
September 15-October 31 (Previous Year)	-	.24	-	.26
April 1-May 15	.13	.16	.13	.14
May 15-June 15	.33	.33	.33	.33
June 15-August 15	.06	.06	.06	.06
August 15-September 15	.75	.69	.79	.76
Total	1.27	1.48	1.31	1.55
Management**	.17	.19	.17	.20
Rapeseed				
September 15-October 31 (Previous Year)	-	.24	-	.24
April 1-May 15	.24	.12	.21	.12
May 15-June 15	.34	.33	.34	.33
June 15-August 15	.05	.03	.05	.03
August 15-September 15	.65	.63	.68	.67
Total	1.28	1.35	1.28	1.39
Management**	.17	.17	.17	.18

Table B.3 (continued)

Crop-Labor Periods	Unfertilized Fallow	Unfertilized Stubble	Fertilized Fallow	Fertilized Stubble
	. . . .	hours	. . . .	
Flax				
September 15-October 31 (Previous Year)	-	.24	-	.24
April 1-May 15	.15	.25	.21	.25
May 15-June 15	.34	.33	.33	.32
June 15-August 15	.05	.05	.06	.05
August 15-September 15	.64	.63	.67	.63
Total	1.18	1.50	1.27	1.49
Management**	.15	.19	.17	.19
Summerfallow				
June 15-August 15		.97		
August 15-September 15		.21		
September 15-October 31		.21		
Total		1.38		
Management**		.18		

*Crop labor requirements were determined by using the assumptions and computer programs developed for: W. J. Craddock, Interregional Competition in Canadian Cereal Production, Special Study No. 12, Economic Council of Canada (Ottawa: Queen's Printer, 1970).

**Quantities of management labor appear as separate restrictions in the model but are included in the "Total" labor requirements for each activity as calculated in this table.

Table B.4

Crop Labor Requirements*
By Seasonal Periods
Large Farm

Crop-Labor Periods	Unfertilized Fallow	Unfertilized Stubble	Fertilized Fallow	Fertilized Stubble
	. . . . hours	. . . .		
Wheat				
September 15-October 31 (Previous Year)	-	.21	-	.23
April 1-May 15	.14	.18	.14	.16
May 15-June 15	.30	.30	.29	.30
June 15-August 15	.05	.05	.05	.05
August 15-September 15	.64	.61	.66	.63
Total	1.13	1.35	1.14	1.37
Management**	.15	.18	.16	.18
Oats				
September 15-October 31 (Previous Year)	-	.21	-	.23
April 1-May 15	.14	.18	.14	.16
May 15-June 15	.30	.30	.29	.30
June 15-August 15	.05	.05	.05	.05
August 15-September 15	.79	.71	.88	.82
Total	1.28	1.45	1.36	1.56
Management**	.17	.19	.19	.21
Barley				
September 15-October 31 (Previous Year)	-	.21	-	.23
April 1-May 15	.14	.18	.14	.16
May 15-June 15	.30	.30	.29	.30
June 15-August 15	.05	.05	.05	.05
August 15-September 15	.71	.65	.76	.72
Total	1.20	1.39	1.24	1.46
Management**	.16	.18	.17	.19
Rapeseed				
September 15-October 31 (Previous Year)	-	.18	-	.21
April 1-May 15	.16	.24	.16	.22
May 15-June 15	.32	.29	.32	.29
June 15-August 15	.03	.03	.03	.03
August 15-September 15	.61	.58	.66	.60
Total	1.12	1.32	1.17	1.35
Management**	.14	.17	.15	.18

Table B.4 (continued)

Crop-Labor Periods	Unfertilized Fallow	Unfertilized Stubble	Fertilized Fallow	Fertilized Stubble
	. . . .	. hours .	. . . .	
Flax				
September 15-October 31 (Previous Year)	-	.17	-	.20
April 1-May 15	.15	.14	.15	.14
May 15-June 15	.32	.32	.32	.31
June 15-August 15	.03	.05	.03	.05
August 15-September 15	.60	.58	.61	.58
Total	1.10	1.26	1.11	1.28
Management**	.14	.17	.14	.18
Summerfallow				
June 15-August 15		.86		
August 15-September 15		.18		
September 15-October 15		.18		
Total		1.22		
Management**		.16		

*Crop labor requirements were determined by using the assumptions and computer programs developed for: W. J. Craddock, Interregional Competition in Canadian Cereal Production, Special Study No. 12, Economic Council of Canada (Ottawa: Queen's Printer, 1970).

**Quantities of management labor appear as separate restrictions in the model but are included in the "Total" labor requirements for each activity as calculated in this table.

Table B.5

Forage Production, Wild Hay Production, and
Straw Baling Labor Requirements
Small, Medium, and Large Farm Models

	Forage			Wild Hay	Baled Straw
	Year 1	Years 2, 3, 4	Year 5		
	. . . .	hours per year	. . . .		
April 1 - May 15	.48				
May 15 - June 15	.43				
June 15 - August 15	.03	3.40	2.93	2.06	
August 15 - September 15	.71		.24		
September 15 - October 31		.08	.24		2.49
Total	1.65	3.48	3.41	2.06	2.49
Management*	.21	.45	.44	.27	.32

*Management labor appears as a separate restriction in each model but is also included in the "total" labor requirements for each activity as calculated in this table.

Source:

Derived from: J. Nicholson, Unpublished Research Material, University of Manitoba.

Table B.6

Cost of Production and Cash Flow Distribution
Wheat Activities-Small Farm

	Wheat Crop			
	Unfertilized		Fertilized	
Cost Item	Fallow	Stubble	Fallow	Stubble
	. . . . dollars			
Soil Test	.18	.18	.18	.18
Seed Replacement	.29	.29	.29	.29
Seed Cleaning	.03	.03	.03	.03
Seed Treatment	.09	.09	.09	.09
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	2.37	7.08
Crop Insurance	.61	.61	.61	.61
Building and Improvement Operating Expenses	.19	.19	.19	.19
Machinery and Equipment Operating Expenses	2.12	2.50	2.13	2.50
Custom Work and Other Direct Crop Expenses	1.07	1.07	1.07	1.07
Total Direct Production Cost	5.53	5.91	7.91	12.98
CASH FLOW DISTRIBUTION				
January, February, March Capital	.32	.32	.32	.32
April, May, June Capital	1.71	1.90	4.09	8.97
July, August, September Capital	3.18	3.36	3.18	3.36
October, November, December Capital	.48	.52	.48	.52
Total*	5.69	6.10	8.07	13.17

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.7

Cost of Production and Cash Flow Distribution
Oats Activities-Small Farm

Cost Item	Oat Crop Unfertilized Fallow	Oat Crop Unfertilized Stubble	Oat Crop Fertilized Fallow	Oat Crop Fertilized Stubble
	. . . .	dollars	. . . .	
Soil Test	.18	.18	.18	.18
Seed Replacement	.54	.54	.54	.54
Seed Cleaning	.04	.04	.04	.04
Seed Treatment	.26	.26	.26	.26
Weed Sprays	.41	.41	.41	.41
Fertilizer	-	-	2.37	7.08
Crop Insurance	.60	.60	.60	.60
Building and Improvement Operating Expenses	.19	.19	.19	.19
Machinery and Equipment Operating Expenses	2.19	2.51	2.31	2.67
Custom Work and Other Direct Crop Expenses	1.07	1.07	1.07	1.07
Total Direct Production Cost	5.48	5.80	7.98	13.04
CASH FLOW DISTRIBUTION				
January, February, March Capital	.57	.57	.57	.57
April, May, June Capital	1.93	2.08	4.36	9.24
July, August, September Capital	2.67	2.82	2.73	2.90
October, November, December Capital	.48	.52	.50	.53
Total*	5.65	5.99	8.16	13.24

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.8

Cost of Production and Cash Flow Distribution
Barley Activities-Small Farm

Cost Item	Barley Crop Unfertilized Fallow	Barley Crop Unfertilized Stubble	Barley Crop Fertilized Fallow	Barley Crop Fertilized Stubble
	. . . . .dollars	. . . .		
Soil Test	.18	.18	.18	.18
Seed Replacement	.52	.52	.52	.52
Seed Cleaning	.04	.04	.04	.04
Seed Treatment	.23	.23	.23	.23
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	2.37	7.08
Crop Insurance	.55	.55	.55	.55
Building and Improvement Operating Expenses	.19	.19	.19	.19
Machinery and Equipment Operating Expenses	2.06	2.43	2.12	2.54
Custom Work and Other Direct Crop Expenses	1.07	1.07	1.07	1.07
Total Direct Production Cost	5.78	6.15	8.21	13.34
CASH FLOW DISTRIBUTION				
January, February, March Capital	.55	.55	.55	.55
April, May, June Capital	1.83	2.01	4.24	9.14
July, August, September Capital	3.09	3.27	3.12	3.32
October, November, December Capital	.47	.51	.47	.52
Total*	5.94	6.34	8.38	13.53

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.9

Cost of Production and Cash Flow Distribution
Rapeseed Activities-Small Farm

	Rapeseed Crop			
	Unfertilized		Fertilized	
Cost Item	Fallow	Stubble	Fallow	Stubble
	. . . . dollars			
Soil Test	.18	.18	.18	.18
Seed Replacement	.18	.18	.18	.18
Seed Cleaning	.00	.00	.00	.00
Seed Treatment	.36	.36	.36	.36
Weed Sprays	2.67	2.67	2.67	2.67
Fertilizer	-	-	2.37	8.42
Crop Insurance	1.24	1.24	1.24	1.24
Building and Improvement Operating Expenses	.19	.19	.19	.19
Machinery and Equipment Operating Expenses	1.89	2.32	1.96	2.36
Custom Work and Other Direct Crop Expenses	1.07	1.07	1.07	1.07
Total Direct Production Cost	7.77	8.20	10.22	16.66
CASH FLOW DISTRIBUTION				
January, February, March Capital	.21	.21	.21	.21
April, May, June Capital	1.84	2.05	4.25	10.49
July, August, September Capital	5.42	5.63	5.45	5.65
October, November, December Capital	.45	.50	.46	.50
Total*	7.92	8.39	10.37	16.85

