THE UNIVERSITY OF MANITOBA

IMPACTS OF FARMLAND TENURE ARRANGEMENTS, DEBT STRUCTURE AND RATE OF RETURN ON PRODUCTIVE ASSETS ON CROP FARM INCOME IN MANITOBA - A SIMULATION STUDY

by

ERROL T. LEWIS

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ABSTRACT

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DEBT STRUCTURE AND RATE OF RETURN
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Concerns about low and variable income situation continue to be pervasive in the agriculture sector despite attempts by both Federal and Provincial Government to improve them. This study re-examines farm income in an attempt to provide new insights on those two concerns.

A sixty-subroutine simulation model was constructed as a representative crop farm. Using this as the basic framework a factorial experimental design was implemented and the various combinations simulated. Each simulation was run for twenty-years under a deterministic mode; using farmland use control, rate of return on productive assets and debt structure as controllable variables and net income, net cash flow and net worth as performance measures.

The major results of the study are that farmland control arrangements positively influenced all performance measures; rate of return displayed positive effects on net cash flow and net worth and net income, and debt structure had increasing impacts on all performance criteria. Net income showed relatively lower values and greater variability than net cash flow and net worth. This

suggests that the lowness and variability of income are inherent in the definition of net income and that net cash flow and net worth are more appropriate criteria.

The major implications of the results are related to land policy, resource adjustment and productivity, farm credit and financial management and farm income stability and welfare. Land use and ownership policies may incorporate a quantitative basis for restricting ownership. Tenure arrangement can also influence land use and conservation policies by serving as the regulatory mechanism.

Incorporation of debt structure as a precondition for borrowing will permit available credit to be loaned to viable farm and to ensure that credit needs of the sector, especially short term and medium term needs, are met quickly by lending institutions.

The results have implication for stabilization policies. They suggest that the perceived problem may not be one of net income but one of cash flow. Therefore, stabilization programmes should be based on cash flow requirements rather than income. This will dissipate some of the inequalities in ownership of income earning resources with consequences for equitability in distribution, levels of income, maintenance of the family farm and rural outmigration.

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CHAPTER I

INTRODUCTION

This chapter introduces the problem area, indicates its importance and validity, isolates the specific aspects under study and presents some essential background information. It presents assumptions, hypotheses and objectives and notes the scope and limitation of the study. The final section of the chapter gives the organization which serves to guide the reader through the remainder of the thesis.

THE PROBLEM AREA

Usually, empirical scientific inquiry in the behavioural sciences follows steps such as conception of idea, problem identification, design of study, execution, analysis and dissemination in order to explain facts or observations in the study area at issue. This study similarly patterns itself and starts by identifying the topic. The broad topic at issue in this study is the farm income problem. This term refers to statistical observations that incomes of farmers are highly variable from year to year, and on average have declined in recent years relative to the real income of comparable people in nonfarm occupations.[1] It has

[1] T.W. Schultz, "Are We Solving Our Farm Problem?" in R.J. Hildreth ed. Readings In Agricultural Policy, University of Nebraska Press, Lincoln, Nebraska, 1968. p. 141..

been suggested that low returns for family labour and investment in commercial agriculture are the outcome of high level of aggregate output and acute oversupply of farmers.[2]

Low and unstable farm income continue to be the major problems besetting the agricultural sector, not only in Manitoba and Canada, but also in other parts of the world. Many farmers in Manitoba and Canada are finding it increasingly difficult to provide a decent standard of living for their families.[3] This difficulty has been accentuated by recent high levels of inflation and the general belief in many quarters that farmers are in need of assistance to supplement incomes:

> From basic economic textbooks, through professional agricultural literature to farm organisation position-papers, all forms of the media, and unto the floors of every Government in Canada, it is accepted that farm incomes are lower and more variable than incomes of the non-farming segment of the population.[4]

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[2] G.E. Brandow, "A Framework For the Farm Problem" in R.J. Hildreth ed. Readings In Agricultural Policy, University of Nebraska Press, Lincoln, 1968. pp. 132-140.

[3] Standard of living is equated to poverty levels. A low income family had a total annual net income of not more than $6,363. This income was approximately equal to a farm having annual gross sales of no more than $14,999. A medium income family had a total annual net income between $6,363 and $10,236. Farms with gross annual sales between $14,999 and $39,999 constituted farms in the medium income range. Farm families receiving annual total net income greater than $10,236 and having annual gross sales in excess of $39,999 were in the high income range. For further details on income and poverty boundaries see C.A.R. Pemberton, "Goals and Aspirations and the Low Income Problem," Unpublished Ph.D. Thesis, University of Manitoba, Winnipeg, October 1976, pp. 22-32.

The preceding statement clearly reflects not only the pervasiveness and complexity of the farm income problem, but also the confusion the topic generates. It is not surprising, therefore, that great concern is expressed about the problem:

> conventional wisdom, reinforced by politicians, governments and farm group, is that farmers are poorly paid for their efforts, are poorer than the rest of society, and are about to exodus farms because of inadequate returns.[5]

Whether the above statements exaggerate, oversimplify or misrepresent the farm income situation may be a moot point. What is important is that every group which participates in the decision-making milieu believes that farm income is the fundamental concern of the agricultural sector. The sector continues to comprise a large share of the national households and the labour force, contributes significantly in the economic welfare of the state, and possesses an effective lobbying force which influences national policy.[6] The foregoing statements suggest an urgent need for new

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[4] R.M.A. Loyns, Farm to Food Prices, Discussion Paper No. 157, prepared for The Economic Council of Canada, Ottawa, January, 1980, pp. 66.

[5] Ibid., p. 67.

[6] Agriculture's contribution include 3.3 percent of the gross domestic product in 1976, 5.0 percent of the total labour force, 10.6 percent of total exports, 15.2 percent of total consumer expenditure on food. There were some 338,578 agricultural households in 1976. See T.S. Veeman and M.M. Veeman, "The Changing Organization, Structure, and Control of Canadian Agriculture." American Journal of Agricultural Economics, Vol. 60, No. 5, December, 1978, pp. 759-768.

investigations of the farm income problem in order that these referential groups will have more detailed and additional information on which to deliberate and to base policy and other decisions. Increasing pressures will be placed on those decision making groups to ameliorate the burdens of the farming sector.

Agricultural policy in Canada in the early sixties had the following goals:

1. Full employment.
2. A high rate of ecomomic growth.
3. Reasonable stable prices.
4. Maintenance of a viable balance of payments.
5. Equitable distribution of income.[7]

Anderson[8] noted that agriculture should be an efficient industry which meets fully the competitiveness of other industries for the resources used in agriculture so that its rates of return would equal those set by the general level prevailing in the economy.

The objectives of agricultural policy for the Province of Manitoba included stabilizing net farm income and enhancing

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[7] W.W. Drummond, W.J. Anderson and T.C. Kerr, A Review of Agricultural Policy in Canada, Agricultural Economics Research Council of Canada, June 1966, p. 67.

[8] W.J. Anderson, Agricultural Policy in Perspective. Agricultural Research Council of Canada, June 1967, p. 10.

the economic viability of low and middle income producers.[9] Implicit in these objectives were the goals of higher net per capita income, less variability in income, and a more equitable income distribution. The objectives enunciated above continue to be evident in both Federal and Provincial farm policies today.[10] Pemberton[11] has reviewed the low income problem and discussed federal and provincial programmes which were designed to deal with it. Loyns,[12] Gilson.[13] and Wirick[14] have discussed the programmes in detail.

The preoccupation of policy-makers with the goals of higher and more stable farm income and more equitable distribution of farm income is justification for investigating the farm income problem. The problem is a complex one comprising inadequate income, variable income and uneven

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[9] The Province of Manitoba, Guidelines for the Seventies, Introduction and Economic Analysis, March 1973, pp. 83-84.

[10] J.C. Gilson, "Canadian Agriculture and a National Food Policy," National Food Policy. Proceedings of the Agricultural and Food Marketing Forum, ed. R.M.A. Loyns, University of Manitoba, Winnipeg, November 1979. pp. 1-15. See Agriculture Canada, Challenge for Growth - An Agri-Food Strategy for Canada. Discussion Paper, Agri-6-81DD July 9, 1981.

[11] Pemberton, op.cit., pp. 1-8.

[12] Loyns, op.cit., pp. 74-78

[13] Gilson, op.cit., pp. 1-15.

[14] R.G. Wirick, A Preliminary Paper in Some Food Policy Aspects of Farm Income, Reference Paper No. 9. Food Prices Review Board (Undated).

distribution of income.

Despite efforts by governments in terms of various agricultural programmes, the problem remains. This apparent failure of the market system and governmental programmes to deal effectively with the income problem warrant new investigations on the topic. Some probable reasons for the apparent ineffectiveness of government programmes in alleviating the farm income problem were that the programmes did not address in sufficient detail, the distributional aspects of income within the agricultural sector, rates of return the farmer receives for his fixed resources, the farmland tenure arrangement under which the farmer operates and the types of debt relationships the farmer is forced to maintain in the operation of his farm.

The low income problem itself comprises a trilogy of problems:

a) the physical asset problem,

b) the resource adjustment problem, and

c) the preference problem.[15]

The low income problem sometimes viewed as an income inadequacy problem, is usually displayed by comparing the farm net income with the nonfarm income. Viewed in this way the average net farm income more often than not lags behind the nonfarm net income.

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[15] Pemberton, op.cit., p. 6.

Tables 1, 2, 3, and 4 present net farm income and total net income for farmers and nonfarmers using different kinds of data. Table 1 shows values when taxfilers data for 1967-1978 are used. Table 2 shows the incomes when data used is Revenue Canada, Taxation "farmer". Table 3 gives the income values when the data used are those for individuals who report farm income as their major source of income. Table 4 gives the income for farm family and nonfarm family using Survey of Consumer Finance data.

In every data case, net farm income and total net farm income tend to be less than the total net income of the nonfarm group. A similar situation is reflected when incomes of the farm family are compared with those of the nonfarm family.

In 1971, average farm family income in Canada was only 72 percent of the average nonfarm family income.[16] Other work has shown that the ratio between per capita income for the farm/nonfarm was .50 for Canada and .42 for Manitoba. When adjustments were made for income-in-kind, and the comparison made between per farm family and per nonfarm family the ratios were .77 for Canada and .63 for Manitoba.[17]

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[16] B.H. Davey and Z.A. Hassan "Farm and Off-Farm Incomes of Farm Families in Canada," Canadian Farm Economies, December 1974, pp. 16-23.

[17] R. Paul Shaw, "Canadian Farm and Nonfarm Family Incomes," American Journal of Agricultural Economics, Vol. 61, No. 4, November 1979, pp. 676-682.

TABLE 1

AVERAGE INCOME OF FARMERS AND NONFARMERS (USING TAXATION DATA FROM TAXFILERS)*

Year	Net Farm Income(a) (Dollars) (1)	Total Net Income(b) (Dollars) (2)	Total Net Income of All Taxfilers (Dollars) (3)	(2) as a Percentage of (3) (%)
1967	2,037	3,981	5,505	72.3
1968	1,702	3,885	5,816	66.8
1969	1,183	3,723	6,263	59.4
1970	993	3,817	6,627	57.6
1971	1,311	4,407	7,063	62.4
1972	1,984	5,492	7,804	70.4
1973	3,433	7,624	8,736	87.3
1974	4,466	10,164	10,147	100.2
1975	4,890	11,697	11,438	102.3
1976	3,875	11,855	12,713	93.3
1977	3,290	12,060	13,718	87.9
1978	3,640	12,680	14,740	86.0

Source: R.D. Bollman, "A Comparison of the Money Incomes of Farmers and Nonfarmers," Canadian Journal of Agricultural Economics, Proceedings of the 1980 Annual Meeting, Edmonton, Alberta, August 1980, Table 1. p. 51.
* A farm taxfiler is any individual who reports a positive unincorporated net self-employment income from farming.

(a) Net Farm Income is defined as the value of agricultural product sold minus operating expenses and depreciation charges. It does not include sales of real estate, machinery or equipment; nor are expenses incurred for purchasing of farm real estate, machinery and equipment assigned as an expenditure in the year of purchase. Only an estimated value of depreciation on the item is included in the farm net accounts.

(b) Total net income is net farm income plus change in value of inventory plus nonfarm income such as investment returns.

TABLE 2

AVERAGE INCOME OF FARMERS AND NONFARMERS USING TAXATION DATA 1965-1978 BASED ON REVENUE CANADA TAXATION DEFINITION OF "FARMER"*

Year	Net Farm Income Per Farm (a)	Total Net Income	Total Net Income of All Taxfilers	Total Net Income Per Farm as a % of Total Net Income of all Taxfilers
	Dollars			Percent
1965	2,659	3,306	4,924	67.1
1966	2,690	3,392	5,218	65.0
1967	2,744	3,499	5,505	63.5
1968	2,391	3,244	5,816	55.8
1969	1,914	2,845	6,263	45.4
1970	1,758	2,799	6,627	42.2
1971	2,159	3,288	7,063	46.5
1972	3,048	4,437	7,804	56.8
1973	5,054	6,783	8,736	77.7
1974	6,789	9,385	10,147	92.3
1975	7,568	10,736	11,438	93.9
1976	6,570	10,045	12,713	79.0
1977	6,133	10,036	13,718	73.2
1978	6,505	10,741	14,740	72.9

Source: R.D. Bollman, "A Comparison of the Money Incomes of Farmers and Nonfarmers," Canadian Journal of Agricultural Economics, Proceedings of the 1980 Annual Meeting, Edmonton, Alberta, August 1980, Table 1.

* A Revenue Canada Taxation "farmer" is any individual whose major source of gross income is from farming.

(a) Net farm income divided by number of recorded farms in Canada. In census years (every five years) the number of farms comes from the Census of Agriculture in intercensal years the number of farms are estimated only.

TABLE 3

AVERAGE INCOME OF FARMERS AND NONFARMERS USING SURVEY OF CONSUMER FINANCE DATA FOR INDIVIDUALS REPORTING FARM INCOME AS THE MAJOR SOURCE OF INCOME

Year	Average Net Farm Income (Dollars) (1)	Average Total Net Income Per Farm (Dollars) (2)	Average Total Net Income of All Individuals (Dollars) (3)	(2) as a % of (3) (%)
1965	2,588	3,022	4,551	66.4
1966*	-----	-----	-----	----
1967	3,016	3,561	5,334	66.8
1968*	-----	-----	-----	----
1969	3,600	4,332	6,162	70.3
1970*	-----	-----	-----	----
1971	3,506	4,291	7,004	61.3
1972	4,220	5,114	7,633	67.0
1973	6,396	7,694	8,410	91.5
1974	8,466	10,148	9,749	104.1
1975	8,929	10,605	10,865	97.6
1976	9,362	11,327	12,430	91.1
1977	8,466	10,491	12,698	82.6
1978	9,358	11,828	13,871	85.3

Source: R.D. Bollman, "A Comparison of the Money Incomes of Farmers and Non-Farmers," Canadian Journal of Agricultural Economics, Proceedings of the 1980 Annual Meeting, Edmomton, Alberta, August 1980, p. 52, Table 2.

* No survey was conducted in these years.

TABLE 4

AVERAGE INCOME OF FARM FAMILY UNITS AND AVERAGE INCOME OF ALL FAMILY UNITS (USING SURVEY OF CONSUMER FINANCE DATA) FOR FAMILY UNITS REPORTING FARM INCOME AS MAJOR SOURCE OF INCOME

Year	Average Net Farm Income Dollars (1)	Average Total Farm Family Income Dollars(a) (2)	Average Total Net Income of All Families Dollars (3)	(2) as a percentage of (3) %
1965	2,694	4,134	5,779	71.5
1966*	----	-----	-----	----
1967	3,219	4,663	6,518	71.5
1968*	-----	-----	-----	----
1969	3,924	6,199	7,686	80.7
1970*	-----	-----	-----	----
1971	3,791	6,398	8,845	72.3
1972	4,538	7,145	9,525	75.0
1973	7,058	10,591	10,694	99.0
1974	9,104	13,092	12,437	105.3
1975	9,894	14,973	13,805	108.5
1976	10,455	16,160	16,090	100.4
1977	9,305	15,716	16,764	93.7
1978	10,200	17,555	18,547	94.6

Source: R.D. Bollman, "A Comparison of the Money Incomes of Farmers and Non-Farmers," Canadian Journal of Agricultural Economics, Proceedings of the 1980 Annual Meeting, Edmonton, Alberta, August 1980, Table 3, p. 53.

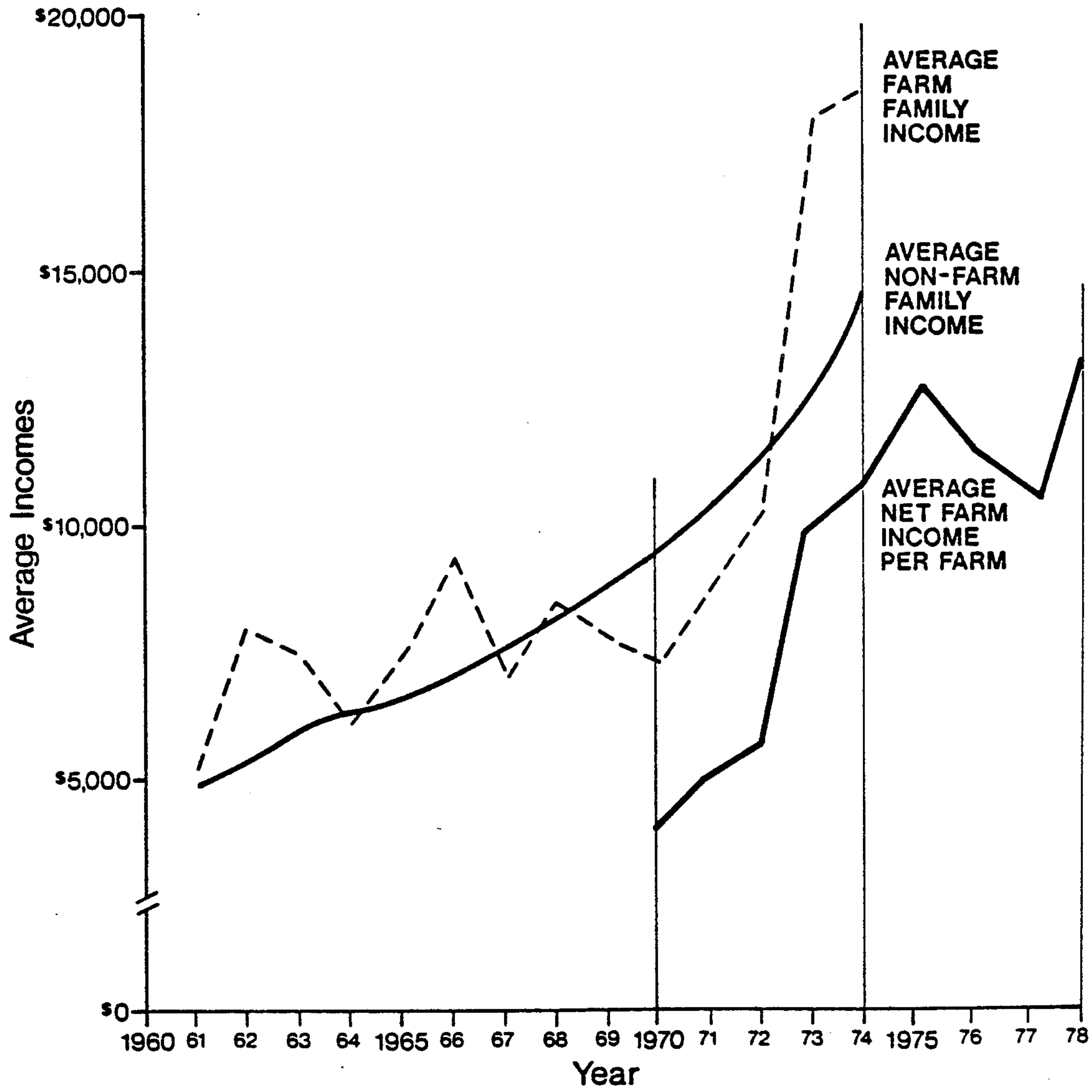
* No survey was conducted in these years.

(a) Both farm and nonfarm incomes of all family members actually involved in the farm business are divided by the number of farms.

The variability in farm income is shown in Tables 1, 2, 3 and 4. Figure 1 clearly demonstrates this variability both in terms of the net farm income per farm and the average farm family income. Such extreme variability is lacking for the nonfarm family income.

Table 5 showing the aggregate net farm incomes and net income per farm for Canada and Manitoba, reveals the variability of net farm income on both the aggregate and per farm levels.

Figure 1: FARM INCOME COMPARISON FOR CANADA, 1961-1978



Source: Wirick, Reference Paper No. 9, Food Prices Review Board, 1976, and calculated.

Table 5

Total Aggregate and Net Per Farm Income
for Canada and Manitoba
1965-1980

Year	Aggregate Income		Net Per Farm Income	
	Canada (million dollars)	Manitoba (million dollars)	Canada (dollars)	Manitoba (dollars)
1965	1660	169	3,452	4,145
1966	1916	148	4,509	3,889
1967	1501	154	3,460	3,989
1968	1813	162	4,200	4,305
1969	1701	114	3,923	3,110
1970	1408	110	3,314	3,085
1971	1423	152	3,888	4,334
1972	1630	169	5,119	4,824
1973	3168	371	8,795	10,958
1974	3521	319	10,508	9,572
1975	4035	397	12,415	12,173
1976	3259	290	12,150	9,033
1977	2754	300	8,609	9,615
1978	3314	340	9,919	11,258
1979	3610	231	12,465	7,884
1980	3039	53	9,265	1,809

Source: Manitoba Department of Agriculture, Manitoba Agriculture Yearbook, Queen's Printer, Winnipeg, 1965-1980; Statistics Canada, Net Per Farm Income The Queen's Printer, Ottawa, Canada, 1965-1980.

STATEMENT OF THE STUDY PROBLEM

The previous section introduced the problem area and with the aid of some background information indicated both the importance of the problem and validity of the research. This section focuses on the specific aspects of the farm income problem with which this thesis deals.

Despite Federal and Provincial governments programs with the original intent of improvement of farmers' income, both low income and variable income concerns persist. Moreover, western Canadian agriculture, dominated by large crop farms, display higher levels of farm net income variability than that displayed by the sector as a whole.

Among the factors contributing to the dual concerns of lowness and variability of net incomes are input costs, low rates of return for farmers labour and management, low rate of return for the use of farmland as a factor of production and nonoptimal or imbalanced financial management. In this regard, it is recognized that land is the most capital-demanding factor of production and the most essential. Rates of return are critical to net income, net cash flow and net worth positions and capital structure (debt structure) are of pivotal importance for successful farming. New investigations are required to evaluate the low and variable aspects of farm income to gain new insights that will allow for better understanding in order to develop specific policies to adequately treat these concerns. But, investigations of net income especially in western Canadian agriculture needs to use an indigenous model representing crop farms within the total operative environment.

In order to throw new light on the concerns about low and variable income, information is needed about the behaviour of a multitude of factors interfacing with farm income. Prime among these factors are farmland use control arrangement, rates of return for different use control of farmland and debt structure ratios. Another source of concern deals with the choice of measures of 'income', 'wealth' or 'welfare' of the farm(er). Normally, income is measured by the farm net income. Sometimes net cash flow and net worth are used as measures of income, wealth or welfare.[18]

Relevant questions for an investigation of lowness and variability of farm income are:

1. Do different farmland use control arrangements have differential effects on farm income measures?
2. Are their significant differences in the effects of alternative rates of return on productive assets on farm income measures?
3. Do debt-structure relationships exercise quantitatively different effects on farm income measures?

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[18] Terms used are classified in Chapter VII.

4. How do variations in farmland use control arrangement, debt-structure ratios and rates of return influence income measures and farm financial health?
5. What are the effects on farm income and farm financial success of combinations of farmland use control arrangements, debt structure ratio and rate of return?

Answers to these and similar questions will assist policy makers, resource allocators and planners to resolve the farm income problem by assisting to design appropriate action-oriented programs for improving farm income.

The specific aspects of the farm income problem with which this study is concerned are the lowness and variability of farm income. Stated more clearly the study concerns itself with the following statement: An assessment of criteria for evaluating farm income could eliminate some of the concerns expressed about the farm income problem. More specificly, the study seeks to quantify to what extent the performance measures of net income, net cash flow and net worth and the selected factors of rate of return, debt-structure relationship and farmland use control arrangement are contributing to the low and variable income dilemma on crop farms in Manitoba.

ASSUMPTIONS, HYPOTHESES, OBJECTIVES

Fundamental premises of this study are:

1. That a significant void exists in the quality and quantity of knowledge about levels and variability of farm net income available to policy makers to assist them in designing programs to specificly address these aspects of the farm income problem.
2. That the current net income measure does not adequately reflect the economic 'income' (welfare) of farmers and that the terms 'low income' and 'variable income' as commonly used may be both anomalous and misleading.
3. That existing models of the farm business do not adequately represent the organization, structure, management, resource, decisions and socio-economic environment with which crop farmers in Manitoba operate.

Therefore, given the statement of the problem and the assumptions the following hypotheses are postulated.

1. Farmland use control arrangements have different impacts on the generation of and variability of farm net income, annual net cash flow and annual net worth. The control use arrangements requiring the least initial capital input requirement, in general,

will not generate greatest net farm income and net cash flow and least net worth.

2. Restructuring short-term debt/long-term debt ratio will have a different effect on net income, net cash flow and net worth than restructuring of medium-term debt/long-term debt ratio. A debt structure relationship based on a short-term debt/long-term debt ratio will generate less cash flow and more cash flow problems than one based on medium-term debt/long-term debt ratio.

3. Receipt of a higher rate of return for productive assets will generate greater amounts of net income, net cash flow and net worth than receipt of a lower rate of return.

4. Interaction effects of farmland use control arrangement, debt structure relationship and rate of return will depend on the level of each factor. In general, the less capital-dependent use control arrangement in combination with short-term debt/long-term debt can be expected to reduce cash flow problem, reduce net income problem but to adversely affect net worth. In combination with medium-term debt/long-term debt, the less capital-dependent use control arrangement will augment cash flow, net income and net worth. In combination with a higher rate of return, the less-capital dependent land use method will improve net

income, net cash flow and net worth. The interaction of three factors will be complex in its effects on net income, net cash flow and net worth.

The broad objective of the study, following from the assumptions and hypotheses is to construct a model capable of representing the organizational and socio-economic environment within which crop farms operate and to use it for analyzing the impacts of farmland use control arrangement alternatives, rates of return for use of productive assets and debt structure ratios on the selected performance criteria of net income, net cash flow and net worth. The outcome will indicate if any new knowledge obtained about levels and variability of farm income and variable income are really meaningful.

The specific objectives of the study in light of the foregoing are:

1. to evaluate the impacts of alternative farmland use control arrangements on the attainment and maintenance of high levels of income by Manitoba crop farms;
2. to investigate how variations in debt structure relationships influence attainment and variability of income;
3. to evaluate the effects of alternate rates of return for productive assets on the farm net income position;

4. to determine risks of survival and financial failure under different debt structure relationship, farmland use control arrangement alternative and rate of return for farmland use combinations;

5. to evaluate the lowness and variability phenomena.

METHODOLOGICAL OVERVIEW

As previously stated, low and variable income aspects of farm income are the focus of this study. In general, the lowness aspect refers to the often observed statistics that farm net income is lower than that of comparable individuals in the nonfarm sector. The variable aspect pertains to the almost annual variations in farm net income. This study will identify and quantitatively measure the impacts of the selected performance criteria already mentioned. By so doing, it will provide new insights into the behaviour of farm income. The study will test the hypotheses stated earlier.

The analytical period coincides with the historical period 1965-85 primarily because the best run of data available for the representative farm was for the period 1965-70. The twenty year period was selected as the length of time for the farmers planning horizon. The study uses available published and unpublished data during that period.

By means of trend analysis, including lagged endogenous variables procedure and autoregressive schemes, missing data and projected data for 1980-85 were generated.

In order to attain the objectives of the study, a simulation model representing a crops farm in Manitoba was constructed. The model was tested and validated. Although both deterministic and stochastic models are available only the deterministic one is utilized and reported. The farm model is simulated for the planning period under assumptions that national economic behaviour or happenings during any segment(s) of the planning period influenced all variables, constants and other decisions similarly. As such, it does not examine the historical behaviour of economic indicators nor does it concern itself with specific business cycle behaviour influencing any variable(s).. In effect, economic variations are assumed to be captured by the trend equations and inflation rates as reflected by the itemized indices used in the study.

The statistical experimental design is a factorial of order 4x2x2. There are therefore, sixteen treatment combinations and the control. Net income, net cash flow and net worth measurements for each treatment combination and control are examined. Use of the factorial design permitted the study of effects of a number of different factors simultaneously so providing much more data from which to extract new information.[19]

The major purpose of the experimentation was to assist in attainment of the objectives. The intent was to find the best and worst performing treatments, to rank the treatments between and to elaborate why treatments behaved as they did. The experiments are required to indicate not only whether they all improved performances, but whether the improvements were due to one, two or three factors, or to different combinations of the three factors.

The control was included to represent a treatment in which the study was not particularly interested but to reveal by comparison the effectiveness of other treatments. The control was represented by the model operating under conditions in place on the case farm with no manipulation of options in one instance and with one each of the farmland control. Results of control runs are directly comparable with treatments results.

The method of drawing conclusions from results is the analysis of data in tabular form examining yearly values, five yearly values and twenty year values, comparing treatment means, and using estimated levels of values to ascertain performances.

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[19] Statistical terms are detailed in Chapter VII.

Results will be presented, discussed, interpreted, and summarized in terms of established statistical procedures bearing in mind limitation in scope of interpreting factorial experimental results.[20] That is, in summarizing results, it was assumed that were it possible to conduct experiments indefinitely under identical conditions, the average difference in performance between two treatments or 'cases' would settle to some fixed value which will be independent of the experiment executed and called the 'true difference' between the two treatments. Therefore, results are interpreted as to what can be said about the true difference between experimental treatments or factors.

Finally, interpretation and practical meanings of results are discussed to give a general picture and to indicate what new information are obtained from the study. Results of this study, while generally applicable to all crop farms as specified in the model, are assumed for interpretive purposes to pertain to crop farms in Manitoba under the specific crops, management and resource situations indicated in the treatments. The model does not pretend to be ideal but rather represents only the author's perception of a model that is a satisfactory respresentative of crop farms in Manitoba to serve as the experimental unit to achieve the objectives identified.

[20] The terminlology used here is found in most standard intermediate statistical texts on design and analysis of statistical experiments. Some more detail will be given in the Chapter on Analysis of Results.

ORGANIZATION OF THE REMAINDER OF THE THESIS

The remainder of the thesis is organized as follows. Chapter II reviews the subject of farm income including fundamental causes, means of resolution, problems of measurements, and programs enacted in Canada to deal with income concerns. Performance criteria and selected factors for scrutiny are also discussed as well as a short problem-related literature review.

Chapter III presents the theoretical and empirical framework from and within which the study is conducted by discussion of specific theories and concepts germane to the research.

Chapter IV deals with the design of the study and focuses on the research method and technique, data requirements for testing hypotheses, sources of data, experimental design, and statistical techniques.

Chapter V examines the significant aspects of the methodology and discusses the validation results. The experimental results are discussed in four parts. Chapter VI discusses the experimental design and evaluates the base treatments. Chapter VII examines the results of Scenario 1 comprised of treatments 1-4.

The results and discussions of Scenario 11 - treatments 5-8, and Scenario III - treatments 9-12 are the subjects of Chapter VIII. Chapter IX examines the results of Scenario IV and compares the performance of all treatments. Chapter X summarises the results of the study, draws conclusions and suggests implications of the result for research and policy.

CHAPTER II

A REVIEW OF THE FARM INCOME PROBLEM

Throughout the last half-century farm income has been identified as one central concern of farm sector policy. Today, in Canada, it preempts all other problems as the major concern of all paticipants in the industry. With the aid of documented literature, private discussions with industry personnel, farmers and other research materials, this chapter reviews the farm income problem especially with respect to identified causes of the problem, suggestions for its resolution, and Canadian programmes designed to deal with it. The chapter also reviews problems of measurements regarding criteria of performance, reviews selected critical factors interfacing on performance measures and also reviews a selcted set of studies. Its purpose is to further identify the problem, and the specific aspects to be investigated in order to keep it in perspective with respect to the conceptual framework and design of the study.

BASIC CAUSES OF THE FARM INCOME PROBLEM

In order to discuss the problem of farm income two assumptions are invoked. These are that:

1. If farm income provides returns on family labour and investment comparable to non-farm industries there is no income problem, and
2. Farm programs can and should be proposed to assist in alleviating an adverse income situation where it exists.

Basic causes of the farm income problem have been identified as follows:[21]

1. While total demand by the general population for all goods and services has been increasing, the agriculture sector receives less in terms of increases in demand from rises in real per family income than does the non-farm producing sector.
2. Statistics continue to support the fact that wages in agriculture have increased relatively more than the average rise in industry.
3. Increases in output surpass increases in use of traditional input both in agricultural and non-agricultural industries which contributed significantly to a general rise in real income.
4. The above, together with the inability of farmers to adjust rapidly enough to these changes have caused earnings of farmers and farm family members earning income from farming to fall behind earnings of

[21] T.W. Schultz, op.cit. pp. 141-157.

individuals with comparable skills earning income outside of agriculture.

5. Recent escalation in inflation rates, interest rates, and input costs have accentuated the problem.

A brief discussion of the rationale for farm income falling behind and the changes in input factor mix will throw further understanding on the farm income problem. Lagging farm incomes are directly related to the demand for and supply of farm products.

An examination of the demand for farm products at the farm gate in affluent societies reveals that increases in per family income add minimally to the demand for farm products. The income elasticity of demand for farm products is much less than unity ranging between .15 andd .25, thus averaging 0.20[22] This implies that in growing economies where relative prices of supplies are constant, total demand for farm products increases less than does aggregate demand for all goods and services.

On the supply side, relatively constant relative supply prices of well-established products prevail. This, in effect, implies that agriculture produces only one commodity since resources are readily substitutable for each other. If agriculture, in fact, can be viewed as producing a single commodity, then current disequilibrium is related to the

[22] Ibid.

agriculture sector.[23] Additional output of agriculture in Canada, for example, far exceed the additional inputs of labour and capital employed. The total value of agricultural production in Canada was $15.6 billion in 1980 while total value of capital employed was $98.7 billion and total wage costs were $916 million[24]

Therefore, increases in real income derive from growth in the labour force, accumulation of capital, and from improvements in quality of these inputs making them more productive.

Slow growth in the demand for farm products and improvements in the quality of inputs used in farming result in a disequilibrium in the mix of factor inputs used in agriculture. What obtains is a substitution of capital for labour. Consequently, the productivity of labour in agriculture is less than that in other occupation. This is not only because of the substitution effect but also because:

a) quality effects of competence and ability of farmers as productive agents give rise to an increase in the effective supply of labour, and

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[23] Ibid.