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.10

Cost of Production and Cash Flow Distribution
Flax Activities-Small Farm

Cost Item	Flaxseed Crop Unfertilized Fallow	Flaxseed Crop Unfertilized Stubble	Flaxseed Crop Fertilized Fallow	Flaxseed Crop Fertilized Stubble
	. . . . dollars			
Soil Test	.18	.18	.18	.18
Seed Replacement	.43	.43	.43	.43
Seed Cleaning	.01	.01	.01	.01
Seed Treatment	.06	.06	.06	.06
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	5.60	5.60
Crop Insurance	.83	.83	.83	.83
Building and Improvement Operating Expenses	.19	.19	.19	.19
Machinery and Equipment Operating Expenses	1.88	2.32	1.89	2.32
Custom Work and Other Direct Crop Expenses	1.07	1.07	1.07	1.07
Total Direct Production Cost	5.60	6.04	11.21	11.64
CASH FLOW DISTRIBUTION				
January, February, March Capital	.46	.46	.46	.46
April, May, June Capital	1.55	1.76	7.16	7.36
July, August, September Capital	3.28	3.49	3.29	3.49
October, November, December Capital	.45	.50	.45	.50
Total*	5.74	6.21	11.36	11.81

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.11

Cost of Summerfallow and Cash Flow Distribution
Small, Medium, and Large Farms

Cost Item	Farm Size Small	Medium	Large
	. . . . . dollars		
Building and Improvement Operating Expenses	.19	.42	.35
Machinery and Equipment Operating Expenses	2.05	2.01	1.99
Custom Work and Other Direct Expenses	1.07	.43	.66
Total Direct Cost	3.31	2.86	3.00
CASH FLOW DISTRIBUTION			
January, February, March Capital	.03	.07	.06
April, May, June Capital	1.56	1.27	1.37
July, August, September Capital	1.59	1.34	1.43
October, November, December Capital	.29	.36	.34
Total*	3.47	3.04	3.20

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.12

Cost of Production and Cash Flow Distribution
Wheat Activities-Medium Farm

Cost Item	Wheat Crop: Unfertilized Fallow	Wheat Crop: Unfertilized Stubble	Wheat Crop: Fertilized Fallow	Wheat Crop: Fertilized Stubble
	. . . .	dollars	. . . .	
Soil Test	.14	.14	.14	.14
Seed Replacement	.29	.29	.29	.29
Seed Cleaning	.03	.03	.03	.03
Seed Treatment	.09	.09	.09	.09
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	2.37	7.07
Crop Insurance	.61	.61	.61	.61
Building and Improvement Operating Expenses	.42	.42	.42	.42
Machinery and Equipment Operating Expenses	1.80	2.22	1.83	2.23
Custom Work and Other Direct Crop Expenses	.43	.43	.43	.43
Total Direct Production Cost	4.75	5.17	7.15	12.26
CASH FLOW DISTRIBUTION				
January, February, March Capital	.36	.36	.36	.36
April, May, June Capital	1.28	1.48	3.66	8.56
July, August, September Capital	2.78	2.98	2.79	2.99
October, November, December Capital	.47	.52	.47	.52
Total*	4.89	5.34	7.28	12.43

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.13

Cost of Production and Cash Flow Distribution
Oats Activities-Medium Farm

	Oat Crop			
	Unfertilized		Fertilized	
Cost Item	Fallow	Stubble	Fallow	Stubble
	dollars			
Soil Test	.14	.14	.14	.14
Seed Replacement	.54	.54	.54	.54
Seed Cleaning	.04	.04	.04	.04
Seed Treatment	.26	.26	.26	.26
Weed Sprays	.41	.41	.41	.41
Fertilizer	-	-	2.37	7.08
Crop Insurance	.60	.60	.60	.60
Building and Improvement Operating Expenses	.42	.42	.42	.42
Machinery and Equipment Operating Expenses	2.03	2.39	2.16	2.55
Custom Work and Other Direct Crop Expenses	.43	.43	.43	.43
Total Direct Production Cost	4.87	5.23	7.37	12.46
CASH FLOW DISTRIBUTION				
January, February, March Capital	.61	.61	.61	.61
April, May, June Capital	1.57	1.74	4.00	8.90
July, August, September Capital	2.35	2.52	2.41	2.60
October, November, December Capital	.50	.53	.51	.55
Total*	5.03	5.40	7.53	12.66

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.14

Cost of Production and Cash Flow Distribution
Barley Activities-Medium Farm

	Barley Crop			
	Unfertilized		Fertilized	
Cost Item	Fallow	Stubble	Fallow	Stubble
	. . . . dollars			
Soil Test	.14	.14	.14	.14
Seed Replacement	.52	.52	.52	.52
Seed Cleaning	.04	.04	.04	.04
Seed Treatment	.23	.23	.23	.23
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	2.37	7.08
Crop Insurance	.55	.55	.55	.55
Building and Improvement Operating Expenses	.42	.42	.42	.42
Machinery and Equipment Operating Expenses	1.91	2.32	1.98	2.43
Custom Work and Other Direct Crop Expenses	.43	.43	.43	.43
Total Direct Production Cost	5.17	5.58	7.62	12.77
CASH FLOW DISTRIBUTION				
January, February, March Capital	.58	.58	.58	.58
April, May, June Capital	1.48	1.68	3.89	8.81
July, August, September Capital	2.77	2.97	2.81	3.02
October, November, December Capital	.48	.53	.49	.54
Total*	5.31	5.76	7.77	12.95

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.15

Cost of Production and Cash Flow Distribution
Rapeseed Activities-Medium Farm

Cost Item	Rapeseed Crop Unfertilized Fallow	Unfertilized Stubble	Fertilized Fallow	Fertilized Stubble
	. . . . dollars	. . . .		
Soil Test	.14	.14	.14	.14
Seed Replacement	.18	.18	.18	.18
Seed Cleaning	.00	.00	.00	.00
Seed Treatment	.36	.36	.36	.36
Weed Sprays	2.67	2.67	2.67	2.67
Fertilizer	-	-	2.37	8.42
Crop Insurance	1.24	1.24	1.24	1.24
Building and Improvement Operating Expenses	.42	.42	.42	.42
Machinery and Equipment Operating Expenses	1.87	2.03	1.94	2.07
Custom Work and Other Direct Crop Expenses	.43	.43	.43	.43
Total Direct Production Cost	7.30	7.46	9.74	15.92
CASH FLOW DISTRIBUTION				
January, February, March Capital	.24	.24	.24	.24
April, May, June Capital	1.55	1.63	3.96	10.07
July, August, September Capital	5.17	5.24	5.20	5.26
October, November, December Capital	.48	.50	.48	.50
Total*	7.44	7.61	9.88	16.07

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.16

Cost of Production and Cash Flow Distribution
Flax Activities-Medium Farm

	Flaxseed Crop			
	Unfertilized		Fertilized	
Cost Item	Fallow	Stubble	Fallow	Stubble
	. . . . dollars			
Soil Test	.14	.14	.14	.14
Seed Replacement	.43	.43	.43	.43
Seed Cleaning	.01	.01	.01	.01
Seed Treatment	.06	.06	.06	.06
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	5.60	5.60
Crop Insurance	.83	.83	.83	.83
Building and Improvement Operating Expenses	.42	.42	.42	.42
Machinery and Equipment Operating Expenses	1.85	2.24	1.86	2.25
Custom Work and Other Direct Crop Expenses	.43	.43	.43	.43
Total Direct Production Cost	5.11	5.50	10.72	11.11
CASH FLOW DISTRIBUTION				
January, February, March Capital	.50	.50	.50	.50
April, May, June Capital	1.25	1.44	6.86	7.05
July, August, September Capital	3.02	3.21	3.03	3.22
October, November, December Capital	.48	.52	.48	.52
Total*	5.25	5.67	10.87	11.29

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.17

Cost of Production and Cash Flow Distribution
Wheat Activities-Large Farm

Cost Item	Wheat Crop: Unfertilized Fallow	Wheat Crop: Unfertilized Stubble	Wheat Crop: Fertilized Fallow	Wheat Crop: Fertilized Stubble
	. . . . dollars	. . . .		
Soil Test	.12	.12	.12	.12
Seed Replacement	.29	.29	.29	.29
Seed Cleaning	.03	.03	.03	.03
Seed Treatment	.09	.09	.09	.09
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	2.37	7.08
Crop Insurance	.61	.61	.61	.61
Building and Improvement Operating Expenses	.35	.35	.35	.35
Machinery and Equipment Operating Expenses	1.84	2.33	1.87	2.34
Custom Work and Other Direct Crop Expenses	.66	.66	.66	.66
Total Direct Production Cost	4.93	5.42	7.33	12.51
CASH FLOW DISTRIBUTION				
January, February, March Capital	.35	.35	.35	.35
April, May, June Capital	1.40	1.64	3.79	8.72
July, August, September Capital	2.89	3.13	2.90	3.13
October, November, December Capital	.43	.48	.44	.49
Total*	5.07	5.60	7.48	12.69