[24] Agriculture Canada, <u>An Overview of Canada's Agri-Food System</u>, Information Services, Ottawa 1981. pp. 12-16.

b) changes in the substitution for and quality of labour have been so rapid that even rapid urban migration from agriculture has not been able to correct them.[25]

RESOLUTION OF THE INCOME PROBLEM

It was previously stated that if income generated from agriculture provided satisfactory returns on family labour and investment comparable to nonfarm industries there would be no problem. It was also postulated that farm programs can and should be developed to treat the symptoms and to prevent the problem.

An infinite number of proposals have been put forward but only a small number of ways exist to deal with the problem. Therefore, proposals are usually variations, hybrids or combinations of the few main procedures. In this section a brief overview of some of these proposals is discussed.

Open Market Resolution

This proposal suggests that price supports, food export programs, marketing boards etc. should be abolished. Then, given the surplus capacity situations prices will decline. But, income will decline inequitably over producers of different commodities. In subsequent years the rate of increase in total farm production will slow and gradual

[25] See T.W. Schultz, op.cit.

improvements in income from the initial low levels will result.

However, with improvements in technology and surplus number of farmers, farm income equilibrium will be at a low, unstable level and unlikely to solve the income problem. This proposal will promote more efficient use of farm resources and would eliminate the attached costs of government programs. A major consideration in this proposal hinges on foreign policy considerations. Fear of inhibiting foreign policy may mean imposition of export restriction on Canadian products such as wheat flour and rapeseed which will have a negative effect on the policy.

Influence Market Demand

Demand for the majority of agricultural products is inelastic as is aggregate farm production, hence, general reduction in output will increase income. Increasing market demand will also increase income. Thus, the strategy under this proposal is to manipulate the market from the demand or supply side. The most common versions are presented below.

Subsidising Domestic or Foreign Consumption

If food consumption of low income families is subsidised, expenditures on food increases. The rise in food expenditure could be greater than the cost of subsidy. It is possible that increases in production may result from increased food expenditures in which case the farmer will lose some of the income benefits. It appears that this approach will be effective in a depressed economy but less valuable where nonfarm incomes are high.

Discover New Uses For Farm Products. While this seems an attractive proposition, records show that technology always operated to reduce demand for agricultural resources and products instead of increasing it.

Manipulation of Consumers Tastes and Preferences By Promotional and Advertising Programmes. Such programs may increase demand for some products while reducing demand for others but they do not resolve the income problem. The current advertising campaign on Canadian news media with respect to eggs is a case in point.

Reduction of Marketing Cost. Demand at the farm gate is a derived demand depending partly on costs of marketing and processing services between the farm gate and consumer. Marketing and processing costs are dominant costs in the final price. Intuitively, the consumer feels exploited. Though reduction in these costs will benefit consumers and farmers, such reductions are not likely to solve the income problem. Cost-push inflation will tend to increase costs of marketing posing serious problems for farmers.

Practicing Multiple Market Price. This proposal holds demand constant and divides the market into segments with different prices. If appropriate conditions of demand elasticity exist in the different market segments, total income will rise. This practice is exemplified by the two-price policy for wheat where a high price is charged in the domestic market because of the highly inelastic demand and as low a price as possible to clear the remaining wheat is charged for export.

In order to be successful this strategy requires administrative distinction between the market segments. It is most effective when one segment is highly inelastic and uses a significant part of all production and the other segment uses large quantities with minimal sacrifice in price.

Manipulate Market Supply

The strategy is to restrict the quantity marketed. The need to impose restraints if reduction of farmers production raise income arises because the individual farmer is a price taker and is not constrained by the relationship between total output and price. Therefore, higher prices generate increased production. The means of dealing with supply restriction are inducements through payments or eligibility for price support and by law. The procedures are:

Input Restriction. The major input in production is land. Restriction consists of substitution of other inputs for land and acreage diversion to other crops. Acreage diversion may be through a Soil Bank. This requires a high degree of participation in order to significantly reduce production. Moreover, to the extent that a soil bank program is successful the higher will be the payment per acre to insure continued high level participation. Restriction of land causes scarcity of the factor and additional income will be imputed to land with consequent increases in land costs for future purchasers. Restriction of land may in the long run contribute only minimally to rates of return for family labour and investment.

Similar restrictions on uses of capital and operating inputs are possible. In the case of labour, restriction affects prices of farm products and income of farm family. The latter does not contribute to the solution of the farm income problem so long as earnings are low.

Reduction of Input/Output Ratio. This implies foregoing previous technology advances and in all probability will be self-defeating.

Direct Restrictions On Marketing

Direct control of marketings intuitively should be more effective than control of input and allows farmers to decide on relative combinations of resources. However, direct control is administratively more cumbersome than acreage allocation. Crops fed to livestock and yield variability would be difficult to restrict.

Impose Multiple Prices On Produces. The intent is to reduce the marginal value of output while leaving the value of production intact. Producers could be assigned marketing quota. From historical data producers marketing more than their allotments are paid less by fee assessments on all marketings of a commodity and remaining proceeds are returned to farmers based on their allocations. However, farmers must change their production else the same total proceeds are shifted around with no impact on income. Producers income will increase if low marginal value of production does restrict quantity marketed in the future.

Changing The Competitive Structure of Agriculture

The free market sale of products in the absence of government programs could be changed through vertical integration with industry or by horizontal association of farm enterprises. Vertical integration wll lead to oligopolistic price and production decisions. It is conceivable that farms could be owned by giant corporations with income just being part of consolidated profit and loss and while the problem of farm income might not necessarily be solved, it would cease to exist. Oligopoly, instead of pure competition is a possible market structure. How long this structure could persist is questionable for all agricultural products.

Income Transfer

Through transfer payments the government could supplement farmers' income. Such income payments operate by the farmer receiving a payment which is the difference between what the market determined and a higher set price (subsidies for input purchases). Such payments do not interfere with disposal of products in the market but may have serious effects on production and input prices. If simple compensation is to be successful to effect income, the scale of the program will be enormous. Production will likely greatly increase and could be unbalanced. Income payments on set quantities of production, while foregoing the incentive of price to expand production, will permit farmers to attain sounder financial situation should they choose to expand. Against this should be noted that so long as there are too many farmers, transfer payments may not have meaningful long term effect in increasing income.

Non-Money Income Supplement. This approach requires the provision of social services such as health centres, hospital and recreational facilities in rural areas as a surrogate for income.

CANADIAN PROGRAMS AIMED AT DEALING WITH THE FARM INCOME PROBLEM

Since World War Two, programs used as instruments to maintain current nonfarm incomes were based on resource use efficiency, and the competitive market system and public intervention. These were called Modified Market System and Managed Market System, respectively.[26]

Programs Under the Modified Markets System

The Agricultural Prices Support Act of 1944 was designed "...for the support of prices of agricultural products during the transition from war to peace."[27]

Moreover, the Price Support Board in prescribing prices was required to ensure adequate and stable returns for agriculture and to maintain as secure as possible a fair relationship between the returns from agriculture and those from other occupations. It was clear that level and

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[26] C. Gibson, op.cit. p. 7.

[27] G.E. Britnell and V.C. Fowke, Canadian Agriculture in War and Peace, 1935-50. Food Research Institute. Stanford University Press, 1962. p. 86.

stability of income were prime concerns.[28] The operational strategies of the Board were:

a) to purchase product at low prices and dispose or sell when market prices were high, and

b) to make direct payments to producers (deficiency payments) where the amount of payment was the difference between the prevailing price and a designated support price.

In 1958, the Federal Government incorporated the Agricultural Stabilization Act which included the price support concept of the Agricultural Prices Support Act of 1944, and gave the additional responsibility of price stabilization to a Price Support Board. This Act emphasized the belief that price support and stabilization will automatically resolve the income problem.[29] It should be noted that the objectives of programs under both the Modified Market System and Managed Market System were those of stable and adequate levels of income but the means of achievement differed.

Under the modified market system the mechanisms of direct price support and deficiency prices operated.

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[28] Gilson, op.cit.

[29] R.W. Crown and E.O. Heady, Policy Integration in Canadian Agriculture. The Iowa University Press, Ames, Iowa 1972. p. 17.

Direct Price Support. A single set of prices is used to pay farmers and to distribute the products to the consumers. The designated level of support is obtained by government purchases of products in the market place. When prices rise above the designated support price, government may resell or dispose in export markets. The cost of this system (transfer of income to farmer) comes from higher prices paid by consumers. If the government loses money in the transaction the general taxpayer contributes also. Experience has shown that substantial losses are incurred by government from purchase and storage of surplus product and consequently production and marketing restrictions ensue.

Deficiency Price Payments. Here two sets of prices are operative, the competitive market price for the consumer and the designated price for the farmer. If the designated price support level is set too high giving rise to increases in government payments to farmers, the government is forced to limit payments to farmers or enact quotas or other production control.

Programs Under The Managed Market System

Programs in this category involved some form of central marketing control. Marketing boards were entrusted to market the product(s) in an orderly fashion in order to stabilize and maintain incomes. Their means of action include product control - import quota, supply management, and administered pricing. Under this system farmers surrender some decision - making independence for higher incomes. The cost (transfer of income to the farmer) comes from the consumer. Eventually import quotas must be implemented to insure success of this approach. Supply control also requires almost total farmer paticipation to guarantee success.

A major body in Canada's marketing policy is the Canadian Wheat Board, which acts as a compulsory marketing Board - administering delivery and acreage quotas, is the sole purchaser and seller of wheat, oats and barley, sets administered (pooled) prices, administers subsidies and advances. In 1970, the Board administered the Canada Lower Inventories for Tomorrow (LIFT) Program enacted in order to withdraw acreage from production to reduce wheat surplus at the time.

The Agricultural Rehabilitation and Development Act (ARDA), passed in 1962 (later renamed Agricultural and Rural Development Act in 1966) and Fund For Regional Economic Development (FRED) were designed to increase income levels on smaller family farms by providing economic incentives for farm consolidation and upgrading efficient land management.

The Western Grain Stabilization Program effected in 1976 was based on joint participation of grain producers and the federal government. It was designed to stabilize incomes of western grain farmers by protecting them against sharp drops in cash flow.[30]

Other programs include the National Farm Product Marketing Act of 1972 and the Two-Price Wheat Program of 1972 and its revisions of 1973 and 1978. The latter, in essence, provides a floor price for wheat used in domestic production of bread and bakery products. All the above programs do not appear to have been successful in stabilizing income.[31]

CRITERIA OF AND MEASURING FARM INCOME

Performance criteria in farming are classified as liquidity, solvency, profitability and financial efficiency and activity.[32] Liquidity is concerned with the farm's ability to meet financial commitments when they arise. Solvency is concerned with the farm's ability to meet its long-run indebtedness. Profitability reflects the margins between total revenue and total costs. Efficiency measures the income generated per dollar of farm asset.

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[30] Western Grain Stabilization Administration, Western Grain Stabilization Handbook, Winnipeg, 1979. p. 1.

[31] Loyns, op.cit. p. 77.

[32] Lee et al. op.cit.

The liquidity performance criteria is represented by cash flow showing in effect the repayment ability of the farm business. Solvency is reflected by the net worth (equity capital), and profitability by the net farm income. Any of the above three criteria, net farm income, net worth and net cash flow are capable of reflecting farm income.[33]

DEFINITIONS AND MEASUREMENT OF FARM INCOME

(Net) Farm Income

Various types of income are involved when reference is made about farm income. Major types are:[34]

a) Realized cash income from sale of farm products and farm related proceeds as from custom hiring and government supplementary payments.

b) Income-in-kind resulting from the value of goods and services used at home and rental value of farm buildings.

c) Unrealized income represented by changes in inventory.

d) Unrealized capital gains resulting from annual appreciation of land,buildings and machinery.

e) Income from nonfarm sources. Much discussion surrounds the inclusion or exclusion of the various types in arriving at a measure of farm income.

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[33] J.P. Penson and D.J. Lins, Agricultural Finance, Prentice Hall, Inc., Englewood Cliffs, N.J. 1980. P. 23.

[34] Ibid.

Inclusion of rental value of farm buildings is not normally included as a source of income since the farmer need not declare it for tax purposes, yet it is included in the gross farm income measure.

Unrealized capital gains are not usually included as income, for while assets increase in value because of it, no income is forthcoming until the asset is sold. But, appreciation of asset increases the borrowing capacity of the farmer which is an infuential factor in the generated levels of income.

Consideration of capital gains on land and buildings is important as it represents a significant part of accumulated wealth and, indeed may be equivalent to farm income.[35] Farmers as owners of resources on which capital gains are accruing see their borrowing power and long term income rise. There is thus a case for including capital gains in measuring farm income and wealth.

Nonfarm income is treated differently by different authors. The inclusion of nonfarm income as a source of income apparently depends on whether the income measured is for the farm as an entity or for the farm family. Contributions of part-time farmers income to farm income is a very important factor and yet it is excluded from traditional net farm income measure.

[35] D.F. Kraft, "Comments On 1977 Outlook For Farm Income". Mimeographed paper, Department of Agricultural Economics, University of Manitoba, December, 1977.

It is difficult to understand this neglect in terms of welfare considerations which are the implications of comparative studies and a major consideration in all programs and policies enacted to deal with low and variable income concerns. A larger number of part-time farmers obtain security by off-farm income and the numbers continue to increase, forming a major proportion of the sector's producers.[36]

There are essentially three net income measures relevant to the farm business; net cash income, net operating income and net farm income. Net cash income is obtained by deducting farm cash expenses, excluding purchases and sales of capital assets, from cash receipts during a specific period of time. This value is sometimes used as an indicator of the annual net cash flow.[37] The difference between gross income and operating expenses is referred to as net operating income.

Net operating income differs from net cash income in the sense that the latter includes all cash receipts and all cash expenses during the referred period addressed by the income account, whereas net operating income addresses the difference between gross income and operating expenses.[38]

Net farm income is the residual between net operating income and fixed costs. It represents the income accruing to labour of the operator and his family, management and equity capital. Net farm income is the most useful, and more accurately represents the true return of the farm for the period under scrutiny. More importantly, net farm income reflects the amount of revenue retained that is availble for family living expenses, income taxes, savings and to meet principal payments on debt.[37] Fixed

[36] G.A. Ball, "The Changing Structure of Agricultural Production in Canada: An Eastern Perspective" in E.W. Tyrchniewicz (ed). Financing Agricultural in The Next Decade. Proceedings of the 1981 CAES workshop held at The University of Manitoba, Winnipeg, June 24 and 25, 1981. pp. 19-20.

[37] Lee, op.cit. p. 155

costs refer to those costs incurred regardless of production. They include interest on borrowed capital, property taxes, depreciation charges and farm insurance.

Statistics Canada indicator of farm income is net farm income derived by summing total cash receipts, income-in-kind, and value of changes in inventory, and deducting estimates of total operating costs and depreciation charges.[38] It is, as previously indicated, a residual measure of returns to the farmer and farm family capital, labour and management. This definition is only useful in addressing the farm as a unit but not the income of the farm operator. A difficulty arising is how can one translate an income measure related to an inanimate entity to one related to the farmer in discussing the farm problem? Programs designed to resolve the farm income problem are related to the farmers income, the farmers' welfare and wealth by comparison with their counterparts in other sectors of the economy.

It is obvious that net per farmer income is better suited for purposes of income comparisons and for designing appropriate programs to deal with farm income. In this case, all incomes accruing to the farmer are germane. Included are farm family income including that part retained by the farmer, paid family labour, and all nonfarm income

[38] Statistics Canada. Farm Net Income. Cat. No. 13-201. Queen's Printer Ottawa. 1980.

including non-farm investments. These data, while available, are not officially published and rarely used.

Other problems of measurements are related to the fact that when data are converted to average net income per farm, they are based on farm numbers which are only estimates in non-census years. Also, regional and product characteristics of farm income are hidden. Loyns[39] observed that during 1970-78, variations in farm income originated mainly in grains and oilseeds, and that since 1970 only the Prairies have not shown real growth in income. Moreover, the Prairies displayed the greatest variation in farm income because of its dependence on grains and oilseeds.

Farmer's Net Worth

The net worth is a residual measure defined as total assets less total liabilities. It is sometimes used as a measure of farm income when wealth and welfare considerations are implied. Land appreciation then automatically enter the measurement. Competitive pressures to increase size of their operations compelled some farmers to 'force save' during their career. In essence, these farmers, forego current consumption for current saving to invest in their farm. This forced saving and inflation of land prices caused some farmers to accumulate large amounts of net worth

[39] Loyns, op.cit. pp. 68-70.

relative to their low annual net income. Younger farmers tend to disregard foregoing consumption for savings and instead consume more, utilize larger amounts of credits and take more risk in order to gain ownership of their farms. Farmers net worth may be a bona fide measure criterion of farm income.[40] In considering net worth it is important to specify whether the value is on a cost basis or current value as the latter will be significantly greater than the former.

Changes in net worth during a year can arise because of gifts, retained earnings, and capital gains and losses. The act of borrowing does not reduce net worth nor do repayment of loans increases net worth.[41] Net worth shows the owner's claims of the farm assets. Net worth changes between years when expressed as a percentage of net worth at the beginning of a given year measures the rate of growth of the farm. Net worth serves as an indicator of the farm business financial status as of a certain date, whereas net income and net cash flow are more like moving pictures showing happenings over time.[42]

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[40] G. Ball, op.cit. p. 19.

[41] Penson and Lins, op.cit. pp. 20-21.

[42] Lee et al. op.cit. pp. 138-139.

Net Cash Flow

This term is a business measure or summary of all financial activities undertaken in the business during a specified period. It includes all cash inflows related to the farm and all cash outflows incurred for operating expenses, capital expenditures, income taxes and other finances. Net cash flow is the stream of cash that the farmer can withdraw or reinvest in the farm operation. Cash flow differs from profits or income, and changes in income can occur without any corresponding changes in cash flow.[43]

A complete cash flow statement includes nonfarm incomes and living expenses and presents a thorough accounting of debt transactions by showing amounts of principal payments and proceeds of new loans while income shows only interest payments. Income contains changes in inventory while cash flow contains sales and purchases as they occur with no adjustments for inventory changes.[44]

Financing terms can influence profitability of investments and modify patterns of cash flow. Depreciation is not included as a part of cash flow. It has been shown that a high net farm income may still cause slowness in meeting financial accounts, and that whereas examination of net income will not clarify the situation, cash flow analysis

[43] Barry, et al. p. 268.

[44] Lee, et al. p. 168.

will resolve the issue.[45]

Cash flow is critical for planning based on past performance and serves as an evaluator of loan needs and repayment capacity of the farm business. Net farm income does not always provide a good picture of the farm's debt servicing capacity.[46]

It should be observed that annual cash flows neglect seasonal variations so that a farm business can show a positive net cash flow for an entire year, but at certain times during the year uses are greater than sources and short term credit and cash reserves are used to smooth out fluctuations.[47]

The Western Grain Stabilization Administration observes that "net cash flow from the sale of grain in any calendar year will reflect what is happening to producers incomes".[48] Thus, although the three criteria of performance, net farm income, net worth and net cash flow provide information on different financial dimensions of the farm business, they are interrelated concepts and all capable of providing

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[45] Ibid. p. 168.

[46] Ibid. p. 169.

[47] Ibid. p. 172.

[48] Western Grain Stabilization Administration, Western Grain Stabilization Handbook. Western Grain Stabilization Administration, 935-303 Main Street, Winnipeg, March, 1979. p. 3.

measures of performance of the farm business.[49]

SELECTED CRITICAL FACTORS INFUENCING PERFORMANCE MEASURES

Very many factors influence farm income and others to varying degree affect the levels of net farm income, net worth and net cash flow, the three criteria of performance discussed earlier. A list of these factors will include prices of commodity, yields and acreage of crops, weather uncertainty and the world economic situation. This study is only concerned with capital and credit, land tenure arrangement and rate of return for land under different tenure arrangement as factors deemed to be most basic in understanding the behaviour of the criteria variables. This section will briefly discuss these factors as they relate to the farm business.

Capital and Credit

The increasing importance of capital as a factor of production in agriculture and on the levels of income, net worth and net cash flow cannot be overemphasized. It is the result of high inflation and interest rates, partly due to marketing boards and government programs, and partly to a new willingness by farmers to assume risk and to speculate.[50] Canadian farmers are rapidly substituting capital

[49] Lee et al. p. 181.

for labour. The major capital items in agriculture are real estate, machinery and livestock. In 1971, total value of farm capital was $24.0 billion, and was 137 percent higher in 1976 with a value of $57.1 billion. The value in 1981 was $115.5 billion with a projection for 1986 of $235 billion.[51] Higher prices and structural changes such as larger-sized farms and technology are contributors to this higher value. As producers increase their farm income objectives, economics of scale demand fewer and larger farms. Increased production is accompanied by increased capital instead of increased labour. Future levels of income will be influenced by the use, availability and investment of capital in agriculture.[52] Total average value of capital on grain farms in Canada was $480,000.[53]

In the area of finance, increasing price inflation, use of purchased inputs and capital, and higher levels of indebtedness have increased finance requirements from $4.9 billion in 1971 to $21.8 billion in 1981. Approximately 50 percent of yearly agricultural cash needs derive from credit.[54]

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[50] G. Ball, op.cit. p. 7.

[51] Jones and Perkins, op.cit. p. 50.

[52] Ibid. p. 53.

[53] Ibid. p. 57.

[54] Agriculture Canada Canada's Agri-Food System - An Overview. Information Services, Agriculture Canada, Ottawa. 1981. p. 18.

Credit serves as a source of funds to acquire assets and as credit in reserve that is, unused credit or credit reserves are usually derived from land appreciation and potential borrowing capacity. About $9.8 billion of farm credit was extended in 1979 and a total outstanding indebtedness of $15.1 billion.[55] Although a variety of sources are available, the Farm Credit Corporation is the major source oflong term loans which have increased rapidly due to rising prices and increasing interest rates with borrowers demanding longer repayment periods.[56]

Credit is a major means of acquiring resource, serving as a building block when used wisely, but very destructive when uncontrolled.[57] Moreover, the combination of decreasing sales, inflation and interest rates causes severe financial (capital and credit) problems for farmers resulting in decreasing income and loss of income and bankruptcies. In 1981, there were 222 farm bankruptcies.[58]

It is quite clear that large amounts of capital and credit are required for viable farming operations. Greater emphasis needs to be placed on credit management if successful use of credit is to be achieved. Farmers must

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[55] Ibid.

[56] Ibid.

[57] G. Ball, op.cit. p. 22.

[58] M. Doyle, "Farmer gets More Help But The Trend is Ominous". <u>Financial Post Toronto</u>, May 30, 1981.

ensure that repayment schedules are adjusted to the debt servicing capacity of the farm. Normally, this is achieved by limiting the total farm indebtednss and by maintaining a proper balance between short-term, medium-term and long-term indebtedness in the farm business.[59] That is, careful attention needs to be placed on debt structure.

A farmer may carry more short term debt than his farm finances permit on the optimistic prognostication that price and productivity will be high. The lender requiring payment as early as possible causes unrealistic short repayment terms for medium term and long term assets such as machinery and land which were acquired with short term funds. This imbalance will have adverse effects on net income, net cash flow and net worth. The debt structure relationship, thus affect the debt servicing capacity of the business and have significant impacts on the performance criteria.

The successful farmer should operate under the principle that credit used to acquire assets should be repayable on the basis of type of assets acquired. Credit for short-term uses should be repayable on a short-term basis, that for medium-term asset acquisition should be repayable on a medium-term basis and credit used to acquire long-term assets should be repayable on a long-term basis.[60]

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[59] Lee, et al. op.cit. p. 191.

[60] Ibid.

Using short-term credit to acquire medium-term or long-term assets will result in difficulties as the farmer tries to generate cash flow from their use since those assets are normally acquired on the assumption that they generate a future stream of income. Therefore, the result of the above situation will be severe liquidity and repayment problems culminating in declining income and farm failure.

Improper use of too much short-term debt necessitates the transfer of short-term assets to medium-term assets and to long-term assets without restructuring the liability side of the balance sheet. This situation is common during expansion phases of farming and may only be detected by the short-term lender checking the farmer's cash flow to ascertain the farmer's ability to repay.[61]

Farmland Use Control Arrangement

Successful agricultural production will demand that the farmer acquire control of the use of these resources in sufficient quantities to ensure efficient crop production.

In the past, primary entry into farming was by the worker -tenant-tenant/owner-owner route. But this method of entry is rapidly disappearing due to the large capital requirements needed to generate a viable owner-operated business. The average value of production asset per farm in

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[61] Penson and Lins, op.cit. p. 191.

the United States of America has grown from about $40,000 in 1960 to about $250,000 in 1970. The average value of production asset per census farm in Canada was $200,000 in 1976. In 1981, this value averaged $518,000, from a minimum average of $284,000 in Quebec to a high of $806,000 in British Columbia.[62] Such a situation poses tremendous problems for potential entrants to farming. One of the hypotheses of this study is that the resolution of the farm income problem will be affected by how completely and rapidly a shift from resource ownership per se to the acquisition of control of use of resources take place. This section looks at alternate methods of control of the use of land.

<u>The Problem of Land.</u> Land is the most important agricultural resource. Certain of its properties such as practically infinite life, immobility and relative fixity in supply convey a high degree of uniqueness to land. While its supply is strictly limited and inflexible, land is the object of competing and growing demands except in areas where agricultural activities may be declining. The demand from agricultural sources is growing because of the continuous increased need for land in the process of structural change which agriculture is undergoing.

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[62] Farm Credit Corporation. <u>Preliminary Analysis of Farm Credit Corporation Survey of Canadian Farmers</u>, presented at Canadian Bankers Association Agricultural Credit Conference, London, Ontario, October 25-28, 1981.

The marginal value of extra land for a farmer wishing to expand may be considerable and may justify a high price. At the same time such a price level may be out of reach for a farmer wishing to purchase a whole farm.[63] Additionally, external influences such as urbanization, industrialization, recreation and nature protection exert growing pressures on land price causing the market price of land to diverge from its value in agricultural production.

The supply of land is broadly fixed. Therefore, its value is determined primarily by the demand for it. In economic analysis it is assumed that in the long run the price of land will tend to correspond to the capitalized net value of the annual return that can be obtained from it in agricultural use. This assumption implies that external influences are insignificant. However, in reality land price will be influenced by the following:

i) physical characteristics such as soil and climate,

ii) technical factors determining yield, and

iii) economic factors influencing the profitability of farming and profitability of the type of product that can be produced.

The greatest financial problems for farmers arise in connection with land purchase. Farmers are therefore, under tremendous pressures to evaluate alternate ways of control-

[63] OECD, op.cit., pp. 10-11.

ling the use of land.

Methods of Acquiring Control of Land. An increase in the farmland acreage under the control of a farm operator is essential for the expansion of production under almost all types of farming. Economics demand that farmers expand their size of operation in order to grow and remain viable.

The traditional means by which farmers acquire resources revolved around the individual's ability to save, on his retained earnings, on gifts and inheritances received, and on the pooling of equity capital among individuals. Today, a high equity base is required by lenders so that acquisition through the individual's saving or retained earnings are almost impossible. The length of time that it will take a farmer to have enough equity saved, or retained as earnings is simply too long. Inflation and technological change continue to drive up the capital required and so escalate the problem. The pooling of equity, when possible, has the advantage of economies of scale and distribution of risks. Partnership arrangements and the formation of corporations are the more common ways of pooling equity.

Alternatives to Control use of Land. The use of land resource may be controlled in the following alternative ways:

1. Leasing

2. Contracting

3. Purchasing

4. Merging

The method of control will vary among individuals and for an individual will be affected by his age and the stage in the life cycle of the operation. The value of any alternative to the operator will depend on the level of indebtedness of the farm and the farm operating nature. Ultimately, the choice of alternative is influenced by the following factors.[64]

i) the market price of land,

ii) the terms of borrowing,

iii) the terms of leasing,

iv) the operator's opportunity cost of capital,

v) the operator's planning horizon,

vi) the income productivity of land, including the expected appreciation in land values,

vii) the future tax policies,

viii) merger alternatives and constraints, and

ix) the value of the land to the operator.

[64] P.J. Barry, J.A. Hopkin and C.B. Baker, Financial Management in Agriculture, The Interstate Printers and Publishers, Inc., Darville, Illinois, 1979, pp. 320-321.

Leasing. The formal legal document drawn up when land is to be controlled by leasing is the lease. The lease is a capital transfer agreement giving the lessee control over assets owned by the lessor for a specific period of time, for an agreed payment called rent.[65] Leasing is a common means of controlling additional land. Nearly half of all farming operation in the United States rely on renting to control the land base.[66]

Table 6 shows the change in percentage of farms and farmland operated by farmers in Manitoba. The percentage of all farms in Manitoba that have been fully and partly rented has remained relatively constant since 1951 at about 40 percent until 1976. Since 1976, there has been an increase of 5 percent to 1981. By contrast, the percentage of farmland operated by full tenants and part tenants has increased from about 38.2 percent in 1951 to 65.0 percent in 1981.

The major types of lease are the share lease and cash lease. The crop share lease is the most commonly used form of rental arrangement. Usually, the landlord provides the land and pays expenses related to the land such as taxes while the tenant provides the other inputs. The arrangement may include a sharing between the landlord and tenant of variable costs such as seeds, fertilizer and chemicals. The

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[65] W.F. Lee, M.D. Boehlje, A.G. Nelson and W.G. Murray, Agricultural Finance, Iowa State University Press, Ames, 1980, p. 90.

[66] Ibid.

TABLE 6

PERCENTAGE OF FARM AND FARMLAND OPERATED BY TENANTS, PART-OWNERS AND OWNERS FOR MANITOBA - 1951-1981

Year	Percentage of Farms Operated By			Percentage of Farmlands Operated By		
	Full Owner	Part Owner Part Tenant	Tenant	Full Owner	Part Owner Part Tenant	Tenant
1951	59.5	28.2	10.1	59.4	28.2	10.1
1956	56.5	32.2	9.0	56.4	32.2	9.0
1961	50.6	38.6	7.5	50.6	38.7	7.5
1966	65.8	27.9	5.9	50.2	41.8	4.9
1971	61.8	32.0	6.3	46.6	48.6	4.8
1981	54.6	37.7	7.8	35.0	57.4	7.6

Source: Calculated from Yearbook of Manitoba Agriculture, 1952-1982.

crops produced are shared on the agreed basis. In the case of the cash lease, the landlord provides the land and pays the land-related charges but does not participate in the crops produced. The tenant pays the agreed cash rent to the landlord as agreed.

Two modifications of the cash and share rents are available. The standing rent combines cash and share rents. It provides for a rental payment as a fixed measure of product in place of cash rent. The flexible rent provides for a basic rental either in the form of product or as cash. The rental is adjustable as prices and yields vary.

Leasing affords the tenant an opportunity to operate a larger and more efficient operation with a minimum of initial capital outlay and to add land by outright purchase as the farm succeeds. With lower annual cash flow, renters are able to use limited capital more effectively in combination with adequate machinery. Under the share lease arrangement, the tenant may benefit due to a reduction in his risk-bearing and from management assistance from the landlord. On the other hand, the tenant faces uncertainty of tenure, and possible inadequate accomodation for his family. Economically, rental arrangements may not contribute to the efficient combination of resources. In addition, while gains in land appreciation are brought about mainly by the tenant's resources, only the landlord reaps the benefits.

But, disadvantages arising from leasing may be overcome if both tenant and landlord sign a formal lease agreement where each participant receives an income in proportion to each person's contribution.[67]

Leasing and Economic Efficiency. The kind of lease and the conditions of the lease may affect the risks, resource allocation, financial growth and income distribution of the landlord and tenant. If the lease is based on a fixed fee, the farm developed may be of an optimum size smaller than that under a share lease because of the tenant's profit-maximizing behaviour.[68]

The tenant equates the marginal cost of the additional land to the constant cash rent in the case of the cash-rent lease. Under the share lease, the marginal cost is equated to the landlord's share. If economies of scale result and diminishing returns to scale occurs, the marginal cost will decrease. Under the cash lease, the tenant accepts all risks whereas with the share lease, all risks are shared between the tenant and the landlord. Maximum economic efficiency obtains with the share lease when both the landlord and tenant share the benefits of production in proportion to their contribution to the business and when

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[67] Lee, et. al, op.cit., pp. 92-93.

[68] E.O.. Heady, Economics of Agricultural Production and Resource Use, Prentice Hall, Inc., Engelwood Cliffs, New Jersey, 1952; Barry et. al, op.cit., pp.344-346.

all variable costs are shared by each in the same proportion as the output is shared.[69]

The costs of leasing are quite small by comparison with outright ownership of land. For the cash lease, the direct cost is the flat rent or cash cost per acre. If lease payments are tax deductible, the relevant costs will be the after-tax costs. For the share lease, the direct costs are the landlord's share of the variable cost. The indirect costs of leasing are intangible since they are represented by the degree of insecurity of the tenure arrangement and the adverse effect of leasing on the availability of credit.[70]

Contract Farming. This is another method by which a farmer may acquire control of the use of resources. Vertical coordination refers to the situation where suppliers, processors or distributors provide resources to the farming population under a producer contract. When two or more firms are merged together it is referred to as vertical integration. Open market arrangements exist when the farm is linked to farm input suppliers and processors or distributors. Contracting gives the farmer direct access to financing from the contracting firm and indirect access through lenders. Under this form of arrangement the farm

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[69] Barry, et. al, op.cit., p. 345.

[70] Ibid.

gives up some management control to the contracting businesses.[71]

Purchase. The purchase of land offers the farmer absolute ownership. The simplest method to control the use of land is to purchase by cash. But the capital outlay to purchase land is large thus generally precluding this form of acquisition. The most commonly used method of acquiring land is with a downpayment and mortgage loan. The acquisition of control of land through purchase usually requires the purchaser to borrow funds. Borrowing is therefore a means by which the farmer can acquire control of resources.

When the farmer is considering the purchase of land he should have the following information:[72]

i) the market price,

ii) the value of the land to himself,

iii) his financial constraints, that is, his cash, credit and debt servicing capacity.

Market Price[73] The market price of land may be obtained from a cursory survey of recent prices obtained for land of comparable quality. Another way of arriving at a market value is by use of the following capitalization formula:[74]

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[71] Lee, et. al., op.cit., pp. 96-98.

[72] Barry, et. al. op. cit., pp. 321.

[73] Ibid.

$$Vo = \frac{A}{i}$$

where Vo = the present value of land

A = projected income per acre

i = discount rate

This formula assumes that the income per acre from the use of land will be constant over an indefinite period. It is obvious that no such situation exists in the real world. Therefore, the value obtained by this method is adjusted for any special qualities such as accessibility to markets, transportation, etc.

Value of Land to the Farmer. The farmer is required to view the property as an investment project in terms of his particular circumstance of taxes, projected net income and financial commitments. The undertaking of a land purchase decision is difficult, partly because the farmer is commiting a large amount of money which will not give him rewards for some time in the future. Moreover, if the farmer's maximum bid price does not meet the seller's expected price, he may loose the opportunity to acquire this tract of land, well aware that additional new land may not be available for sometime in the future.