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.18

Cost of Production and Cash Flow Distribution
Oats Activities-Large Farm

	Oat Crop			
	Unfertilized		Fertilized	
Cost Item	Fallow	Stubble	Fallow	Stubble
	. . . . dollars			
Soil Test	.12	.12	.12	.12
Seed Replacement	.54	.54	.54	.54
Seed Cleaning	.04	.04	.04	.04
Seed Treatment	.26	.26	.26	.26
Weed Sprays	.41	.41	.41	.41
Fertilizer	-	-	2.37	7.08
Crop Insurance	.60	.60	.60	.60
Building and Improvement Operating Expenses	.35	.35	.35	.35
Machinery and Equipment Operating Expenses	2.10	2.50	2.23	2.66
Custom Work and Other Direct Crop Expenses	.66	.66	.66	.66
Total Direct Production Cost	5.08	5.48	7.58	12.72
CASH FLOW DISTRIBUTION				
January, February, March Capital	.60	.60	.60	.60
April, May, June Capital	1.71	1.90	4.14	9.06
July, August, September Capital	2.47	2.67	2.54	2.74
October, November, December Capital	.46	.50	.47	.52
Total*	5.24	5.67	7.75	12.92

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.19

Cost of Production and Cash Flow Distribution
Barley Activities-Large Farm

Cost Item	Barley Crop Unfertilized Fallow	Barley Crop Unfertilized Stubble	Barley Crop Fertilized Fallow	Barley Crop Fertilized Stubble
	dollars			
Soil Test	.12	.12	.12	.12
Seed Replacement	.52	.52	.52	.52
Seed Cleaning	.04	.04	.04	.04
Seed Treatment	.23	.23	.23	.23
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	2.37	7.08
Crop Insurance	.55	.55	.55	.55
Building and Improvement Operating Expenses	.35	.35	.35	.35
Machinery and Equipment Operating Expenses	1.95	2.41	2.03	2.53
Custom Work and Other Direct Crop Expenses	.66	.66	.66	.66
Total Direct Production Cost	5.35	5.82	7.81	13.01
CASH FLOW DISTRIBUTION				
January, February, March Capital	.57	.57	.57	.57
April, May, June Capital	1.60	1.82	4.01	8.96
July, August, September Capital	2.88	3.11	2.92	3.16
October, November, December Capital	.44	.49	.45	.51
Total*	5.49	5.99	7.95	13.20

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.20

Cost of Production and Cash Flow Distribution
Rapeseed Activities-Large Farm

Cost Item	Rapeseed Crop: Unfertilized Fallow	Unfertilized Stubble	Fertilized Fallow	Fertilized Stubble
	. . . . dollars	. . . .		
Soil Test	.12	.12	.12	.12
Seed Replacement	.18	.18	.18	.18
Seed Cleaning	.00	.00	.00	.00
Seed Treatment	.36	.36	.36	.36
Weed Sprays	2.67	2.67	2.67	2.67
Fertilizer	-	-	2.37	8.42
Crop Insurance	1.24	1.24	1.24	1.24
Building and Improvement Operating Expenses	.35	.35	.35	.35
Machinery and Equipment Operating Expenses	1.84	2.36	1.90	2.41
Custom Work and Other Direct Crop Expenses	.66	.66	.66	.66
Total Direct Production Cost	7.41	7.93	9.84	16.40
CASH FLOW DISTRIBUTION				
January, February, March Capital	.23	.23	.23	.23
April, May, June Capital	1.64	1.89	4.04	10.34
July, August, September Capital	5.24	5.50	5.27	5.52
October, November, December Capital	.43	.49	.44	.49
Total*	7.54	8.11	9.98	16.58

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.21

Cost of Production and Cash Flow Distribution
Flax Activities-Large Farm

	Flaxseed Crop			
	Unfertilized		Fertilized	
Cost Item	Fallow	Stubble	Fallow	Stubble
	. . . . dollars	. . . .		
Soil Test	.12	.12	.12	.12
Seed Replacement	.43	.43	.43	.43
Seed Cleaning	.01	.01	.01	.01
Seed Treatment	.06	.06	.06	.06
Weed Sprays	.94	.94	.94	.94
Fertilizer	-	-	5.60	5.60
Crop Insurance	.83	.83	.83	.83
Building and Improvement Operating Expenses	.35	.35	.35	.35
Machinery and Equipment Operating Expenses	1.75	2.05	1.76	2.05
Custom Work and Other Direct Crop Expenses	.66	.66	.66	.66
Total Direct Production Cost	5.15	5.45	10.76	11.05
CASH FLOW DISTRIBUTION				
January, February, March Capital	.49	.49	.49	.49
April, May, June Capital	1.31	1.46	6.92	7.06
July, August, September Capital	3.07	3.21	3.07	3.21
October, November, December Capital	.42	.46	.42	.46
Total*	5.29	5.62	10.90	11.22

*The totals shown for the Cash Flow Distribution section do not agree with those of the Total Direct Production Cost calculation. Total Direct Production Cost was developed as a base from which adjustments could be made to reflect the Index of Prices Paid by Farmers. As a result of these adjustments, costs for each activity in the model rise each period. The Cash Flow Distribution shown above is that of the first period of the model for the activities indicated.

Table B.22

Forage Production Budget and Cash Flow Distribution
Small Farm

Year One		Cost Per Acre
		..dollars...
Soil Test		.18
Seed-1.5 bushels oats at .64	.96	
8.0 pounds brome at .45	3.60	
4.0 pounds alfalfa at .68 =	2.72	7.28
Seed Cleaning - Oats		.04
Seed Treatment		.23
Sprays		.41
Fertilizer		8.15
Building and Improvement Operating Expense		.19
Machinery and Equipment Operating Expense		2.77
Custom Work and Other Direct Expense		1.07
		20.32

Years Two, Three, Four	Cost Per Acre Per Year	
	.... dollars ...	
Mowing	.54	
Raking	.38	
Baling	1.00	
Haul and Stack	.51	
Twine	1.14	
Fertilizer	4.28	
Building and Improvement Operating Expense	.19	
Custom Work and Other Direct Expense	1.07	
	9.11	27.33

Year Five	
Mowing	.27
Raking	.19
Baling	.67
Haul and Stack	.34
Twine	.78
Plowing	.63
Deep Tilling	.75
Building and Improvement Operating Expense	.19
Custom Work and Other Direct Expense	1.07
	4.89
Total	52.54

Table B.22 (continued)

Cash Flow Distribution

	Year One	Total for Years Two, Three, Four	Year Five	Total
	. . . . . . dollars			
January, February, March Capital	7.31	.15	.05	7.51
April, May, June Capital	10.23	.15	.05	10.43
July, August, September Capital	2.25	14.04	4.49	20.78
October, November, December Capital	.53	12.99	.30	13.82
	20.32	27.33	4.89	52.54

Table B.23

Forage Production Budget and Cash Flow Distribution
Medium Farm

Year One			Cost Per Acre
			..dollars...
Soil Test			.14
Seed-1.5 bushels oats at .64	.96		
8.0 pounds brome at .45	3.60		
4.0 pounds alfalfa at .68 =	2.72		7.28
Seed Cleaning			.04
Seed Treatment			.23
Sprays			.41
Fertilizer			8.15
Building and Improvement Operating Expense			.42
Machinery and Equipment Operating Expense			2.65
Custom Work and Other Direct Expense			.43
			19.75
Years Two, Three, Four		Cost Per Acre Per Year	
		.... dollars ...	
Mowing		.54	
Raking		.38	
Baling		1.00	
Haul and Stack		.51	
Twine		1.14	
Fertilizer		4.28	
Building and Improvement Operating Expense		.42	
Custom Work and Other Direct Expense		.43	
		8.70	26.10
Year Five			
Mowing			.27
Raking			.19
Baling			.67
Haul and Stack			.34
Twine			.78
Plowing			.63
Deep Tilling			.75
Building and Improvement Operating Expense			.42
Custom Work and Other Direct Expense			.43
			4.48
Total			50.33

Table B.23 (continued)

Cash Flow Distribution

	Year One	Total for Years Two, Three, Four	Year Five	Total
	. . . . dollars			
January, February, March Capital	7.35	.33	.11	7.79
April, May, June Capital	9.90	.33	.11	10.34
July, August, September Capital	1.95	12.30	3.91	18.16
October, November, December Capital	.55	13.14	.35	14.04
	19.75	26.10	4.48	50.33

Table B.24

Forage Production Budget and Cash Flow Distribution
Large Farm

Year One			Cost Per Acre
			..dollars...
Soil Test			.12
Seed-1.5 bushels oats at .64	.96		
8.0 pounds brome at .45	3.60		
4.0 pounds alfalfa at .68 =	2.72		7.28
Seed Cleaning			.04
Seed Treatment			.23
Sprays			.41
Fertilizer			8.15
Building and Improvement Operating Expense			.35
Machinery and Equipment Operating Expense			2.76
Custom Work and Other Direct Expense			.66
			20.00
Years Two, Three, Four		Cost Per Acre Per Year	
		.... dollars ...	
Mowing		.54	
Raking		.38	
Baling		1.00	
Haul and Stack		.51	
Twine		1.14	
Fertilizer		4.28	
Building and Improvement Operating Expense		.35	
Custom Work and Other Direct Expense		.66	
		8.86	26.58
Year Five			
Mowing			.27
Raking			.19
Baling			.67
Haul and Stack			.34
Twine			.78
Plowing			.63
Deep Tilling			.75
Building and Improvement Operating Expense			.35
Custom Work and Other Direct Expense			.66
			4.64
Total			51.22

Table B.24 (continued)

Cash Flow Distribution

	Year One	Total for Years Two, Three, Four	Year Five	Total
	. . . . dollars			
January, February, March Capital	7.34	.27	.09	7.70
April, May, June Capital	10.05	.27	.09	10.41
July, August, September Capital	2.11	12.96	4.13	19.20
October, November, December Capital	.50	13.08	.33	13.91
	20.00	26.58	4.64	51.22

Table B.25

Cost of Production and Cash Flow Distribution
Wild Hay for Small, Medium, and Large Farms

Operation	Tractor Costs* Repairs	Tractor Costs* Fuel	Machine Costs* Repairs	Machine Costs* Fuel	Total Cost	Land Covered	Total Cost
	. . . . .	dollars per hour	. . . . . .		.	acres per hour	dollars per acre
Mowing	.25	.67	.26	.01	1.19	3.0*	.40
Raking	.25	.55	.34	.01	1.15	4.0*	.29
Baling	.37	.94	1.35	.01	2.67	4.8*	.56
Haul and Stack	.25	.55	.30	.03	1.13	2.0	.56
Twine							.65
							2.46
Cash Flow Distribution							
July, August, September Capital							2.46

*Source:

Derived from: J. Nicholson, unpublished Research Material, University of Manitoba, pp. 4.44 and 4.49.