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[74] Ibid., p. 244.

The determination of the maximum bid price that the farmer can pay is an essential step in the decision to acquire control of the use of land by either outright purchase or rental-purchase option. Several methods are available for determining the bid price.[75] All methods are expansion of the commonly used income capitalization method mentioned earlier. Considerations are given explicitly to such factors as influences of planning horizon, opportunity cost of capital, interest rates, amortization plan, income taxes and capital gains.

Capital budgeting principle is used to evaluate the decision to purchase. If the present value of projected cash receipts is greater than the present value of cash outflow (NPV $\geqslant$ 0), the land may be purchased and vice versa. In effect, the criterion is that if the maximum bid price is greater than or equal to the asking price of the land, then the farmer may purchase it.

Debt Servicing Capacity. The determination of the debt servicing ability of the farmer's operation when the additional acreage is added is another essential step in the

[75] J.S. Plaxico and D.D. Klelke, "The Value of Unrealized Farmland Capital Gains," American Journal of Agricultural Economics, Vol. 61, No. 5, 1978, pp. 727-737, D. Harris and R. Nehring, "Impact of Farm Size on the Bidding Potential For Agricultural Land," American Journal of Agricultural Economics, Vol. 58, 1976. pp. 161-169, W.F. Lee, "A Capital Budgeting Model for Evaluating Farm Real Estate Purchases," Canadian Journal of Agric. Economics, Vol. 11, No. 3, June, 1976. pp. 1-10, Barry, et. al. op.cit., pp. 322-323.

decision to purchase land. The maximum debt which can be serviced from the farm finances depends on:

i) the amount of retained earnings,

ii) the fixed requirements for consumption, and other withdrawals from the retained income,

iii) the contractual rate of interest on borrowed money, and

iv) the amortization schedule.

If the debt servicing capacity of the operation is greater than the required debt to purchase the land, the land may be purchased, and vice versa.[76]

Rates of Return From Farmland (Productive Assets or Capital)

The rate of return on farmland as a fixed factor of production refers to the rate of return on capital invested in land. If the returns were as high as returns in other industries no income problem will exist. It was assumed that low returns for family labour and capital investment in commercial agriculture result from high level of aggregate output and excessive numbers of farmers. Therefore, the corollary that high rates of return wll help in resolving the farm income problem follows.

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[76] Barry, et. al. op.cit., pp. 333-336.

Rate of return belongs to the income to investment ratio group of ratios indicating the efficiency of capital employment on the farm. Rate of return on farmland is defined as the total gross cash income divided by the average total investment in land. The higher the rate of return the higher the net farm income, since net farm income is calculated by deducting interest paid on farm indebtedness from the gross margin. Gross margin is obtained by deducting farm cash operating expenses and landlord share from gross farm income.

Average rates of return from a one-third share agreement for Manitoba for 1970 was calculated by Kraft.[78] Assuming that average annual conditions for such variables as yields, prices, rotations and expenditures held, he found that in 1971, the rental rate of return was 3.04 percent of the purchase price and rose to between 8.9 percent and 10.8 percent between 1973-75. The increased levels were considered as aberrations resulting from more rapid increases in price of grain than that of land.

Since 1976, rental rates appeared to have returned to more normal levels ranging from 3.63 percent to 5.12 percent, and averaging 4.26 percent of purchase price. Rental rates relative to current market prices rose rapidly

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[78] D.F. Kraft, "Ownership or Leasing of Farmland" in R.M.A. Loyns andT.L. Reynolds (eds) Farm Management and Marketing For Agricultural Lenders. Department of Agric. Econ. Univ. Man. 1981. pp. 71-92.

when compared with initial purchase price. Rental rate increases for the 1970's were great than rates of return on government bonds with fixed coupon for future periods.[79]

Increases in share rent result directly from price increases for grain which though displaying yearly variability have risen faster than costs of farm operations. Rates of return for cash renting showed similar patterns to share rent, the result of increasing cash flows by tenants willing to pay more rent.[80]

Farmland obtains a relatively low cash returns during the initial years of ownership but displays a strong potential for growth when product prices accelerate faster than operating costs.[81]

Appreciated value of farmland contributes significantly to its rate of return. Farmland purchased during the 1960's increased by an annual value of between 8-10 percent by 1989 while land purchased during the 1970's increased by between 11-15 percent by 1979.[82]

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[79] Ibid p. 71.

[80] Ibid.

[81] Ibid.

[82] Ibid.

[83] V.J. Fields and D.F. Kraft. "The Influence of Grain Freight Rates On The Farmland Market In The Praise

Recent studies[83] showed that farmland markets in the Prairies are strongly associated with changes in net cash returns to land and management. A 10 percent increase in net cash returns generates a 1 percent increase in land prices in the following year, eventually rising to a 10 percent increase if higher incomes are maintained in subsequent years.

Nominal rates of return on farmland investments comprise rental and capital gains (losses). For Manitoba, values in the 1970's ranged between 15-22 percent per annum. Purchasing land permits the farmer to capture capital gains. If the land appreciates sufficiently, higher net worth results. Thus, purchase of farmland is expected to generate high return in the form of appreciation and result in higher net worth than renting. During the 1970's, rate of land appreciation averaged 14.2 percent in Manitoba.[84] Lower interest rates will lower cost of ownership and lower rate of inflation needed to show gains in net worth.

Provinces." <u>The Logistics and Transportation Review</u>, Vol. 17, No. 1, 1981, pp. 45-32.

[84] D.F. Kraft, op.cit. p. 81.

A SELECTED REVIEW OF PROBLEM-RELATED STUDIES

This section reviews some previous empirical research work that are relevant to the conceptualization of the model and to the direction this research pursues. It does this, wherever possible by:

i) categorizing the studies on the basis of the empirical techniques used,

ii) emphasizing the distinct features of the models, and/or by pointing out any improvement over earlier models, and

iii) noting the limitations of the models.

It was emphasized earlier that while the thesis is not intended to study farm growth per se, the growth of the farm is a necessary process over its planning horizon in order to generate income, and therefore, to study impacts of variables and decisions on farm income.

Consequently, the studies reviewed are generally growth-oriented, and specifically relevant for their contribution of valuable theoretical and conceptual knowledge towards the formulation of the simulation model used in this research.

The original literature review was undertaken with the hope of finding a suitable model, which could be directly adaptable to the problem under study. After perusal of the literature, none was found with all the desirable features.

MULTI-PERIOD LINEAR PROGRAMMING MODELS

One of the first multi-period models was developed by Swanson.[85] The objective in this study was to maximize the discounted present value of the net revenue over a planning period of five years. The size of the activity in each year established the minimum size for the subsequent year.

Loftsgard and Heady[86] developed a multi-period model which was to become the precursor of the later poly-period models. The objective was similar to that of the Swanson model. Optimal plans were developed subject to fixed resources, consumption withdrawal, and cost allowances. This model improved on the Swanson model by allowing the transfer of net income to the pool of operating capital available for the next year.

Both the Swanson model, and the Loftsgard-Heady model were criticized because of the following limitations: (1) they did not allow for investment in durable inputs, and were, therefore, short run models, (2) they ignored external sources of capital, (3) they only permitted a fixed amount of consumption expenditure, (4) they assumed only a specific

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[85] E.R. Swanson, "Integrating Crop and Livestock Activities in Farm Management Activity Analysis," Journal of Farm Economics, Vol. 37, No. 5. December, 1955, pp. 1249-1258.

[86] L.D. Loftsgard and E.O. Heady, "Application of Dynamic Programming Models for Optimum Farm and Home Plans," Journal of Farm Economics, Vol. 41, February, 1959, pp. 51-67.

objective goal, and (5) they neglected taxes, risk and uncertainty.

Subsequent models attempted to remedy the shortcomings of the earlier models. One of these was the model developed by Irwin and Baker.[87] They investigated the financing of alternative annual production activities through the use of external capital. Even though the model ignored investment in durable assets, it was an improvement on the earlier models. It allowed for the intra-year transfer of finances and incorporated some details of the capital market.

Later models permitted investment alternatives as an attempt to portray the long-run characteristics of farm growth. Barr and Plaxico[88] developed a model capable of simultaneous determination of optimum plans for cattle and range improvement practices. The objective of the model was to maximize the present value of net income over the planning period. Capital accumulation and alternative investments were allowed.

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[87] G.D. Irwin and C.B. Baker, Effects of Lender Decisions of Farm Financial Planning. Illinois Agricultural Experimental Station Bulletin No. 688, November, 1962.

[88] A.L. Barr and James Plaxico, Optimum Cattle Systems and Range Improvement Practices for Northwestern Oklahoma: Dynamic and Static Analysis. Oklahoma Agricultural Experimental Station, Miscellaneous Bulletin No. 62, July, 1961.

[89] S.R. Johnson, A Multi-Period Stochastic Model of Firm

Johnson[89] developed a stochastic poly-period model. The problem under study was the influence on growth of the firm of the initial asset position of the farm, the variability of yields and the consumption patterns. This model was important because it incorporated risk into the multi-period analysis framework.

Martin and Plaxico[90] constructed a poly-period model to investigate farm growth and capital accumulation of farms. Among the distinctive features of this model were: (1) the incorporation of investment in durable assets, (2) the inclusion of capital borrowing from external sources, (3) the inclusion of a consumption function, and (4) the provision for the operating capital requirements of the productive activities. The model represented the production process by one composite production activity. This had the effect of simplifying the production process as the growth of the farm was viewed as a scale relationship. It implied that all the production activities in the composite plan grew proportionately.

Growth, Economics of Firm Growth. Great Plains Agricultural Council Publication No. 29, South Dakota Experimental Station, Bulletin No. 541. June, 1967. pp.83-134.

[90] J.R. Martin and J.S. Plaxico, Polyperiod Analysis of Growth and Capital Accumulation of Farms in the Rolling Plains of Oklahoma and Texas, USDA Technical Bulletin 381, September, 1967.

[91] M.D. Boehlje and T.K. White, "A Production-Investment

Boehlje and White[91] re-introduced activity choice alternatives into multi-period programming framework. While the model did not incorporate stochastic elements, it attempted to incorporate yearly production and investment over ten time periods. They investigated the impact of varying the availability of resources and different optimizing criteria of farm firm growth. The model permitted the selection of product to produce, technique of production and investment alternatives. Four submatrices were included in the model: (1) production and annual inputs, (2) investment to deal with the flow of funds and the interconversion of financial assets to fixed facilities, (3) credit to deal with long and intermediate-term borrowing, payment of interest and principal, and (4) division of income between consumption and investment.

Mitchell[92] developed a model to analyse net farm income goal attainment in Crop District Number 10 in Manitoba. The model allowed the possibility of interaction between production, financial, withdrawal and transfer activities. The model did not include stochastic elements, but included consideration of income tax which had been neglected in some earlier models.

Decision Model of Farm Firm Growth," American Journal of Agricultural Economics, August, 1969, pp. 546-563.

[92] R. Mitchell, "A Multi-period Linear Programming Analysis of Net Farm Income Goal Attainment In Manitoba Crop District Number 10." Unpublished M.Sc. Thesis, University of Manitoba, 1972.

Pemberton[93] incorporated survey methodology and decision models into the multiperiod programming framework. The purpose of this study was to test the hypothesis that high income farmers were motivated more towards monetary goals and have higher levels of aspiration than do low income farmers. The model incorporated a representative pattern of goal orientation and levels of aspiration of farmers. The analysis was over a period of twenty years. The results showed that the economic attainment of the representative high income farmer was always significantly higher than that of the low income farmer.

Framingham et al[94] developed a linear programming model of the agricultural industry. The model constraints were land, extent of output expansion and contraction and provincial product demand. It was distinct from previous models by the explicit incorporation of alternate income and employment constraints. The model maximized net farm income. The results of the study were that:

(i) when production adjustment was allowed on the bases of economic prices, losses occurred on most of the small and medium sized farms but that the largest farms normally

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[93] Pemberton, op.cit.

[94] C. F. Framingham, L.B.B. Baker and W.J. Craddock, Farm Income, Employment and Manitoba Agriculture: A Linear Programming Approach to Consideration of Policy Alternatives. Vol. 1.1 Research Bulletin 78-1, Department of Agricultural Economics, University of Manitoba, October, 1978.

earned profits.

(ii) when income constraints were specified, income obtained by medium sized farms increased as required by the income constraint.

Ahmad[95] modified the Framingham model by incorporating the survival approach to arrive at an efficient size of farm. The model was used to determine the optimal organization of crop production in Manitoba. Optimal organization implied maximized net income. The result indicated that net income resulting from optimal organization was 50 percent higher than the actual net income and suggested an adjustment of farms towards optimal size. More recent applications include the use of multiperiod risk programming to investigate lenders responses to farm income risks,[96] the use of polyperiod programming to analyze business growth for young farmers[97] and the use of programming to study long run income earning ability of traditional dry land farming systems.[98]

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[95] B. Ahmad, "A Model to Determine the Impact of Improved Agricultural Efficiency in Manitoba," Unpublished Ph.D. Thesis, University of Manitoba, October, 1978.

[96] L. Sanint, "Lenders Risk Response to Farm Income Risks in Texas: A Multiperiod Risk-Programming Analysis of Credit Reserves," Unpublished Ph.D. Thesis, Texas A & M University, 1980.

[97] J.O. Adedeji, "Use of Polyperiod Programming Techniques in Analysing Farm Business Growth For Young Farmers: An Ex Ante Approach," Unpublished Ph.D. Thesis, University of Kentucky, 1977.

Donald[99] used linear programming to determine the combination of farm enterprises and off-farm employment that would maximize farm income. The results showed that relative income levels in the maximum income potential alternatives for similar size farm differed very little but there was large differences in the relative income levels between small size farms and the larger size farms.

RECURSIVE PROGRAMMING MODELS

Day,[100] Schallar and Dean,[101] and Schaller[102] were among the first to apply this technique. These models were applied to problems that were defined on an area basis. Therefore, the included restrictions were of an aggregate regional nature. Flexibility constraints were placed on the rate of availability of new profitable technology, and the rate of exit of labour from the agricultural sector. Upper

[98] E.W. Crawford, "A Programming Simulation Study of Constraints Affecting the Long-Run Income-Earning Ability of Traditional Dryland Farming Systems in Northern Nigeria," Unpublished Ph.D. Thesis, Cornell University, 1980.

[99] S.L. Donald, "An Economic Analysis of Small Farms in Selected Areas of Louisiana," Unpublished Ph.D. Thesis, The Louisiana State University and Agricultural and Mechanical College, Louisiana, 1979.

[100] Day, op.cit.

[101] N.W. Schaller and W.G. Dean, Predicting Regional Crop Production, USDA Technical Bulletin 1329, April, 1965.

[102] N.W. Schaller, "A National Model of Agricultural Production Response," Agricultural Economics Research, Vol. XX, No. 2, April, 1966, pp. 33-46.

and lower bounds were also placed on other exogenous factors.

Heidhues[103] constructed a recursive programming model to study farm adjustments resulting from alternative EEC policies in northern Germany. The model incorporated the following features: (1) a detailed treatment of finances, (2) fixed assets dealing with investment and disinvestments, (3) trends and time lags in technology, (4) price variations, and (5) provision for a rising standard of living. Equations were developed to deal with capital stocks and capital flows. These assured that: (1) cash flow was adequate to meet current commitments, (2) fixed obligations, such as debt, were met, and (3) income was allocated between withdrawal for consumption and investment.

SIMULATION MODELS

Researchers at Purdue University have been the leaders in constructing and applying simulators to farm growth problems.

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[103] T. Heidhues, "A Recursive Programming Model of Farm Growth in Northern Germany," Journal of Farm Economics, Vol. 48 (3), Part 1, August, 1966, pp. 668-684.

[104] L.M. Eisgruber, Farm Operation Simulator and Farm Management Decision Exercise, Research Progress Report 162, Purdue University, February, 1965.

Eisgruber[104] constructed a simulation model of a farm operation to analyze the effects of annual farm plans and land buying decisions on the accumulation of net worth. The yearly input variables included crop acreage, levels of fertilization, types and numbers of livestock, and land purchase decisions. The decisions in the model depended on the type of land use. Stochastic price and yield values were incorporated into the model.

Patrick and Eisgruber[105] constructed a simulation model to study the farm planning process under a multiple goal situation. This model was developed from Eisgruber's model; however, the stochastic element was omitted. Many of the concepts enshrined in the behavioral theory of the firm are predominant in this model.

The decisions within the model were based on: (1) several family goals, (2) the farmer's expectations in terms of yield and prices, and (3) a consumption function dependent on the size of the family, income level, and the age of the farm operator. Among the basic input information were: (1) the interest rate, (2) the initial resource base, (3) managerial ability, and (4) loan limits. Two worthy features of this model were: (1) the recognition of the influence of household and farm goals, farmer's expecta-

[105] G.F. Patrick and L.M. Eisgruber, "The impact of Management Ability and Capital Structure on Growth of the Farm Firm," American Journal of Agricultural Economics, Vol. 50, No. 3, August 1968, pp. 491-506.

tions, resource base and technical expertise on management ability and the decision making process, and (3) the recognition of the dynamic aspect of the decision making process.

Harshbarger[106] re-introduced stochastic variations into the Patrick model. He added land procurement and machinery expansion as alternatives in the model. The objective in that study was to find out what extent of farm growth could be expected in a risky and dynamic environment, under alternative management policies.

Lins[107] built a simulation model which stressed financial strategies. The main difference between this model and previous ones was that the stochastic mode was used only to investigate the effects of selected strategies on farm financial arrangements. A limitation of the study was the failure to replicate the growth process to get a distribution of outcomes.

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[106] Harsbarger, op.cit.

[107] D.A. Lins, "An Empirical Comparison of Simulation and Recursive Linear Programming Firm Growth Models," Agricultural Economics Research, Vol. 21, January, 1969, pp. 7-12.

[108] D. Bostwick, Partitioning Financial Returns: An Application to the Growth of Farm Firms. USDA, ERS-390, Washington, D.C., 1969, pp. 662-665.

Bostwick[108] built a simulation model to study the growth of a farm producing small grains, forages and beef. The decision rules incorporated within the model included land purchase, investment, and credit decisions. The uniqueness of this model was that it was a non-computerized simulator.

LaDue[109] designed a model to be used primarily as a planning mechanism, to simulate the essential physical and financial characteristics of farm operation. The model may be used for either a dairy-crop farm, or for a crop farm with only those crops found on a dairy farm. The distinctive features of this model included: (1) a systems approach for management, (2) use of either a fiscal or calender year, (3) use of monthly time units, and (4) user defined systems which permitted the use of systems not specified in the model. The coefficients in the model were of two types: (1) those which must be submitted for each situation to be simulated, and (2) those which were assigned initial values by the model.

Kraenzle[110] constructed a dynamic and stochastic simulation model representative of the disinvestment and retirement stages of a dairy farmer. The objective of this

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[109] E.L. LaDue, "A Computerised Farm Business Simulator for Research and Farm Planning." Unpublished Ph.D. Thesis, Michigan State University, 1971.

[110] C.A. Kraenzle, "An Economic Evaluation of Decision Strategies in the Disinvestment and Retirement Stages of Farming." Unpublished Ph.D. Thesis, University of Connecticut, 1973.

study was to ascertain at what age a farmer can disinvest with enough net worth to support himself and/or his spouse through the retirement years. The model used time trend equations to interpolate the values of exogenous variables. The distinctive features of the model included: (1) two life expectancy functions, (2) a health function, (3) a social security function, and (4) an income tax function. The policy variables included five retirement strategies, three herd strategies and two disinvestment strategies.

Several other studies dealing with farm management problems have used simulation models. Generally, they incorporated varying aspects of those models discussed earlier; some are modifications and/or extensions of others.[111]

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[111] G.K. Flaskerud, "Firm Growth Simulation As a Farm Management and Credit Evaluation Device," Unpublished Ph.D. Thesis, Oklahoma State University, July 1970; A. Strickland, "Combining Simulation and Linear Programming in Studying Farm Firm Growth," Unpublished Ph.D. Thesis, Michigan State University, 1970; V.L. Harrison, "Management Strategies and Decision Processes for the Growth of Farm Firms," Unpublished Ph.D. Thesis, Purdue University, 1970; D.E. Umberger, "Factors Affecting Farm Growth Rates: A Simulation Analysis of Columbia Basin Irrigated Farms," Unpublished Ph.D. Thesis, Washington State University, 1972; B. Sonntag, "Simulated Near-Optimal Growth Paths for Hog-Corn Farms Under Alternative Resource Price and Efficiency Situation," Unpublished Ph.D. Thesis, Purdue University, 1971; G.D. Swab, "A Computerized Decision-Making Model for the Beef/Forage Enterprise," Unpublished Ph.D. Thesis, Purdue University, May 1974; A.E. Lines, "A Computerized Model for Planning the Growth and Organization of Swine Farms," Unpublished Ph.D. Thesis, Purdue University, 1973; R.E. Hatch, "Growth Potential and Survival Capability of Southern Plains Dryland Farms: A Simulation Analysis Incorporating Multiple Goal Decision-Making," Unpub-

SUMMARY

The purpose of this chapter was to provide a review of the nature of the farm income problem, including programs and policies designed to assist in resolution of the problem and problems of measuring income. The chapter identified alternative measures of performance of the farm business and presented the factors to be explored. The final section discussed empirical techniques that have been used in studying farm income related problems. Given the problem and objectives, this chapter highlighted the research area in order that the conceptual economic statistical and empirical framework for pursuing the study could be developed. The latter is the subject of Chapter III.

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lished Ph.D. Thesis, Oklahoma State University, July 1973; M.L. Hardin, "A Simulation Model for Analyzing Farm Capital Investment Alternatives," Unpublished Ph.D. Thesis, Oklahoma State University, 1978.

CHAPTER III

THE CONCEPTUAL ECONOMIC AND EMPIRICAL FRAME WORK

Several analytical approaches are candidates for pursuing the objectives of this study. Simulation approach was chosen as indicated in Chapter 1. This chapter will briefly present a conceptual view of approaching the study, state alternative approaches to pursuing the problem, discuss economic, empirical and other concepts relevant to the study, and present a discussion on simulation. The intent of this chapter is to provide the theoretical and empirical framework from and within which the study will be conducted.

THE AGRICULTURAL FIRM AS AN INTEGRATED SYSTEM

Much of the economic research generated by concerns of income lowness and instability has been in the area of comparative statistics. The relative levels of farm income were compared with those of non-farm income. Empirical research specially designed to investigate income behaviour are almost non-existent. At another level, farm firm growth studies have utilized one or other of net income, net worth or net cash flow as maximising criteria. The basic conceptual strategy used in this study is to view the farm as the vehicle for studying the low and variabie aspects of farm income. The farm is the unit experimented upon by simulation, factorial and statistical techniques as explained later in the thesis.

The agricultural firm is viewed as an integrated system comprised of components, entities and variables all working in unison, and in fact appearing as single unit. More will be said about this in the next chapter.

In order to develop the conceptual framework for this investigation, it was necessary to focus attention on the concept of a firm and the methodologies available for studying problems related to the firm. The conceptualization process therefore, embodied both theoretical and empirical considerations relevant to understand and describe the interrelationships involved in the following scenario.

A farm firm was perceived as an entity which was established, grew, was consolidated, survived, and finally sold or transferred to a beneficiary. All this was set within precepts of neoclassical economic theory. But, profit maximization and certainty of events and knowledge are two crucial dictates of that theory. In the real world economic events occur in an uncertain environment. Agriculture is subject to uncertainties of weather, biological phenomena, inflation, yields and interest rates. The growth of the organization takes place under both static and dynamic conditions. A proper perception of the farm dictates that dynamic aspects of growth, risk, and uncertainty considerations should be explicitly accounted for.

In order to deal with goals other than profit maximization, such as leisure and specific consumption levels, multidimensional utility considerations and behavioural characteristics are referenced. Capital investment theory helped in understanding the decisions to invest through the use of credit. The use of credit demands an understanding of financial management and analysis in order to ensure financial survival. Since the farmer uses large amounts of credit to finance the acquisition of control of the use of the land resource, theoretical considerations relevant to acquisition of resources are explained.

This chapter explores some of the theoretical and empirical concepts that are relevant to the development of the model. It discusses the following:

i) the firm and firm growth,

ii) the traditional theory of the firm,

iii) dynamic aspects of growth,

iv) uncertainty,

v) the behavioural theory of the firm,

vi) capital investment analysis, and

vii) systems theory.

FIRM AND FIRM GROWTH

A°firm may be defined as a technical unit which transforms inputs into output with the intention of making a profit. A common assumption in economic analysis is that the firm attempts to maximize its total profits.

The growth of the farm is an essential phenomenon in agriculture. Growth may be defined as the:

> increase in size or improvement in quality as a result of a process of development, akin to natural biological processes on which an interacting series of internal changes lead to increases in size accompanied by changes in the characteristics of the growing object.[112]

In this study growth connotes increase in acreage of farm, increase in net worth and increase in profits. The growth of the farm, therefore, may be due to the acquisition of new resources, to the improvement in the quality of current resources or to the increased value of current resources. As the farm grows, its profits will change, and this change will be reflected in the income status of the farm.

[112] E.T. Penrose, The Theory of the Growth of the Firm, John Wiley and Sons, Inc., New York, 1959, p. 1.

THE TRADITIONAL THEORY OF THE FIRM

The traditional theory of the firm had its origins in the writing of such classical economists as Ricardo, McCulloch, Jevons, Menger, Weiser, Bohm-Bawerk, Clarke and Marshall. Ricardo, while studying the distribution of income between the landlord and tenant, developed the concept of diminishing returns. The introduction of calculus to economics by Cournot paved the way for the entry of Jevons and Menger as founders of the marginal theory and the marginalist school.[113]

Marshall refined the marginal theory, related it to the 'Representative Firm' and played a significant role in developing the concept of marginal productivity as an extension of marginal utility.[114] Economists of the marginalist school were primarily concerned with the market system and how it acheived the goal of allocating its scarce resources among several ends. It was assumed that competitive pressures were necessary and sufficient to compel firms either to operate at maximum efficiency or to be forced out of business. A very serious omission on the part of the classical economists was that they neglected the value of product combinations and ignored the effect of

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[113] J. Oser, The Evaluation of Economic Thought, Harcourt, Brace and World, Inc., New York, 1973. Chs. 12-24.

[114] Ibid.

managerial ability on the competitiveness of the firm.[115]

The decision-making arena was broadened by the development of theories of monopolistic competition and product differentiation.[116] and monopoly, monopsony and price discrimination.[117]

Marshall's contribution to the theory of the firm was elaborated upon when it was shown that the supply curve of a firm depended not only on the output but on alternate types of technological and pecuniary cost situations.[118]

Though this theory has been the centrepiece of economic thought, controversy still surrounds the basic principles explaining the behaviour of the firm. It is believed that there is still concern as to what really constitutes the theory, what are its shortcomings and how to improve it.[119]

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[115] S. Cleland, Linear Programming and the Theory of the Firm, Macmillan, New York, 1960, pp. 202-207.

[116] E.H. Chamberlin, The Theory of Monopolistic Competition, Cambridge, Massachuesetts, Harvard University Press, 1933, pp. 198-232.

[117] Joan Robinson, The Economics of Imperfect Competition, Macmillan and Co., Ltd, London, 1933. pp. 47-82.

[118] J. Viner, "Cost Curves and Supply Curves" in American Economic Association Readings in Price Theory, eds. G. Stigler and K. Arrow, Richard D. Irwin, Inc., Chicago, Homewood, Illinois, 1952, pp. 198-232.

[119] R.M. Cyert and J.G. March, A Behavioural Theory of the Firm, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1963, p. 5.

The initial theories of the classical economists, together with subsequent refinements have been generally accepted, and play a strategic role in the theory of firm growth. While the traditional theory has been the basis of most microinvestigations in agricultural economics, it is criticized because of its inability to empirically test some of its fundamental premises. Thus, the traditional theory does not take full account of the uncertain real-life decision-making environment of the manager, nor of the inter-dependent relationships within the firm which operate to adjust its course of action.

Failure to recognize that the concepts embodied in the traditional theory are primarily relevant to resource allocation and price determination are probably the cause of some of the criticisms levelled at the theory. These criticisms of the theory of the firm should be understandable since it was constructed for the purpose of assisting in the theoretical investigations of one of the central problems of economic analysis.[120]

Only to the extent that the position of the agricultural firm approaches the assumptions enshrined in the theory, will it find relevance to the farm operation. If the farmer's major goal is profit maximization, the goal can be achieved by applying the necessary and sufficient conditions

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[120] Penrose, op.cit., p.11.

for profit maximization to all his investment and decision-making. But, because the farmer is confronted by asset and borrowing capacity constraints and may have other goals, his plans will have to fulfill the requirements of constrained profit maximization.

It follows, therefore, that if interest is not in the above concerns, the traditional theory of the firm cannot give answers. Other theories of the firm have to be applied. Further, the traditional theory is a static theory analyzing a 'time slice', a cross section of the system, and by so doing eliminating the passage of time in so far as the problem is concerned, but not necessarily completely ignoring the influence of time. If interest is in variables which change over time such as investment and structural changes, answers must be found in other theories or in modification of the traditional theory.

DYNAMIC ASPECTS OF GROWTH

J.R. Hicks[121] considers economic dynamics in terms of changes in a system. A dynamic model is one where outputs at different dates are different outputs and inputs at different dates are different inputs. This approach has been criticized for including under a dynamic system many problems which are static in nature. It has been alluded to

[121] J.R. Hicks, Value and Capital, Oxford Press, New York, 1939, p. 115.

as 'statics involving time'. R.F. Harrod[122] thinks of dynamics as dealing with systems involving continuous changes instead of a once-for-all change. It has been argued that the essentials of dynamic analysis is that of the process of change and not whether the system is stationary or not. The variables at different vintages should be involved in an essential way.[123] Baumol[124] views economic dynamics in terms of its predictive ability and particularly its ability to relate an event to preceding events. It is the study of economic phenomena in relation to preceding and succeeding events.

P.A. Samuelson[125] modifies Ragnar Frisch's idea by viewing a system as dynamic if its behaviour over time is determined by functional equations where variables at different points in time are involved in an essential way. Christ[126] perceives dynamics in terms of a theory which permits changes or explains changes in the endogenous

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[122] R.F. Harrod, Towards a Dynamic Economics, Macmillan and Co. Ltd., London, 1948, p. 15.

[123] Ragnar Frisch, "On the Notion of Equilibrium and Disequilibrium'" Review of Economic Studies, 1935-1936.

[124] W.J. Baumol, Economic Dynamics, The Macmillan Company, New York, 1952, p. 2.

[125] P.A. Samuelson, Foundations of Economic Analysis, Harvard University Press, Cambridge, Massachuesetts, 1974, p. 314.

[126] Carl F. Christ, Econometric Models and Methods, John Wiley and Sons Inc., New York, London, Sydney, 1968, p. 169.

variables of the system with continuous change, even though there are no changes in either the economic structure or the exogenous variables save for time.

The application of dynamic concepts is important to this study for in dealing with the firm the relationships between present and past events are important. The occurrences in the economic environment are important and functional equations either explicitly or implicitly describe the functional relationships involved in the farm operation.

GROWTH UNDER UNCERTAINTY

The traditional theory of the firm does not provide for the operation of a firm under uncertain situations. Under this theory the entrepreneur assumes that particular actions will result in determinate consequences which are objectively certain. But farm managers are aware that their estimations of future outcomes are not determinate and that they need to prepare contingencies for any potential decision. When no objective estimate can be formed on the basis of past information the situation is one of uncertainty. The farmer operates in persistently uncertain environment and uncertainty has to be included as an essential consideration. Entrepreneural estimations should include allowances for uncertainty of outcomes with respect to yields, prices, income, marketing, interest rates and general increases in price levels. Any analytical model of farm growth, of necessity, must include provisions for uncertainty.

Several elaborate theoretical frameworks involving choices and plans of actions have been developed for decision-makers confronted by uncertainty. Hicks[127] accommodated uncertainty by assuming that people's expectations about the future are precise. He recognized that these expectations may not be held with full certainty and not equate future prices on par with current prices. To circumvent this situation it is suggested that allowances should be made for risk. Hicks analysis assumes that there is a perfectly competitive market.

The distinction between risk and uncertainty follows the exposition of Knight.[128] Risk refers to phenomena where empirical evidence from a large number of cases in the past permits probability calculations for each of the several outcomes. Risk can be insured against and incorporated into costs. Uncertainty exists when no objective estimates can be formed on the basis of past occurrences. Parameters of the probability distribution cannot be empirically established. Expectations can, therefore, only be made on the basis of experience, intuition or guess estimates. The

[127] Hicks, op.cit., Parts 3 and 4.

[128] F.H. Knight, Risk, Uncertainty and Profit, Houghton Mifflin Co., Boston and New York, 1921, pp. 231-232.

subjective nature of expectations in an uncertain environment means that uncertainty cannot be reduced to a cost. Thus, unlike risk which has negligible effects on the decison-maker, uncertainty can have devastating effects.

One exposition of uncertainty is based on the principle of subtracting a risk premium corresponding to the degree of uncertainty before discounting. In order to determine the amount of money expected with certainty which the manager equates in value to uncertainty (certainty equivalent), it is assumed that a probability distribution is subjectively constructed. The certainty equivalent of the prospect can be determined by the mean, the dispersion and skewness of the distribution.[129]

Another framework assumes that the present satisfaction of anticipating future outcome of a decision is the more relevant consideration than the future outcome (profit or loss) itself. It further posits that the entrepreneur concentrates his attention exclusively on one particular gain and on one particular loss as the ideal representation of the possibilities of gain and loss respectively.[130]

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[129] A.G. Hart, Anticipation, Uncertainty and Dynamic Planning, Augustus M. Kelley, Inc., New York, 1951, pp. 51-74, G. Tinter, "The Theory of Choice Under Subjective Risk and Uncertainty", Econometrica, 1941 and G. Tinter, "The Pure Theory of Production Under Technological Risk and Uncertainty," Journal of Political Economy, Vol. L, No. 5, 1942, pp. 645-667.

[130] G.L.S. Shackle, Expectations in Economics, Cambridge University Press, Cambridge, England, 1949.

The perception of uncertainty by the farm manager and how he treats it will play a significant role in the growth and success of the farm.

BEHAVIOURAL THEORY OF THE FIRM

Simon[131] laid the foundation for the behavioural theory of the firm. It is assumed that not all human behaviour is rational and therefore do not all strive for profit maximization or maximum utility. The decision-maker strives for a 'satisfactory' group of solutions for his problems. When the levels of returns are unsatisfactory the manager seeks out alternatives and contrives to do so until an acceptable and 'satisfactory' level is found.

The theory includes the importance of a psychological hypothesis about the determination of the aspiration level of individuals. An individual, during the course of time, accumulates information on how he performs in specific endeavours, and sets goals for subsequent performances. If the goals are attained the expectations are high, if not attained, the expectations are low.[132] Behavioural considerations other than profit maximization may affect the goals of the individual such as the desire to conform to the

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[131] H.A. Simon, Models of Man, John Wiley and Sons, Inc., New York, 1957, p. 198.