Table B.26

Cost of Production and Cash Flow Distribution
Straw Baling for Small, Medium, and Large Farms

Operation	Tractor Costs* Repairs	Tractor Costs* Fuel	Machine Costs* Repairs	Machine Costs* Fuel	Total Cost	Straw Baled	Total Cost
	. . . . . dollars per hour				. . . . . .	tons per hour	dollars per ton
Baling	.37	.94	1.35	.01	2.67	6.0*	.45
Haul and Stack	.25	.55	.30	.03	1.13	2.0	.56
Twine							1.30
							2.31
Cash Flow Distribution							
July, August, September Capital							2.31

*Source:

Derived from: J. Nicholson, unpublished Research Material, University of Manitoba, pp. 4.44 and 4.49.

Table B.27

Ten Year Average Farm Prices, 1959-1968
Specified Grains and Forage

Year	Wheat	Oats	Barley	Flax	Rapeseed	Forage
	. . . .		dollars per bushel.			dollars per ton
1959	1.37	.64	.78	3.04	2.00	15.00
1960	1.61	.62	.84	2.75	2.00	12.90
1961	1.78	.63	1.05	3.30	1.80	17.50
1962	1.70	.59	1.00	3.00	1.75	14.00
1963	1.71	.55	.92	2.85	2.50	15.00
1964	1.63	.60	1.02	2.95	2.70	16.00
1965	1.65	.71	1.05	2.69	2.45	16.50
1966	1.80	.75	1.15	2.70	2.45	16.50
1967	1.60	.75	1.00	3.15	2.00	17.50
1968	1.40	.60	.85	2.90	1.95	18.50
Average	1.62	.64	.97	2.93	2.16	15.94

Source:

Manitoba Department of Agriculture, Yearbook of Manitoba Agriculture, 1968 (Winnipeg: Queen's Printer, 1969), pp. 42-52.

Table B.28

Cow-Calf Budget

Cost Item		Per Cow	Per Marketable Calf
		. . . dollars	
Salt and minerals		3.70	4.35
Veterinarian and medicine		2.50	2.94
Breeding costs:			
Purchase bull	600.00		
Trucking new bull in: 15 hundred weight at 30 cents	4.50		
Trucking old bull out: 18 hundred weight at 30 cents	5.40		
Commission and yardage: in and out	11.77		
	621.67		
Less: Sale of old bull; 1800 pounds at 25 cents	450.00		
	171.67		
Assuming 100 cows in herd		1.72	2.02
Building operating cost		3.00	3.53
Machinery operating cost		6.00	7.06
Miscellaneous		4.50	5.29
Total Direct Cost*		21.42	25.19
Cash Flow Distribution*			
January, February, March Capital			7.81
April, May, June Capital			5.79
July, August, September Capital			5.79
October, November, December Capital			5.80
Total			25.19

*Total Direct Cost and the Cash Flow Distribution in this table are for period one of the model. Costs and flows for other periods reflect the effects of adjusting according to the Index of Prices Paid and Received by Farmers.

Note: See page 220 for list of references on livestock production.

Table B.29

Livestock Production Budgets
Specified Activities

Cost Item	Grow Own Stocker		Buy Stocker Calves		Feed Own Calves
	. . . .		dollars		
Cost of animal	-	400 pounds at $23.44 per hundred weight*	93.76		-
Salt and minerals	2.55		2.55		2.10
Veterinarian and medicine	2.00		2.00		3.00
Trucking in	-	400 pounds at 30 cents per hundred weight	1.20		-
Commission and yardage	-	400 pounds at 30 cents per hundred weight	1.20		-
Truck out	-		-	1,000 pounds at 30 cents per hundred weight	3.00
Commission and yardage	-		-	1,000 pounds at 30 cents per hundred weight	3.00
Building operating cost	1.00		1.00		2.00
Machinery operating cost	2.00		2.00		4.00
Total Direct Cost**	7.55		103.71		17.10

Table B.29 (continued)

Cost Item	Grow Own Stocker	Buy Stocker Calves	Feed Own Calves
	. . . .	dollars	
Cash Flow Distribution**			
Period 1			
October, November, December Capital	1.88	98.04	3.72
Period 2			
January, February, March Capital	1.89	1.89	3.69
April, May, June Capital	1.89	1.89	9.69
July, August, September Capital	1.89	1.89	
October, November, December Capital	-	-	-
Total	7.55	103.71	17.10

*See Table B.42

**Total Direct Cost and the Cash Flow Distribution in this table are for period one of the model. Costs and flows for other periods reflect the effects of adjusting according to the Index of Prices Paid and Received by Farmers.

Note: See page 220 for list of references on livestock production.

Table B.30

Feeder Cattle Budgets

Cost Item	Own Feeders	Purchase Feeders: October 1–January 24	Purchase Feeders: February 1–May 27	Purchase Feeders: June 1–September 24
	dollars			
Purchase 800 pound feeder*	-	182.08	184.64	195.44
Trucking in: 800 pounds at 30 cents per hundred weight	-	2.40	2.40	2.40
Commission: 800 pounds at 25 cents per hundred weight	-	2.00	2.00	2.00
Salt and minerals	1.33	1.33	1.33	1.33
Veterinarian, medicine and vitamins	2.00	2.00	2.00	2.00
Trucking out: 1,100 pounds at 30 cents per hundred weight	3.30	3.30	3.30	3.30
Selling cost	3.00	3.00	3.00	3.00
Building operating cost	.67	.67	.67	.67
Machinery operating cost	1.34	1.34	1.34	1.34
Total Direct Cost**	11.64	198.12	200.68	211.48

Table B.30 (continued)

Cost Item	Own Feeders	Purchase Feeders October 1–January 24	February 1–May 27	June 1–September 24
	. . . .	. dollars	. . . .	. . . .
Cash Flow Distribution**				
Period 1				
January, February, March Capital	-	-	191.74	-
April, May, June Capital	-	-	8.94	201.22
July, August, September Capital	-	-	-	10.26
October, November, December Capital	4.24	190.72	-	-
Period 2				
January, February, March Capital	7.40	7.40	-	-
Total	11.64	198.12	200.68	211.48

*See Table B.42 for average price per hundred weight.

**Total Direct Cost and the Cash Flow Distribution in this table are for period one of the model. Costs and flows for other periods reflect the effects of adjusting according to the Index of Prices Paid and Received by Farmers.

Note: See page 220 for list of references on livestock production.

TABLE B.31

Livestock Production Budgets
Specified Activities

Cost Item	Sell Cows		Sell Cull Cow	Herd Growth
	. . . . dollars			
Salt and mineral	3.63		4.63	1.00
Veterinarian, medicine, and vitamins	2.45		3.95	1.50
Breeding costs*	2.02		4.04	2.02
Trucking out	-	1100 pounds at 30 cents per hundred weight	3.30	-
Commission and yardage	-		2.50	-
Building operating costs	2.94		3.61	.67
Machinery operating costs	5.88		7.22	1.34
Miscellaneous	4.40		4.40	-
Total Direct Cost**	21.32		33.65	6.53
Cash Flow Distribution**				
January, February, March Capital	7.81		7.81	-
April, May, June Capital	5.79		5.79	-
July, August, September Capital	5.79		7.81	2.02
October, November, December Capital	1.93		12.24	4.51
Total	21.32		33.65	6.53

*See Table B.28 for the calculation of breeding costs.

**Total Direct Cost and the Cash Flow Distribution in this table are for period one of the model. Costs and flows for other periods reflect the effects of adjusting according to the Index of Prices Paid and Received by Farmers.

Note: See Table B.43 for average price per hundred weight. See page 220 for list of references on livestock production.

Table B.32

Livestock Labor Requirements
Specified Activities

Time Period	Cow Calf	Grow Stockers	Feeder Calves	Feeder Cattle October-January	Feeder Cattle February-May	Feeder Cattle June-September
	. . . .	. . . .	hours . . .	. . . .	. . . .	. . . .
January 1 - March 31	6.06	7.38	4.98	2.00	4.00	-
April 1 - May 15	2.60	3.24	2.08	-	3.00	-
May 16 - June 15	.84	1.38	1.31	-	1.00	1.00
June 16 - August 15	1.32	1.69	2.25	-	-	4.00
August 16 - September 15	.72	.75	-	-	-	2.00
September 16 - October 31	1.31	1.70	-	2.00	-	1.00
November 1 - December 31	4.04	4.92	3.32	4.00	-	-
Total Labor*	16.89	21.06	13.94	8.00	8.00	8.00

Table B.32 (continued)

Time Period	Sell Cows	Sell Cull Cows	Herd Growth
	. . . .	hours	
January 1 - March 31	6.06	6.06	-
April 1 - May 15	2.60	2.60	-
May 16 - June 15	.84	1.84	1.00
June 16 - August 15	1.32	3.32	2.00
August 16 - September 15	.72	1.72	1.00
September 16 - October 31	1.31	2.62	1.31
November 1 - December 31	-	4.04	4.04
Total Labor*	12.85	22.20	9.35

*The total amount of labor shown above includes 25 percent management labor. Therefore, 25 percent of each of the totals above appears as requirements in a separate operator labor restriction row of the model.

Note: See page 220 for list of references on livestock production.