[132] J.G. March and H.A. Simon, Organisations, John Wiley and Sons, New York, 1958, pp. 172-183.

behavioural pattern of one's associates, habit formation and the desire for security. The behaviour of the household is important in terms of decision making environment. When such factors are inserted into a decision making model, the manager may be 'satisficing' instead of profit maximizing.[133]

CAPITAL INVESTMENT ANALYSIS

Capital theory deals with the acquisition and utilization of durable inputs such as land, plant and equipment. The theory seeks to determine the most profitable point in time to acquire such inputs, how long to keep them in use before replacement, when and how to invest in their maintenance and repair and so on.[134]

Theories of investment are really techniques for choosing among investment projects. They have been developed because the traditional theory of the firm is a static short period theory. It does not provide ways for choosing investments which derive benefits over a future period of time. The theory had to be improved to facilitate investment choices over time. This section reviews some of the approaches to

[133] R. Ferber, "Implications of A Behavioural Theory of the Household for Production Economics," Production Economics in Agricultural Research, Proceedings of Conference held at the University of Illinois, A-E-4108, March 1966.

[134] W.J. Baumol, Economic Theory and Operations Analysis, Prentice Hall, New Jersey, 1965, p. 431.

investment analysis.

The Discounted Cash Flow Approach

This approach to capital investment decisions incorporated the time value of money, that is, a dollar held today is worth more than a dollar received sometime in the future since the present dollar can earn interest so that its value can grow. This is reflected in the existence of a bond market. If a farmer invests one dollar in bonds on a given marketing date at an interest rate of i, he will obtain $(1 + i)$ dollars on the second transaction date. One dollar to be paid on the second transaction date is the market equivalent of $(1 + i)^{-1} = 1/(1+i)$ dollars paid on the first dollar. $(1 + i)^{-1}$ is the discount rate to be paid on the second transaction date. A discount rate can be determined for amounts to be paid at any future date. The present value or discounted value (PV) of a sum,(SN) invested at a specific interest rate(i) available at some specific time, (N years) in the future is given by $PV = SN(1 + i)^{-N}$ Present values allow an economically useful comparison of alternate income and outlay streams.[135]

[135] J.M. Henderson and R.E. Quandt, Microeconomic Theory - A Mathematical Approach, McGraw Hill Co. Ltd. 1971, pp. 292-297.

Definitions

Cash Flow. This term refers to the whole series of net proceeds and net outlays associated with an investment. The net outlays are the total outflows of funds, whether owned or borrowed, required for the investment and which usually occurs at the beginning of the project. The net proceeds are the net cash return and usually occur in a stream either as a result of revenues increasing more than expenses, costs decreasing, or a combination of both. Depreciation and non cash expenses are omitted.[136]

The Present Value Criterion of Acceptance. This criterion accepts all independent investments having positive net present values and rejects those with a negative value. That investment giving the highest expected present value of cash flow at a given discount rate is implemented. If funds are unlimited, all investment alternatives with positive net present values are implemented.

The Yield of Investment or Internal Rate of Return. This criterion accepts those investments whose yields are greater than the minimum desired rate of return required

[136] H. Bierman, Jr., and S. Smidt, The Capital Budgeting Decision, The Macmillan Co., New York, 1960, p. 7.

by the investor. That investment alternative having the highest rate of return is implemented. If funds are unlimited, all investment alternatives with rates of return greater than the market rate (or some minimum rate set by management) are implemented.

The Yield of Investment Criterion of Acceptance. This term refers to that rate of interest making the present value of the cash proceeds expected from an investment equal to the present value of the cash outlays required by the investment. It is the rate which makes the present value of cash flow equal zero.[137]

The Net Present Value Method.

This method involves the following four steps:[138]

1. The determination of an appropriate discount rate which reflects management's minimum acceptable rate of return. This rate may be the borrowing rate or cost of capital, the opportunity cost or the subjective rate of time preference. This rate represents the 'cut-off criterion' in judging the desirability of an investment.

2. The computation of the present values of the net cash inflows expected to result from the investment. The present value of the net cash inflows discounted at the

[137] Ibid. p. 27.

[138] R.D.Aplin and G.L. Casler, Capital Investment Analysis, Grid, Inc., Columbus, Ohio, 1973, pp. 29-30.

firm's discount rate shows the maximum amount of money that the firm can afford to pay for the opportunity of making the investment without being financially worse off.

3. The calculation of the present value of cash outlays required to undertake the investment.

4. The determination of the net present value of the investment by deducting the present value of cash outlay from the present value of cash inflows.

The Yield of Investment Method

Here management seeks to find that rate of discount that will make the present value of cash inflows expected from a project equal to the present value of the cash outlays. This rate of discount is the yield of the investment.[139] The discount rate is found by a trial and error method. Firstly, a discount rate is arbitrarily chosen and the present value of cash flows is determined. If the present value of cash proceeds is greater than the present value of cash outlays choose a higher discount rate. If the present value of cash proceeds is less than the present value of cash outlays, choose a lower discount rate. The procedure continues until an appropriate rate is found where the present value of cash proceeds is equal to the present value of cash outlays.

[139] Bierman and Smidt, op.cit., p. 28.

<u>The Simple Rate of Return</u>

This approach expresses the net revenue added per year by the investment as a percentage of the investment. It is commonly computed by the following formula:[140]

$$R = \frac{E - D}{C}$$

where R = the average rate of return
E = the additional average annual after-tax earnings before depreciation, expected from the investment
D = the additional average annual depreciation
C = amount of capital required by the investment.

The manager chooses that investment alternative giving the highest rate of return. If funds are unlimited all projects with rates of return greater than the minimum 'cut-off' rate will be implemented.

<u>The Payback Period</u>

This approach estimates the length of time it will take the investment to pay off itself out of the returns generated. The payback period is determined by the formula: formula:[141]

$$P = C/E$$

where P = the payback period expressed in number of periods
C = the total capital outlay for the investment

[140] Aplin and Casler, op.cit., p. 8.

[141] Aplin and Casler, op.cit., p. 6.

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

The manager selects those projects having payback periods less than the cut-off period set by the manager. If funds are unlimited, all investments having payback period less than the cut-off period will be undertaken.

SYSTEMS THEORY

Systems theory had its early beginnings when it was recognized that the answers to certain problems required an interdisciplinary approach to research. Ackoff, notes:

> In the last two decades we have witnessed the emergence of the 'system' as a key concept in scientific research. Systems, of course, have been studied for centuries, but something new has been added ... The tendency to study systems as an entity rather than as a conglomeration of parts is consistent with the tendency in contemporary science no longer to isolate phenomena in narrowly confined contexts, but rather to open interaction for examination and to examine larger and larger slices of nature.[142]

The use of systems approach reflects a shift from the commonly used analytical solution. It implied that because of the increasing complexities involved in various jobs, isolated solutions were inappropriate. Rather, a holistic approach was assumed to be more worthy.

The underlying rational behind the systems approach:

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[142] P.P. Schoderbet, Management Systems, John Wiley and Sons, Inc., New York, 1971, p. 1.

> is a perspective of the organization as a conglomerate of interrelated and interdependent parts. No one of the parts can perform effectively without others, and any action taken on (or by) one will have effects which can be traced throughout the organization and throughout the complex environment in which the organization exists.[143]

Boulding[144] sees the systems framework for viewing organizations as a dynamic one, recognizing that the interaction of all parts is required to produce the desired effects. The underlying assumptions behind a general systems theory are based on the quest for orderliness.

The farm operation is an organization. It possesses componets whose interrelationships and interdependences are crucial for its viability. There is, indeed, a holistic approach to studying farm growth and income. For example, the farmer does not breakdown the operation into its components, and then study each part in isolation; instead he views the whole organization as an interrelated and interdependent entity. Other characteristics of a system, such as goal seeking, inputs and outputs and the transformation of inputs into outputs, are integral characteristics of the farm.

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[143] D.I. Cleland and W.R. King, Management: A Systems Approach, McGraw Hill Book Co. Inc., New York, 1972, p. 142.

[144] K. Boulding, "General Systems As a Point of View" in Mihajlo D. Misarovic ed. Views on General Systems Theory, John Wiley and sons, Inc., 1964. pp. 25-38.

The discussion to this point discussed theoretically-related concepts considered important to conceptuative the model of the crop farm. As was noted earlier the crop farm is a business firm, operating in a dynamic, uncertain, financially dominated environment where resources are constrained, investment alternatives are examined and hard choices made. Moreover, the firm is an interrelated complex system of components. In order to achieve the methodological objective of this study, more than mere acquaintance with the topics discussed was necessary. They were integral to attaining that objective.

SIMULATION

The Meaning of Simulation

The term 'simulation' has been the source of much controversy due to the absence of a standardized definition. Sometimes, the term refers to "the assumption of the appearance of something without having its reality."[145] T. H. Naylor et al[146] defines simulation as a technique that involves setting up a model of a real situation (systems), and then performing experiments on the model.

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[145] H. Guetzkow, Simulation in Social Science, Prentice-Hall, Inc., Englewood Cliffs, N. J. 1963, pp. 1-2.

[146] T. H. Naylor, Computer Sumulation Experiments With Models of Economic Systems, John Wiley and Sons, Inc., New York 1971.

Probably the most complete definition is that proposed by Shubik.[147] He defines simulation of a system as:

> The operation of a model or simulator which is a representation of the system . . . The model is amenable to manipulation which would be impossible, too expensive, or impractical to perform on the entities it portrays. The operation of the model can be studied and, from it, properties concerning the behaviour of the actual system or its subsystems can be inferred.

In this study, the word simulation means a research technique. It conveys the methodology involved in the construction, and manipulation of an operative model; the model being both a symbolic and physical representation of the decision maker within his environment.

Use of Simulation

Simulation has been used in the past for investigating and learning about the behaviour patterns of both individual and group situations. In this respect it has been used for aircraft and other engineering designs, for the development of information, for teaching and training purposes.[148] At a further level of abstraction the economist has always tried to simulate the environment in which he made decisions. The graphical and methematical models used to study the impacts of decisions and changes in important variables may be

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[147] M. Shubik, Simulation of the Industry and the Firm, American Economic Review, Vol. 50, 1960.

[148] Guetzkow, op. cit., p. 5.

considered to be simulation.

The present use of simulation in scientific literature is directly related to the development of, and the rapidly increasing utilization of systems analysis, the greater used of a formal type of model, the increased employment of mathematical techniques and the development of and availability of high speed electronic computers.

Conway et al[149] noted that probably the oldest use has been for designing new systems and improving the design of old systems in engineering, as for example, in the simulation of air defense system. Simulation has also been used for teaching college students about the behaviour of complex social systems by having the students make decisions, handle data, and experience the consequences in the simulated systems, comparable to those occurring in the real system. Cohen et al[150] and Orcutt[151] have also used the technique as a training device where the trainees made decisions by participating in comparable decision in the simulated situation where "the trainee is able to get some feel of

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[149] R. W. Conway, B. M. Johnson and W. L. Maxwell, "Some Problems of Digital Systems Simulation," Management Science, Vol. 1, No. 1, 1959, p. 72.

[150] K. J. Cohen, et al, "The Carnegie Technical Management Game" in readings of Simulation in Social Science, ed. A. Guetzkow, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1962, pp. 104-123.

[151] G. H. Orcutt, "Simulation of Economic Systems", The American Economic Review, Vol. 50, No. 5, December 1960, P. 895.

what he would experience in the real situation and some indication of the likely outcome of various actions and responses on his part."

Several simulation techniques have been developed and used by researchers. Some of these are gaming, Monte Carlo technique, digital computer simulation, analog computer simulation, machine simulation and real-time simulation. The Monte Carlo and Opeational gaming methods are discussed in this section. There appears to be confusion as to the differentiation of the various techniques. It is this confusion that prompted the statement;

> It is difficult to agree on a common terminology for current gaming, however, because its antecedents suggest diverse usages. Traditional war-gaming, Monte Carlo computation, parlor games, and Von Neumann - Morgenstern theory of games all have contributed ideas and words. Beyond this historically inspired confusion, diverse local usages spring up at individual establishments to meet the needs of particular problems.[152]

The Monte Carlo Method

The name Monte Carlo is given to the technique of selecting numbers randomly from one or more probability distributions for use in a particular trial or run in a simulation study. Its purpose is to reproduce data in the same manner as would occur in a real life situation. The

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[152] C. J. Thomas and W. L. Deemer, Jr., "The Role of Operational Gaming in Operations Research", <u>Operations Research</u>, Vol. 1, 1957, P. 3.

Monte Carlo method in general, is used to solve problems which depend in some important way upon probability problems where experimentation is impracticable and the creation of the exact formula is impossible.[153]

Operational Gaming Method

Gaming refers to the utilization of a game model which allows human participants to serve as decision makers, acting within the system, and observing the performance of the model as a result of their actions. Usually the literature fails to distinguish between games and simulation, but they may be differentiated by the concept of play. A game model simulates a dynamic environment where human beings make decisions at various stages of the simulation and are primarily used for training. The serious use of games for determining optimal solutions for strategies and for determining optimal structures for systems is called operational gaming.[154]

Despite the versatility of the simulation technique, it is important to realize that the usefulness of the information provided by such a model, or indeed the validity of any

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[153] D. D. McCracken, "The Monte Carlo Method" Scientific American, Statistical Testing: Monte Carlo Method, Elsevier Publishing Company, Amsterdam, 1964, P. 1.

[154] J. W. Longsworth, "Management Games and the Teaching of Farm Management" Australian Journal of Agricultural Economics, Vol. 13, No. 1, June 1969. p. 61.

inference drawn from a simulation will depend on the ability of the model to completely duplicate an actual system. The model builder should consider it of primary importance to approach that actuality as closely as is humanly possible.

SIMULATION AND DECISION MAKING

The decision making process has been difficult to conceptualize in a traditional manner because of inadequate knowledge about many of the factors the decision maker considers. Decision making models have not adequately dealt with the importance of the learning-process, the restrictions on the manager to analyse information, predicting expectations and making evaluations on his business.[155]

The position of the firm at a given point in time and the directions it follows over time are functions of type of response and the ability of the manager to respond to the various factors making up the planning environment, to the resource base, and to the institutional policies promulgated by the managerial strategies used and the technical efficiency of resources. The outcome of any plan of action can be expected to differ from the expected outcome due to imperfect knowledge.

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[155] C. E. Harshbarger, The Effects of Alternative strategies Used in Decision-Making on Firm Growth, Unpublished Ph.D. Thesis, Purdue University, 1969, pp. 39-40.

Thus, the manager makes adjustment in his planning framework and may or may not engage in new courses of action. Hence, the behaviour of the firm really reflects the response of the decision maker to changes in the many factors which associate with management. Because of the several interrelated factors affecting the decision process, realistically there cannot be a universal approach to decision making, but the use of simulation technique is likely to produce the second best to a universal approach.

A simulation model permits decision making in countinuously changing environment characterized by a disequilibrium-type of growth. Risk and uncertainty are explicitly made very important in the decision making process. The farmers decision-making process is influenced by profit maximization together with goals of the farm family, technical skills, expectations and family involvement. Simulation models consider all these factors that interact to have some effect on the decision making process.

The importance of preceding and succeeding events as explanations of the process change should not be treated casually in firm growth theory.[156] Therefore, simulation models prescribe a potentially powerful approach in investigating the behaviour of the firm over time. It involves less abstraction than in the case of analytical

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[156] Baumol, op. cit., pp. 4-5.

models. Once the decision-process has been achieved, simulation generates many alternatives and chooses the best one. It permits the researcher to vary independent variables and to observe what the effects are on the outcome; it permits the researcher to describe a particular decision process by following through the effects of different inputs. The model is very flexible and allows for various concepts of management behaviour and decision in studying farm growth and the decision making process. It allows the researcher to study the effects of different goals on farm growth.

By simulating for a farm over a period of time one can determine effects on growth of price and yield variability, land acquisition policies, levels of equity required before additional land may be purchased, down-payment levels and goals of the firm. By using a simulation model a researcher is provided with much flexibility: decision rules can be altered; planning horizon may be changed; different expectations criteria may be used; the entire process may be updated to account for technology changes, new developments in government programs etc., or, the goal structure of the farmer can be altered.

Decision making is a continual process as man seeks to utilize all his resources and his reason in the effort to survive; farmers seek to attain goals one of which is the production of adequate food and clothing for society. The importance of decision making at the farm is reflected in the contribution of the farm sector to the GNP. And, yet the knowledge of decision making is incomplete. The crux of decision making is the process by which an individual evaluates alternatives and makes a choice.

Festinger[157] believes that to understand the decision-process requires knowledge of: (a) how will the individual behave in the decision situation, (b) his reaction after making the decision, and (c) the relation existing between prior-decision and post-decision behaviour. The use of simulation for teaching has not as yet been completely determined and needs greater study. There is a great need to develop ideas which could be useful to educational agencies dealing with farmers. Simulation will generate and supply information concerning growth, income potential and the types of decisions to be expected.

Simulation permits appraisal of farm programs. Good understanding of those forces which shape the future structure of the agricultural sector is invaluable for the formulation of income and price policies consistent with material well-being. The growing importance of the nonfarm sector in the voting and pricing mechanism indicates that

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[157] Leon Festinger, Conflict, Decision and Dissonance, Stanford University Press, Stanford, California, 1964, p. 2.

any future agricultural adjustments and policies should be viewed within the framework of the national economy as well as within the agricultural sector.