Table B.33

Cow-Calf Activity
Feed Requirements

	Pre-Calving Requirements		Post-Calving Requirements		Bull Requirements			
	Daily	Total	Daily	Total	Daily	Total*	Total	Model Coefficient
Days on feed	-	150.0	-	45.0	-	230.0	-	-
Net energy for maintenance (megacalories)	11.49	1,723.50	15.32	689.40	9.00	82.80	2,495.70	2,495.70
Protein (pounds)	1.40	210.00	2.30	103.50	2.50	22.70	336.20	3.36**
Weight of feed (pounds)	18.00	2,700.00	28.00	1,260.00	24.70	227.20	4,187.20	41.87**
Maximum roughage (pounds-70 percent of weight of feed)	-	1,890.00	-	882.00	-	159.10	2,931.10	29.31**

*One bull services 25 cows, therefore, the total requirements shown in this column were calculated on a per cow basis.

**Coefficient specified in hundred weight because of other model requirements.

Note: See page 220 for list of references on livestock production.

Table B.34

Stocker Activity
Feed Requirements

	400 - 600 Pounds		600 - 681.47 Pounds		Model Coefficients	
	Daily	Total	Daily	Total	November 1-December 31	January 1-May 15
Days on feed	-	133.33	-	62.67	-	-
Gain (pounds)	1.50	200.00	1.30	81.47	-	-
Net energy for maintenance (megacalories)	4.53	603.98	5.84	365.99	276.33	693.64
Net energy for production (megacalories)	2.50	367.40	2.80	192.68	168.08	392.00
Protein minimum (pounds)	1.45	190.66	1.50	111.24	.87*	2.15*
Weight of feed (pounds)	14.30	1,906.62	17.75	1,112.39	8.72*	21.47*
Urea maximum (pounds)	-	19.07	-	11.12	-	-
Molasses maximum (pounds)	-	190.66	-	111.24	-	-
Tallow maximum (pounds)	-	95.33	-	55.62	-	-
Roughage maximum (pounds)	-	762.65	-	444.96	3.49*	8.58*

*Coefficient specified in hundred weight because of other model requirements.

Note: See page 220 for list of references on livestock production.

Table B.35

Feeder-Calf Activity
Feed Requirements

	Weight Range		Model Coefficients		
	400-800 Pounds	800-1000 Pounds	November 1-December 31	January 1-April 11	April 11-June 26
Days on feed	160.58	75.47	-	-	-
Net energy for maintenance (megacalories)	828.15	533.40	277.58	550.57	533.40
Net energy for production (megacalories)	726.01	493.00	227.95	498.06	493.00
Protein minimum (pounds)	270.11	181.57	.86*	1.84*	1.82*
Weight of feed (pounds)	2,701.05	1,815.67	8.60*	18.41*	18.16*
Urea maximum (pounds)	27.01	18.15	.09*	.18*	.18*
Molasses maximum (pounds)	270.11	181.57	.86*	1.84*	1.82*
Tallow maximum (pounds)	135.05	90.78	.43*	.92*	.91*
Roughage maximum (pounds)	648.25	435.76	2.06*	4.42*	4.36*

*Coefficient specified in hundred weight because of other model requirements.

Note: See page 220 for list of references on livestock production.

Table B.36

Feeder Cattle Activities*
Feed Requirements

	Nutrient Specification	Model Coefficients		
		October 1-December 31	January 1-January 24	Other Feeding Periods
Days on feed	116.32	-	-	-
Net energy for maintenance (megacalories)	857.51	662.16	195.35	857.51
Net energy for production (megacalories)	770.00	606.53	163.47	770.00
Protein minimum (pounds)	286.96	2.24**	.63**	2.87**
Weight of feed (pounds)	2,869.60	22.42**	6.27**	28.70**
Urea maximum (pounds)	28.69	.22**	.06**	.29**
Molasses maximum (pounds)	286.96	2.24**	.63**	2.87**
Tallow maximum (pounds)	143.47	1.12**	.31**	1.43**
Roughage maximum (pounds)	688.70	5.38**	1.50**	6.89**

*These use either farmer's own grown-out stockers at 800 pounds or purchased feeders at the same weight. The final product, a good-slaughter-beef animal, is marketed at 1,100 pounds after a 116.32 day feeding period. Three periods were possible in the model: October 1 - January 24; February 1 - May 27; and, June 1 - September 24.

**Coefficient specified in hundred weight because of other model requirements.

Note: See page 220 for list of references on livestock production.

Table B.37

Herd Growth Activity*
Feed Requirements

	60 Day Growth Period May 15 - July 15						
	681.47-700 Pounds		700-800 Pounds		800-841.60 Pounds		
	Daily	Total	Daily	Total	Daily	Total	Total
Days on feed	-	7.06	-	37.38	-	15.56	60.00
Gain (pounds)	2.62	18.53	2.68	100.00	2.68	41.60	160.13
Net energy for maintenance (megacalories)	5.79	40.87	6.16	230.28	6.59	102.53	373.68
Net energy for production (megacalories)	6.23	43.98	6.63	247.85	7.09	110.31	402.13
Protein minimum (pounds)	1.90	13.41	2.10	78.50	2.30	35.78	127.70
Weight of feed (pounds)	18.70	132.00	21.10	788.78	23.18	360.63	1,281.42
Roughage maximum (pounds)	-	35.75	-	189.31	-	86.55	311.61

Table B.37 (continued)

	Early Winter Feeding November 1-December 31		Total Additional Feed Requirements	Model Coefficients
	Daily	Total		
Days on feed	-	61.00	121.00	-
Net energy for maintenance (megacalories)	7.06	430.66	804.34	804.34
Net energy for production (megacalories)	3.00	183.00	585.13	585.13
Protein minimum (pounds)	1.40	85.40	213.10	2.13**
Weight of feed (pounds)	18.00	1,098.00	2,379.42	23.79**
Roughage maximum (pounds)	-	263.52	575.13	5.75**

*Requirements indicated in this table are additional to those required for the normal growth of a stocker animal.

**Coefficient specified in hundred weight because of other model requirements.

Note: See page 220 for list of references on livestock production.

Table B.38

Sell Cows Activity
Feed Requirements

	Totals Cow-calf Activity*	November 1-December 31 Reduction	Total	Model Coefficients
Net energy for maintenance (megacalories)	2,495.90	700.89	1,794.81	1,794.81
Protein minimum (pounds)	336.20	85.40	250.80	2.51**
Maximum roughage (pounds)	-	-	2,162.50	21.62**
Weight of feed (pounds)	4,187.20	1,098.00	3,089.20	30.89**

*See Table B.33.

**Coefficient specified in hundred weight because of other model requirements.

Note: See page 220 for list of references on livestock production.

Table B.39

Sell Cull Cow Activity*
Feed Requirements

	Sell Cows Activity Coefficients	Herd Growth Activity Coefficients	Model Coefficients
Net energy for maintenance (megacalories)	1,794.81	804.34	2,599.15
Net energy for production (megacalories)	-	585.13	585.13
Protein minimum (hundred weight)	2.51	2.13	4.64
Roughage maximum (hundred weight)	21.62	5.75	27.37
Weight of feed (hundred weight)	30.89	23.79	54.68

*This table was derived from coefficients developed for the "Sell Cows" Activity and the "Herd Growth" Activity; Tables B.38 and B.37, respectively.

Note: See page 220 for list of references on livestock production.

Table B.40

Nutrient Values of Various Feeds

Feed	Net Energy Maintenance	Net Energy Production	Protein
	. . .megacalories per. . . hundred weight		percent
Wheat	95.0	62.0	13.0
Oats	80.0	50.0	12.0
Barley	84.0	53.0	11.0
Forage (alfalfa hay, 25 percent fiber)	55.0	23.0	15.3
Wild Hay	45.0	19.0	6.5
Tallow (fat)	192.0	121.0	-
Molasses (beet pulp)	82.0	51.0	8.4
Urea	-	-	272.0

Source:

Net energy for maintenance and production figures were derived from: Frontiers in Nutrition Supplement, Appendix to Number 192, May, 1967.

Table B.41

Bedding Requirements-Livestock Activities

Livestock Type	Daily Requirement Per Head Per Day	Number of Days	Total Pounds	Model Coefficient
	. . pounds . . .			hundred weight
Cows	8.0	200.00	1600	16.00
Bulls	8.0	230.00	1840	-
1 Bull services 25 cows, therefore, 1840/25 yields				.74
Cow-calf Activity Coefficient				16.74
Stockers	3.0	196.00	588	5.88
Feeder Calves	3.0	236.05	708	7.08
Feeders	4.0	116.32	465	4.65
Herd Growth				
Heifer on preparation ration	4.0	60.00	240	2.40
Bred Heifer-Wintering Period	6.0	60.00	360	3.60
				6.00

Note: See page 220 for list of references on livestock production.

List of References for Tables B.28 to B.41

Beef Manual (rev. ed.; Winnipeg: Manitoba Department of Agriculture, 1971).

S. A. Chambers and R. Mitchell, 1966 Manitoba Cow Calf Enterprise Analysis (Winnipeg: Economics and Publications Branch, Manitoba Department of Agriculture, Economics Report No. 6, November, 1967).

Feedlot Finishing of Cattle and Lambs in Western Canada (Ottawa: Canada Department of Agriculture, Publication 1236, 1965).

Guidelines for Cow-Calf Production (Winnipeg: Manitoba Department of Agriculture, Publication No. 512, May, 1970).

L. M. Johnson and W. J. Craddock, An Economic Analysis of Beef Cattle-Grain Operations in West Central Manitoba (Regina: Economics Branch, Canada Department of Agriculture in co-operation with Department of Agricultural Economics and Farm Management, University of Manitoba, Winnipeg, Publication 70/9, 1970).

Principles and Practices of Commercial Farming (2d ed.; Winnipeg: Faculty of Agriculture and Home Economics, The University of Manitoba, 1968), Chapter 9.

Table B.42

Ten Year Average Purchasing Prices
Specified Livestock Classes

Year	Stocker Calves November	Good Feeder Steers February	Good Feeder Steers June	Good Feeder Steers October
	. . . .	dollars per hundred weight	. . . .	
1959	19.90	23.25	24.43	20.99
1960	21.81	20.98	22.14	19.78
1961	23.51	22.98	20.99	21.32
1962	27.54	22.37	24.62	24.84
1963	22.80	22.26	24.50	22.39
1964	19.12	21.43	22.02	19.09
1965	20.70	19.99	23.33	22.12
1966	25.10	25.99	26.22	24.33
1967	26.38	26.14	27.81	25.96
1968	27.55	25.43	28.20	26.81
Average	23.44	23.08	24.43	22.76

Source:

Canada Department of Agriculture, Livestock and Meat Trade Report, Vols. 40-49, 1959-1968 (Ottawa: Market Information Section, Production and Marketing Branch, Canada Department of Agriculture).

Table B.43

Ten Year Average Selling Prices
Specified Livestock Classes
Given Month

Year	Stocker Calves October	Finished Feeder Calves June	Sell Feeders September	Good Slaughter Steers January	Good Slaughter Steers May	Good Slaughter Steers September	Good Cows October	Medium Cows October
	. . . . dollars per hundred weight							
1959	22.16	23.36	22.46	25.27	23.55	25.06	14.75	13.41
1960	20.76	21.94	19.61	21.20	21.61	22.18	14.03	12.58
1961	23.31	20.11	21.14	21.89	20.94	21.90	14.13	12.97
1962	27.01	24.90	25.77	23.48	24.11	27.62	16.13	15.26
1963	23.42	23.60	22.94	23.68	22.69	25.15	16.59	15.37
1964	19.47	22.03	20.50	20.35	22.80	22.27	14.39	13.33
1965	21.05	24.58	22.84	20.97	23.35	23.55	14.03	13.11
1966	25.31	24.46	25.42	25.52	25.36	24.88	17.04	16.09
1967	23.97	26.45	26.92	25.78	25.40	28.57	18.67	17.04
1968	27.28	27.31	26.79	26.38	26.48	28.83	19.37	17.90
Average	23.37	23.87	23.44	23.45	23.63	25.00	15.91	14.70

<u>Source</u>:

Canada Department of Agriculture, <u>Livestock and Meat Trade Report</u>, Vols. 40-49, 1959-1968 (Ottawa: Market Information Section, Production and Marketing Branch, Canada Department of Agriculture).

Table B.44

Initial Short-Term Debt and Repayment Schedule
Small Farm

Debt Principal: 952.00 dollars

Interest Rate: 10 percent per annum (on the unpaid balance)

Instalments: three (3), March 31, June 30, and September 30 of period one.

Schedule:

Time Period	Principal	Interest	Paid on Principal	Total Payment
	. . . .	. . dollars . .	. . . .	. .
January 1 - March 31	952.00	23.80	317.00	340.80
April 1 - June 30	635.00	15.88	317.00	332.88
July 1- September 30	318.00	7.95	318.00	325.95

Table B.45

Initial Intermediate-Term Debt and
Three-Year Repayment Schedule
Small Farm

Debt Principal: 2,096.00 dollars

Interest Rate: 9 percent per annum

Instalments: amortized payments taken out of generated capital in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	dollars	. . . .	
1	2,096.00	188.64	828.13	639.49
2	1,456.51	131.08	828.13	697.05
3	759.46	68.67	828.13	759.46

Table B.46

Initial Intermediate-Term Debt and
Ten-Year Repayment Schedule
Small Farm

Debt Principal: 2,096.00 dollars

Interest Rate: 9 percent per annum

Instalments: amortized payments taken out of generated capital in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	dollars	. . . .	
1	2,096.00	188.64	326.60	137.96
2	1,958.04	176.22	326.60	150.38
3	1,807.66	162.69	326.60	163.91
4	1,643.75	147.94	326.60	178.66
5	1,465.09	131.86	326.60	194.74
6	1,270.35	114.33	326.60	212.27
7	1,058.08	95.23	326.60	231.37
8	826.71	74.40	326.60	252.20
9	574.51	51.71	326.60	274.89
10	299.62	26.98	326.60	299.62

Table B.47

Initial Long-Term Debt and Twelve-Year
Repayment Schedule
Small Farm

Debt Principal: 9,234.00 dollars

Interest Rate: 8 percent per annum

Instalments: annual amortized payment taken out of generated capital in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars	. . . .	
1	9,234.00	738.72	1,225.30	486.58
2	8,747.42	699.79	1,225.30	525.51
3	8,221.91	657.75	1,225.30	567.55
4	7,654.36	612.35	1,225.30	612.95
5	7,041.41	563.31	1,225.30	661.99
6	6,379.42	510.35	1,225.30	714.95
7	5,664.47	453.16	1,225.30	772.14
8	4,892.33	391.39	1,225.30	833.91
9	4,058.42	324.67	1,225.30	900.63
10	3,157.79	252.62	1,225.30	972.68
11	2,185.11	174.81	1,225.30	1,050.49
12	1,134.62	90.68	1,225.30	1,134.62

Table B.48

Initial Long-Term Debt and Twenty-Five-Year
Repayment Schedule
Small Farm

Debt Principal: 9,234.00 dollars

Interest Rate: 8 percent per annum

Instalments: annual amortized payment taken out of generated capital in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. . dollars	. . . . . .	. . . . . .
1	9,234.00	738.72	865.03	126.31
2	9,107.69	728.62	865.03	136.41
3	8,971.28	717.70	865.03	147.33
4	8,823.95	705.92	865.03	159.11
5	8,664.84	693.19	865.03	171.84
6	8,493.00	679.44	865.03	185.59
7	8,307.41	664.59	865.03	200.44
8	8,106.97	648.56	865.03	216.47
9	7,890.50	631.24	865.03	233.79
10	7,656.71	612.54	865.03	252.49
11	7,404.22	592.34	865.03	272.69
12	7,131.53	570.52	865.03	294.51
*	*	*	*	*

*Since the model only runs for twelve periods the balance of the schedule is not shown.

Table B.49

Initial Short-Term Debt and Repayment Schedule
Medium Farm

Debt Principal: 2149.00 dollars

Interest Rate: 10 percent per annum (on the unpaid balance)

Instalments: three (3), April 30, August 31, and December 31 of period one

Schedule:

Time Period	Principal	Interest	Paid on Principal	Total Payment
	. . . .	. dollars .	. . . .	
January 1 - April 30	2,149.00	71.56	716.33	787.89
May 1 - August 31	1,432.67	47.71	716.33	764.04
September 1- December 31	716.34	23.85	716.34	740.19

Table B.50

Initial Intermediate-Term Debt and
Three-Year Repayment Schedule
Medium Farm

Debt Principal: 3,136.00 dollars

Interest Rate: 9 percent per annum

Instalments: amortized payments taken out of generated capital annually in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	dollars	. . . .	
1	3,136.00	282.24	1,238.89	956.65
2	2,179.35	196.14	1,238.89	1,042.75
3	1,136.60	102.29	1,238.89	1,136.60

Table B.51

Initial Intermediate-Term Debt and
Ten-Year Repayment Schedule
Medium Farm

Debt Principal: 3,136.00 dollars

Interest Rate: 9 percent per annum

Instalments: amortized payment taken out of generated capital annually in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars	. . . .	. . .
1	3,136.00	282.24	488.65	206.41
2	2,929.59	263.66	488.65	224.99
3	2,704.60	243.41	488.65	245.24
4	2,459.36	221.34	488.65	267.31
5	2,192.05	197.28	488.65	291.37
6	1,900.68	171.06	488.65	317.59
7	1,583.09	142.48	488.65	346.17
8	1,236.92	111.32	488.65	377.33
9	859.59	77.36	488.65	411.29
10	448.30	40.35	488.65	448.30

Table B.52

Initial Long-Term Debt and Twelve-Year
Repayment Schedule
Medium Farm

Debt Principal: 12,114.00 dollars

Interest Rate: 8 percent per annum

Instalments: amortized payments taken out of generated capital annually in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars	. . . .	. . . . .
1	12,114.00	969.12	1,607.46	638.34
2	11,475.66	918.05	1,607.46	689.41
3	10,786.25	862.90	1,607.46	744.56
4	10,041.69	803.34	1,607.46	804.12
5	9,237.57	739.00	1,607.46	868.46
6	8,369.11	669.53	1,607.46	937.93
7	7,431.18	594.49	1,607.46	1,012.97
8	6,418.21	513.46	1,607.46	1,094.00
9	5,324.21	425.94	1,607.46	1,181.52
10	4,142.69	331.41	1,607.46	1,276.05
11	2,866.64	229.33	1,607.46	1,378.13
12	1,488.51	118.95	1,607.46	1,488.51

Table B.53

Initial Long-Term Debt and Twenty-Five-Year
Repayment Schedule
Medium Farm

Debt Principal: 12,114.00 dollars

Interest Rate: 8 percent per annum

Instalments: amortized payments taken out of generated capital annually in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . . dollars	. . . .		
1	12,114.00	969.12	1,134.82	165.70
2	11,948.30	955.86	1,134.82	178.96
3	11,769.34	941.54	1,134.82	193.28
4	11,576.06	926.08	1,134.82	208.74
5	11,367.32	909.38	1,134.82	225.44
6	11,141.88	891.35	1,134.82	242.47
7	10,899.41	871.95	1,134.82	262.87
8	10,626.54	850.12	1,134.82	284.70
9	10,341.84	827.35	1,134.82	307.47
10	10,034.37	802.75	1,134.82	332.07
11	9,702.30	776.18	1,134.82	358.64
12	9,343.66	747.49	1,134.82	387.33
*	*	*	*	*

*Since the model only runs for twelve periods the balance of the schedule is not shown.

Table B.54

Initial Short-Term Debt and Repayment Schedule
Large Farm

Debt Principal: 4481.00 dollars

Interest Rate: 10 percent per annum (on the unpaid balance)

Instalments: Three (3), March 31, June 30, and September 30 of period one.

Schedule:

Time Period	Principal	Interest	Paid on Principal	Total Payment
	. . . .	dollars	. . . .	
January 1 - March 31	4,481.00	149.22	1,493.66	1,642.88
April 1 - June 30	2,987.34	99.48	1,493.67	1,593.15
July 1 - September 30	1,493.67	49.74	1,493.67	1,543.41

Table B.55

Initial Intermediate-Term Debt and
Three-Year Repayment Schedule
Large Farm

Debt Principal: 8,029.00 dollars

Interest Rate: 9 percent per annum

Instalments: amortized payment taken out of generated capital annually in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars .	. . . .	
1	8,029.00	722.61	3,171.89	2,449.28
2	5,579.72	502.17	3,171.89	2,669.72
3	2,910.00	261.89	3,171.89	2,910.00

Table B.56

Initial Intermediate-Term Debt and
Ten-Year Repayment Schedule
Large Farm

Debt Principal: 8,029.00 dollars

Interest Rate: 9 percent per annum

Instalments: amortized payment taken out of generated capital annually in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars .	. . . .	. . . .
1	8,029.00	722.61	1,251.08	528.47
2	7,500.53	675.05	1,251.08	576.03
3	6,924.50	623.20	1,251.08	627.88
4	6,296.62	566.70	1,251.08	684.38
5	5,612.24	505.10	1,251.08	745.98
6	4,866.26	437.96	1,251.08	813.12
7	4.053.14	364.78	1,251.08	886.30
8	3,166.84	285.02	1,251.08	966.06
9	2,200.78	198.07	1,251.08	1,053.01
10	1,147.77	103.31	1,251.08	1,147.77

Table B.57

Initial Long-Term Debt and Twelve-Year Repayment Schedule Large Farm

Debt Principal: 23,137.00 dollars

Interest Rate: 8 percent per annum

Instalments: amortized payments taken out of generated capital annually in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars .	. . . .	
1	23,137.00	1,850.96	3,070.16	1,219.20
2	21,917.80	1,753.42	3,070.16	1,316.74
3	20,601.06	1,648.08	3,070.16	1,422.08
4	19,178.98	1,534.32	3,070.16	1,535.84
5	17,643.14	1,411.45	3,070.16	1,658.71
6	15,984.43	1,278.75	3,070.16	1,791.41
7	14,193.02	1,135.44	3,070.16	1,934.72
8	12,258.30	980.66	3,070.16	2,089.50
9	10,168.80	813.50	3,070.16	2,256.66
10	7,912.14	632.97	3,070.16	2,437.19
11	5,474.95	438.00	3,070.16	2,632.16
12	2,842.79	227.37	3,070.16	2,842.79

Table B.58

Initial Long-Term Debt and Twenty-Five-Year
Repayment Schedule
Large Farm

Debt Principal: 23,137.00 dollars

Interest Rate: 8 percent per annum

Instalments: amortized payments taken out of generated capital annually in fourth quarter of period.

Schedule:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars .	. . . .	. .
1	23,137.00	1,850.96	2,167.44	316.48
2	22,820.52	1,825.64	2,167.44	341.80
3	22,478.72	1,798.30	2,167.44	369.14
4	22,109.58	1,768.77	2,167.44	398.67
5	21,710.91	1,736.87	2,167.44	430.57
6	21,280.34	1,702.43	2,167.44	465.01
7	20,815.33	1,665.23	2,167.44	502.21
8	20,313.12	1,625.05	2,167.44	542.39
9	19,770.73	1,581.66	2,167.44	585.78
10	19,184.95	1,534.80	2,167.44	632.64
11	18,552.31	1,484.18	2,167.44	683.26
12	17,869.05	1,429.52	2,167.44	737.92
*	*	*	*	*

*Since the model only runs for twelve periods the balance of the schedule is not shown.

Table B.59

Family Consumption Expenditures*
Small, Medium, and Large
Farm Models

Period	Model		
	Small	Medium	Large
	. . . . . . dollars		
1	2,511.	3,121.	3,519.
2	2,552.	3,172.	3,577.
3	2,593.	3,223.	3,635.
4	2,634.	3,274.	3,693.
5	2,675.	3,325.	3,751.
6	2,716.	3,376.	3,809.
7	2,757.	3,427.	3,867.
8	2,798.	3,478.	3,925.
9	2,839.	3,529.	3,983.
10	2,880.	3,580.	4,041.
11	2,921.	3,631.	4,099.
12	2,962.	3,682.	4,157.

*Family consumption expenditures are based on observed levels as recorded in the averages shown in Table A.9. Expenditures were indexed upward over the period of the model by relating them to the extrapolation of a linear regression on the Consumer's Price Index over the period 1949 to 1969 (44 , p. 34).

Table B.60

Farm Cash Overhead
Small Farm

Expense Types	1968 Averages*
	dollars
Car - fuel	170.00
Car - repairs and other	156.00
Truck - fuel	144.00
Truck - repairs and other	133.00
Small tools and miscellaneous	68.00
Hydro and Telephone	148.00
Miscellaneous overhead	37.00
Total for quarterly distribution	856.00
Building and equipment insurance	39.00
Land Taxes	291.00
Building and equipment depreciation	1,414.64
Additional charges for fourth quarter	1,744.64

Indexed Overhead Cost Distribution**

Period	Quarterly Expense	Total Fourth Quarter	Period Total
	. . . .	dollars	
1	214.00	1,958.64	2,600.64
2	219.05	2,004.88	2,662.03
3	224.10	2,051.11	2,723.41
4	229.15	2,097.34	2,784.79
5	234.20	2,143.58	2,846.18
6	239.25	2,189.82	2,907.57
7	244.30	2,236.06	2,968.96
8	249.35	2,282.30	3,030.35
9	254.40	2,328.54	3,091.74
10	259.45	2,374.78	3,153.13
11	264.50	2,421,02	3,214.52
12	269.55	2,467.26	3,275.91

*See Table A.8 for full expense statements.

**Costs of production and overhead costs were indexed upward over time by relating base year costs to an extrapolation of a linear regression on the Index of Prices Paid by Farmers (44, p. 34) over the period 1949-1969.

Table B.61

Farm Cash Overhead
Medium Farm

Expense Types	1968 Averages*
	dollars
Car - fuel	179.00
Car - repairs and other	144.00
Truck - fuel	121.00
Truck - repairs and other	189.00
Small tools and miscellaneous	105.00
Hydro and Telephone	181.00
Miscellaneous overhead	71.00
Total for quarterly distribution	990.00
Building and equipment insurance	80.00
Land Taxes	564.00
Building and equipment depreciation	2,183.00
Additional charges for fourth quarter	2,827.00

Indexed Overhead Cost Distribution**

Period	Quarterly Expense	Total Fourth Quarter	Period Total
	. . . .	. dollars	. .
1	247.50	3,074.50	3,817.00
2	253.34	3,147.09	3,907.11
3	259.18	3,219.68	3,997.22
4	265.02	3,292.27	4,087.33
5	270.86	3,364.86	4,177.44
6	276.70	3,437.45	4,267.55
7	282.54	3,510.04	4,357.66
8	288.38	3,582.63	4,447.77
9	294.22	3,655.22	4,537.88
10	300.06	3,727.81	4,627.99
11	305.90	3,800.40	4,718.10
12	311.74	3,872.99	4,808.21

*See Table A.8 for full expense statements.

**Costs of production and overhead costs were indexed upward over time by relating base year costs to an extrapolation of a linear regression on the Index of Prices Paid by Farmers (44, p. 34) over the period 1949-1969.

Table B.62

Farm Cash Overhead
Large Farm

Expense Types	1968 Averages*
	dollars
Car - fuel	230.00
Car - repairs and other	208.00
Truck - fuel	200.00
Truck - repairs and other	227.00
Small tools and miscellaneous	150.00
Hydro and Telephone	225.00
Miscellaneous overhead	95.00
Total for quarterly distribution	1,335.00
Building and equipment insurance	77.00
Land Taxes	924.00
Building and equipment depreciation	3,571.00
Additional charges for fourth quarter	4,572.00

Indexed Overhead Cost Distribution**

Period	Quarterly Expense	Total Fourth Quarter	Period Total
	. . . .	dollars	. . . .
1	333.75	4,905.75	5,907.00
2	341.63	5,021.57	6.046.46
3	349.51	5,137.39	6,185.92
4	357.39	5,253.21	6,325.38
5	365.27	5,369.03	6,464.84
6	373.15	5,484.85	6,604.30
7	381.03	5,600.67	6,743.76
8	388.91	5,716.49	6,883.22
9	396.79	5,832.31	7,022.68
10	404.67	5,948.13	7,162.14
11	412.55	6,063.95	7,301.60
12	420.43	6,179.77	7,441.06

*See Table A.8 for full expense statements.

**Costs of production and overhead costs were indexed upwards over time by relating base year costs to an extrapolation of a linear regression on the Index of Prices Paid by Farmers (44, p. 34) over the period 1949-1969.

Table B.63

Land Value Per Acre 1963-1968
Crop District Number 10

Year	Value
	dollars
1963	46.
1964	57.
1965	64.
1966	77.
1967	85.
1968	88.
Average	70.

Source:

Manitoba Department of Agriculture, Yearbook of Manitoba Agriculture, 1969 (Winnipeg: Queen's Printer, 1970), p. 33.

Table B.64

Security Value of Representative Farms
Beginning Period One

	Farm Size		
	Small	Medium	Large
	. . . . dollars		
Land Value	18,148.	33,058.	53,889.
Buildings Value	6,724.	8,556.	10,785.
	24,872.	41,614.	64,674.
Less: Long-Term Debt	9,234.	12,114.	23,137.
Security Value for Model	15,638.	29,500.	41,537.

Source:

Derived from Farm Net Worth Statements - Table A.3.

Table B.65

Repayment Schedule For Land Purchase Debt,*
No Additional Equipment Required

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at Year End
	. . . .	. dollars .	. . . .	. .
1	70.00	5.60	6.22	.62
2	69.38	5.55	6.22	.67
3	68.71	5.50	6.22	.72
4	67.99	5.44	6.22	.78
5	67.21	5.38	6.22	.84
6	66.37	5.31	6.22	.91
7	65.46	5.24	6.22	.98
8	64.48	5.16	6.22	1.06
9	63.42	5.07	6.22	1.15
10	62.27	4.98	6.22	1.24
11	61.03	4.88	6.22	1.34
12	59.69	4.78	6.22	1.44
**	**	**	**	**

*Debt Principal: 70 dollars, based on value of land per acre - See Table B.63.

Interest Rate: 8 percent per annum.

Instalments: amortized payments made according to the above schedule and taken out of generated capital annually in the fourth quarter of the period.

Term of Debt: 30 years.

**Since the model runs for only twelve periods the balance of the schedule is not shown.

Table B.66

Land Purchase Requiring Additional Equipment: Small Farm
Schedule of Added Costs and Debt Repayment

Period	Overhead* Total, Quarters One, Two, Three	Overhead* Fourth Quarter	Depreciation On Added Equipment**	Interest On Land Debt***	Interest On Machinery Debt+	Income and Expense Coefficient	Payments on Principal Land***	Payments on Principal Machinery+	Total Fourth Quarter Cash Coefficient
	dollars								
1	1.93	1.52	2.21	5.60	1.76	13.01	.62	3.26	14.96
2	1.97	1.55	2.26	5.55	1.46	12.80	.67	3.55	15.04
3	2.02	1.59	2.31	5.50	1.14	12.56	.72	3.87	15.13
4	2.06	1.62	2.36	5.44	.79	12.29	.78	4.22	15.22
5	2.11	1.66	2.42	5.38	.41	11.98	.84	4.60	15.31
6	2.15	1.70	2.47	5.31	-	11.63	.91	-	10.38
7	2.20	1.73	2.52	5.24	-	11.69	.98	-	10.47
8	2.24	1.77	2.57	5.16	-	11.74	1.06	-	10.56
9	2.29	1.80	2.62	5.07	-	11.79	1.14	-	10.65
10	2.33	1.84	2.68	4.98	-	11.83	1.24	-	10.74
11	2.38	1.88	2.73	4.88	-	11.87	1.33	-	10.82
12	2.42	1.91	2.78	4.78	-	11.90	1.44	-	10.91

*Overhead costs on additional land are assumed to be the same per acre as on land owned initially.

**An increase in farm size by greater than 160 acres on a small farm requires that machinery investment be raised to the level initially shown for a medium size farm.

Machinery Investment - Medium Size Farm	$14,172.00
- Small Size Farm	9,804.00
Additional Investment Required	$ 4,368.00

Depreciation on equipment for the small size farms averaged 11.33 percent. Taking 11.33 percent of 4,368. dollars gives a total additional depreciation expense of 494.83 dollars. Since the assumed maximum size for a small farm is 640 acres and the maximum additional land purchase without a requirement for additional machinery is 160 acres, the depreciation charge calculated above is charged to 224 acres or 2.21 dollars per acre.

***See Table B.65 for schedule.

+The investment required as calculated above must be costed over the 224 acres also. An investment of 4,368. dollars over 224 acres gives a per acre investment of 19.50 dollars. It is assumed that this debt is paid off on a five year amortized basis with interest at 9 percent per annum. The schedule appears below:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars .	. . . .	. .
1	19.50	1.76	5.01	3.26
2	16.24	1.46	5.01	3.55
3	12.69	1.14	5.01	3.87
4	8.82	.79	5.01	4.22
5	4.60	.41	5.01	4.60

Table B.67

Land Purchase Requiring Additional Equipment: Medium Farm
Schedule of Added Costs and Debt Repayment

Period	Overhead* Total, Quarters One, Two, Three	Overhead* Fourth Quarter	Depreciation On Added Equipment**	Interest On Land Debt***	Interest On Machinery Debt+	Income and Expense Coefficient	Payments on Principal Land***	Payments on Principal Machinery+	Total Fourth Quarter Cash Coefficient
	dollars								
1	1.30	5.40	2.43	5.60	1.90	16.63	.62	3.52	19.46
2	1.34	5.53	2.49	5.55	1.58	16.48	.67	3.84	19.65
3	1.36	5.66	2.54	5.50	1.23	16.30	.72	4.18	19.83
4	1.40	5.78	2.60	5.44	.86	16.08	.78	4.56	20.02
5	1.42	5.91	2.66	5.38	.44	15.82	.84	4.97	20.20
6	1.46	6.04	2.72	5.31	-	15.52	.91	-	14.97
7	1.48	6.16	2.77	5.24	-	15.66	.98	-	15.16
8	1.52	6.29	2.83	5.16	-	15.80	1.06	-	15.34
9	1.54	6.42	2.89	5.07	-	15.92	1.14	-	15.52
10	1.58	6.55	2.94	4.98	-	16.05	1.24	-	15.71
11	1.60	6.67	3.00	4.88	-	16.16	1.33	-	15.89
12	1.64	6.80	3.06	4.78	-	16.27	1.44	-	16.08

*Overhead costs on additional land are assumed to be the same per acre as on land owned initially.

**An increase in farm size by greater than 320 acres on a medium size farm requires that machinery investment be raised to the level initially shown for a large farm.

Machinery Investment	- Large Size Farm	$23,731.00
	- Medium Size Farm	14,172.00
Additional Investment Required		$ 9,559.00

Depreciation on equipment for the medium size farms averaged 11.54 percent. Taking 11.54 percent of 9,559. dollars gives a total additional depreciation expense of 1,102.92 dollars. Since the assumed maximum size for a medium farm is 1,280 acres and the maximum additional land purchase without a requirement for additional machinery is 320 acres, the depreciation expense calculated above is charged to 454 acres or 2.43 dollars per acre.

***See Table B.65 for schedule.

+The investment required, as calculated above, must be costed over the 454 acres also. An investment of 9,559. dollars over 454 acres gives a per acre investment of 21.06 dollars. It is assumed that a debt is created to make this investment and that it is paid off on a five year amortized basis with interest at 9 percent per annum. The schedule appears below:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	. dollars .	. . . .	. .
1	21.06	1.90	5.41	3.52
2	17.54	1.58	5.41	3.84
3	13.71	1.23	5.41	4.18
4	9.53	.86	5.41	4.56
5	4.97	.44	5.41	4.97

Table B.68

Land Purchase Requiring Additional Equipment: Large Farm
Schedule of Added Costs and Debt Repayment

Period	Overhead*		Depreciation On Added Equipment**	Interest On Land Debt***	Interest On Machinery Debt+	Income and Expense Coefficient	Payments on Principal		Total Fourth Quarter Cash Coefficient
	Total, Quarters One, Two, Three	Fourth Quarter					Land***	Machinery+	
	dollars								
1	.92	4.49	3.16	5.60	2.45	16.62	.62	4.55	20.87
2	.94	4.59	3.24	5.55	2.04	16.36	.67	4.96	21.05
3	.96	4.70	3.32	5.50	1.59	16.06	.72	5.40	21.23
4	.98	4.81	3.39	5.44	1.11	15.72	.78	5.89	21.41
5	1.00	4.91	3.46	5.38	.58	15.33	.84	6.42	21.59
6	1.02	5.02	3.54	5.31	-	14.89	.91	-	14.78
7	1.04	5.12	3.62	5.24	-	15.02	.98	-	14.96
8	1.06	5.23	3.69	5.16	-	15.14	1.06	-	15.14
9	1.08	5.34	3.76	5.07	-	15.26	1.15	-	15.32
10	1.10	5.44	3.84	4.98	-	15.37	1.24	-	15.50
11	1.12	5.55	3.92	4.88	-	15.47	1.34	-	15.68
12	1.14	5.65	3.99	4.78	-	15.57	1.44	-	15.86

*Overhead costs on additional land are assumed to be the same per acre as on land owned initially.

**An increase in farm size by greater than 560 acres on a large size farm requires that machinery investment be raised to a level 50 percent above the initial investment level.

Machinery Investment - Large Farm	$23,731.00
Additional Investment Required (50 percent of the above value)	$11,865.00

Depreciation on equipment for the large size farms averaged 11.63 percent. Taking 11.63 percent of 11,865. dollars gives a total additional depreciation expense of 1,379.78 dollars. Since the assumed maximum size for a large farm is 1,920 acres and the maximum additional land purchase without a requirement for additional machinery is 560 acres, the depreciation expense calculated above is charged to 436 acres or 3.16 dollars per acre.

***See Table B.65 for schedule.

+The investment required, as calculated above, must be costed over the 436 acres also. An investment of 11,865. dollars over 436 acres gives a per acre investment of 27.21 dollars. It is assumed that a debt is created to make this investment and that it is paid off on a five year amortized basis with interest at 9 percent per annum. The schedule appears below:

Period	Principal Beginning of Year	Interest For Year	Annual Payment	Principal Paid at End of Year
	. . . .	dollars	. . . .	
1	27.21	2.45	7.00	4.55
2	22.67	2.04	7.00	4.96
3	17.71	1.59	7.00	5.40
4	12.31	1.11	7.00	5.89
5	6.42	.58	7.00	6.42