Simulation has been shown to be an effective method of teaching farm business analysis or farm business management to adult education classes. Its use has indicated improved decision skills more than other instructional methods. It is probably c apable of teaching skills other than knowledge of facts.

The onus in growth and farm management rests on the presence of a 'superior' manager capable of 'superior' decision making capabilities. Realistically, such an ideal is impossible but the use of a simulation model may be the second best way to approximate it. Such a model can be used to develop superior working managers since it allows the following:

i) the use of unlimited variables to generate decisions,

ii) the consequences of changes in actions with regard to decisions to be known immediaely,

iii) the actual behaviour of the manager and the firm to be simulated giving a more 'realistic' decision making environ,

iv) the 'superior' manager to handle the complexly-interrelated economic environment by his ability to make more complex decisions,

v) consideration of all variations in prices of inputs, series of products, institutional and equilibrium conditions in arriving at decisions, and

vi) decisions are not made in an isolation-type frame of reference.

Simulation models are usually nonoptimizing models in the sense that they do not guarantee an optimum outcome. However, by the incorporation of search routines they can find the optima. Simulation finds its greater relevance when the system studied is very complex in terms of interrelationships and when a great deal of flexibility is required. Specifically, situations involving the achievement of and evaluation of multiple goals, indivisibilities and lumpiness, sequential decisions using different decision rules and systems analysis are germane for the use of simulation.

THE RELATIONSHIP BETWEEN SIMULATION AND TRADITIONAL FIRM THEORY

Because simulation is normally a nonoptimizing technique and involves several goals its reconciliation with the theory of production developed is not clear cut. However, when it is considered that any solution beyond the production possibility frontier is infeasible given the state of the art, it is easily reconciled that the solution generated by simulation must be either within or on the possibility curve. Further, in this study the primary goal is the achievement of maximum net income which is also reflected in the maximization of net worth. Consequently, it can be expected that the theoretical and actual solution will be very close. What, then can be said at this stage of conceptualization about the solution generated by a simulation procedure? It is that the solution must lie on or within the transformation curve and the most profitable farmer is likely to be producing in close proximity to the optimal solution generated if profit maximization is the goal.

How can the concept of the output expansion path, that is growth, be reconciled with simulation? Following the previous thought process, it might be expected that the solution generated by simulation will be located at such a position within, or on the possibility curve germane to the relevant period of production, given the set of constraints on production. Similarly, there is no reason to expect the solution generated by the simulation model not to move outwards as conditions of production change. The net result of the increase in factor usage over the planning period will be a 'simulatory' expansion path. This expansion path will have the same connotation of the normal expansion path, and indeed may either coincide with it or lie in close proximity to it. The exact characteristics of the 'simulatory' expansion path will depend on the profitability of the farm business in association with the personal goals of the manager.

Should there be a significant divergence in the growth of the firm under the assumptions of traditional optimization theory from that under nonoptimizing simulation solutions?

Any production unit will minimize the cost of producing any given level of output at the economic efficient level of production, if the marginal physical product of a dollar's worth of one resource is equal to the marginal physical product of a dollar's worth of every other resource used. Given the resoruce supplies of the farm and the techniques of production available, the production transformation curve for any two products shows all possible combination of products that can be produced efficiently. Therefore, assuming that production is taking place within the technically efficient region, profit of the farm business will not be maximized only under the following conditions:

i) If the marginal physical product of a dollar worth of one resource is not equal to the marginal physical product of a dollar's worth of every other resource.

ii) If the marginal physical product of a dollar's worth of one resource is equal to the marginal physical product of a dollar's worth of every other resource but the point of tangency lies below the maximum point.

Solutions from simulation studies of the farm firm can be analyzed using these concepts.

MATHEMATICAL PROGRAMMING AND SIMULATION - A COMPARISON

Linear programming has had very wide applications. As a result, many standard packages are available for linear programming; therfore, cost of computer program time, is less than for simulation. Irwin[158] has pointed out that linear programming cannot deal with multiple and conflicting goals. Not only can simulation handle multiple goals, but it deals with sequential decisions during the planning horizon through different criteria.

Simulation can treat multiple goals in one of two ways. The decision rule within the model may be dependent on several variables, any of which may represent different goals. For example, the model may borrow to purchase a machine, if an additional 160 acres of land can be bought. But, the purchase of an additional 160 acres may depend on the goal of full ownership. The goals of life expectancy and land acquisition are both reflected.

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[158] G. D. Irwin, "A Comparative Review of Some Firm Growth Models," Agricultural Economics Research, Vol. 20, No. 3, July 1968, pp. 84-94.

Values of any number of variables are available. Therefore, the decision maker may use any number of variables in the interior function. Decision criteria of any kind may be used, and these need not be determined before a simulation run.

The greater advantage of simulatiobn is its flexibility. Since it takes on any structure depending on the specific problem, it can incorporate any amount of variables, decisions rules and interrelationships required to portray the problem realistically. In the case of mathematical programming, relationships must be linear. Recursive programming, when used over more than one period, may prevent the achievment of optimum long-run solution, by having attained short-run optimization in the earlier period. Multi-period programming, however, does not suffer this disadvantage.

There are, some disadvantages involved in the use of simulation. Among these are:

i) heavy cost of development of the problem in terms of computer logic,

ii) long time for a computer run,

iii) large core storage requirement,

iv) specification of heuristics, and

v) model evaluation and verification.

CHOICE OF SIMULATION TECHNIQUE

The preceding discussion led to the choice of simulation as an appropriate technique in terms of the purpose and objectives of this study.

Simulation allows the incorporation in the model of all the theoretical concepts discussed previously. The ability of the technique to permit specification of heuristics is important. Many decisions taken by the farmer are 'naive' and incorporate 'hunches' or heuristics.

In studying the farm business for the purpose of this thesis, it is required to incorporate any kind of relationship relevant to the farm and its environment. Simulation adquately permits this. By providing the opportunity for sequential decision criteria, by being able to incorporate the predominating non-linearities that abound on farms, by adquately allowing for indivisibilities in the decision variables, and by providing for the evaluation of actual farm-situation alternatives, simulation was selected as the most appropriate empirical technique.

SUMMARY

The purpose of this chapter was to isolate the theoretical concepts which provided input for understanding the behaviour of the agricultural firm, and empirical techniques for constructing the model as a representative of the firm. Neoclassical economic theory was the actual basic building block. The addition of behavioural theory concepts, risk and uncertainty, and dynamic aspects of growth assisted in setting the firm in real world perspective. Capital investment theory provided insights into credit management and portfolio control needed for firm survival and growth. Systems theory gave insights into the firm as a system with interdependent relationships, all of which act together to provide the desired effect.

Finally, the empirical technique of simulation used in the study was introduced and its choice as the model technique justified. The concepts discussed here form the framework from and within which the model of the farm is developed in Chapter IV.

CHAPTER IV

THE CONCEPTUAL MODEL

Previous chapters have collectively presented the problem, developed the bases from which the model is to be formulated, identified the central themes of resource control, financial management, and rates of return to fixed inputs, and briefly reviewed some pertinent literature.

This chapter discusses the conceptualized model. It identifies some fundamental characteristics of simulation models: its purpose, essentials in planning the model, and validation. The farm model is then presented in terms of its formulation, description, subsystems and variables.

PURPOSE OF SIMULATION

Simulation methodology is used for two major purposes:[159]

i) To predict the outcome of a system. As forecasters of behaviour, no consideration is given to the specific mechanisms and processes involved; no theoretical position is necessarily clarified.

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[159] R.S. Lehman, Computer Simulation and Modeling: An Introduction, Lawrence Erlbaum Associates, Publishers, Hillsdale, N. J. 1977, p. 13.

ii) To maximize the scientific benefit by expressing, testing and exploring relationships and consequences implied by theory. Here, primary interest is the advancement of theoretical understanding of the processes involved in a system.

The use of simulation in this study is both predictive and exploratory. The model also attempts to provide instructional benefits by demonstrating particular relationships between input variables and parameters and the outcome attained.

CONCEPTUALIZATION OF SIMULATION MODELS

An essential step in planning any simulation is the detailed specification of the conceptual process. A conceptual model is a concise, systematically organized statement of the process, including the specification of input, output, processes and subprocesses involved, the variables, parameters, and organization of the relevant data.[160]

A successful conceptual simulation model should possess three general criteria:[161]

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[160] Ibid. p. 28

[161] Ibid. pp. 224-244.

i) The process must be dynamic. Unlike symbolic models in which time is allowed to vary backward and forward, procedural or simulation models utilize time as a unidirectional forward characteristic. The execution of the model on a per segment basis, for example, on a per year basis, represents the dynamics of the system.

ii) The process must be a 'closed' one. All relevant input and variables must be completely specified.

iii) The process must be well specified.

Specification of the Model

A well specified simulation model consists of six vital elements; units, properties, inputs, processes, sequencing, and consequences. Units or components are the entities with which the model is concerned, and which are to be operated on by the process. Among these units are the economic factors, institutional parameters, pragmatic considerations, and goals of the farmer.

Properties are the sets of values and constants relevant to the units. They are the status, input and output variables. Inputs initiate the processes and may be control parameters, experimenter-specified or user-specified. They assist in developing patterns of behaviour of components. Output variables are generated by the components of the system. The status of a unit at any time is determined by its properties.

Processes are the actual working parts of the simulation. They comprise the functions, procedures and relationships in a model, serving to indicate how variables are related to units, to each other and how changes in variables are generated.

Decision-making is an integral part of the model, contributing significantly to the processing order. Sequencing involves the succession of processes and subprocesses in the execution of the simulation. Flowcharting effectively portrays the temporal sequencing of the system. Consequences are output of the system obtained either during processing or at the end of programming.

VALIDATION OF SIMULATION MODELS

Validation is one of the most difficult and critical aspects of simulation. It is the determination of how well the model reflects the real world situation it purports to represent. A validated model implies its adequacy especially with respect to the design objective. A distinction is usually made between validation and testing and verification. Testing refers to the testing of the program for errors, that is, debugging. Verification attests to the correct operation of the program.

No generally agreed procedure for validation exists because of the possibility of having multiple criteria and because validity depends on the purpose of the study.[162] The ability of a simulation model to generate testable hypotheses poses another problem for validation.[163]

Validation is related to the relationship between the output of the real and simulated systems, to credibility of the theory as a legitimate scientific statement, and to the theory's relationship to the model. Validation of a model may be accomplished in the following ways:[164]

i) Comparison of two outputs. A valid simulation gives output that is statistically the same as that obtained from the real world system using comparable data. Indistinguisability tests are the basis for comparing validity. These tests do not distinguish between outputs, and do not indicate whether the model can advance scientific understanding.

ii) Theoretical validity. The model is required to meet the normal requirements of the scientific method.

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[162] Ibid

[163] Ibid. pp. 230-231.

[164] Ibid.

iii) Validation of the model as a representative of theory.

Indistinguishability Tests

The accuracy of the theory's prediction is assessed by the degree of fit between the results of the simulation and the real world situation. If they are, the simulation passes the test and vice versa. Procedures adapted as tests are the Turing test, Turing-extension test, and 'known results' matching techniques.[165] Most researchers find the Turing-type tests highly cumbersome, and utilize 'known results' techniques. The procedure of matching known results involves establishing a series of experimental runs of the model and assessing the goodness of fit of the results.

Evaluating the 'matching' is done by a simple inspection of results, by side-by-side comparison of protocol output, and by statistical goodness of fit.

Multistage Procedure[165]

[165] Op.cit. Ibid.
165 T. H. Naylor, (ed), Computer Simulation Experiments With Models of Economic Systems, John Wiley and Sons, Inc., New York, 1971.

This validation procedure employs the phenomenae of rationalism, empiricism, and positive economics. The first stage describes the behaviour of the system as a set of postulates - the hypotheses. The second stage tests the validity of the hypotheses. But, these hypotheses may fail the scientific method requirement of falsification, and may either be abandoned or retained with no effect on the overall validation. The final stage assesess the ability of the model at predicting outcome of the system.

Maisel-Gnugnoli Procedure[166]

Validation is accomplished by observing to what extent the model meets its design objectives. It is assured in one of three ways as depicted in Figure 2.

i) by the use of expert reaction to the simulation (left-hand channel).

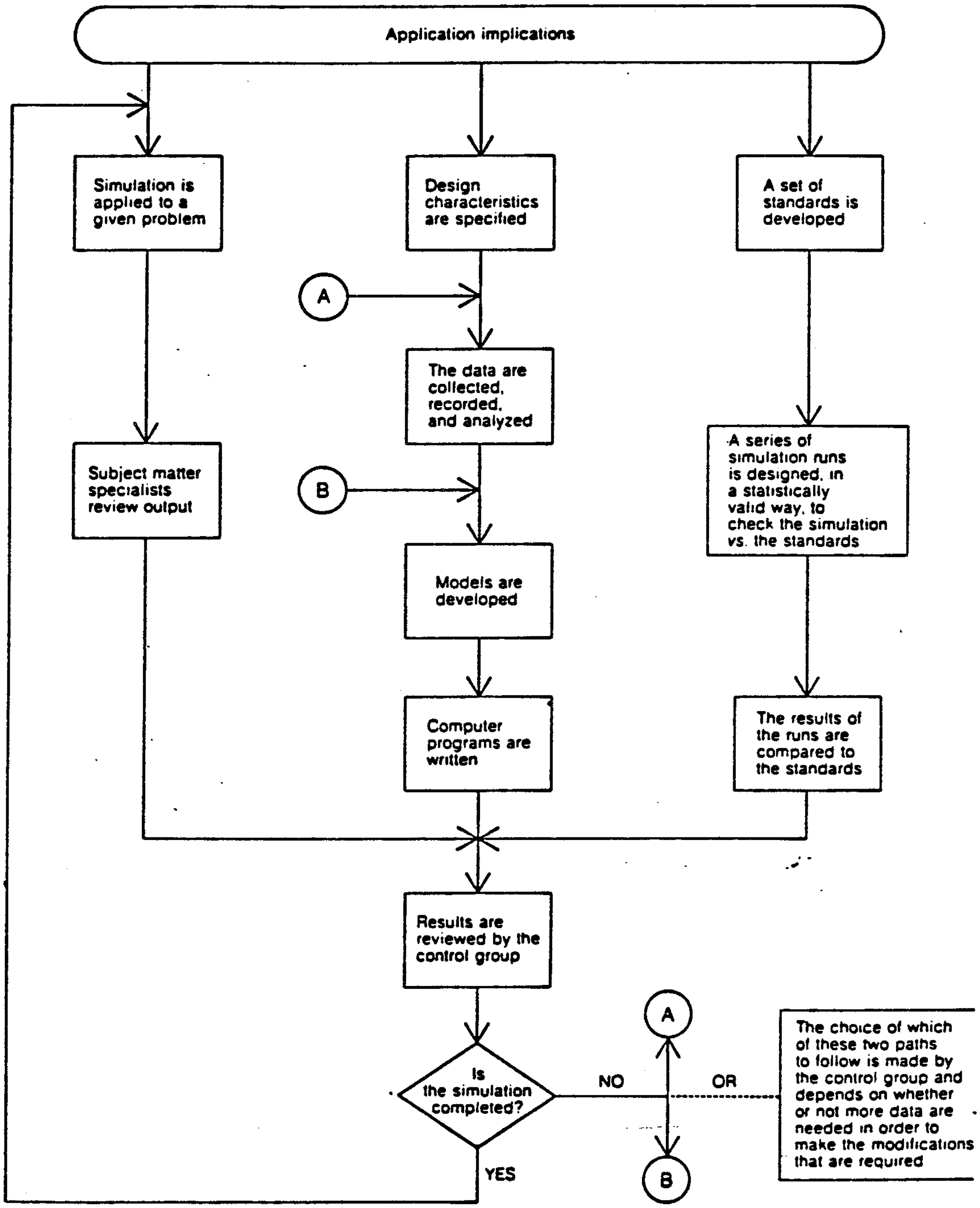
ii) by being built into the simulation model (central channel).

iii) by comparing results with set standards (right-hand channel).

If the results were statistically the same as real world results, if the theory stands the test of scientific methodology, and if the simulation program represents an

166 H. Maisel and G. Gnugnoli, Computer Simulation Descrete Stochastic System, Science Research Associates, Inc., Chicago, 1972, p. 33.

Figure 2: ESTABLISHING THE VALIDITY OF A COMPUTER SIMULATION



Source: H. Maisel and G. Gnugnoli, Simulation of Discrete Stochastic Systems, Science Research Associates, Inc., Chicago, 1972, p. 34.

application of the theory, then the model can contribute to scientific knowledge.

The validation procedure followed in this study involved assumptions of theoretical validity (generality, falsifiability, accuracy and simplicity); as a representation of the theory as shown by the documentation of the simulation program including the program logic and rationale; by reaction of experts to the model formulation, logic and subsystem results, and by matching results from the simulation subsystems and the complete system with historical real world results.

Validation Tests

The actual tests used for establishing validation were: Student's 't' test, Theil's Inequality Coefficient, Goodness of Fit and Root Mean Square Simulation Error.[167]

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[167] Details concerning these tests are available in the following texts:

D.V. Huntsberger and P. Billingsley, Elements of Statistical Inference, 4th ed. Allyn and Bacon, Inc. Massachusetts, 1977, pp. 219-232,
Henry Theil, Econometrics and Management Science, Management Science. Vol. 11, No. 10, June 1965, pp. B200-B212.,
G. Snedecor and W.G. Cochran. Statistical Methods. 6th ed. Iowa State University Press, Ames, Iowa, 1967. p. 549,
P.S. Pindyck & D.L. Rubinfeld. Econometric Models and Economic Forecasts. McGraw-Hill Book Company, Toronto, 1976, pp. 314-320.

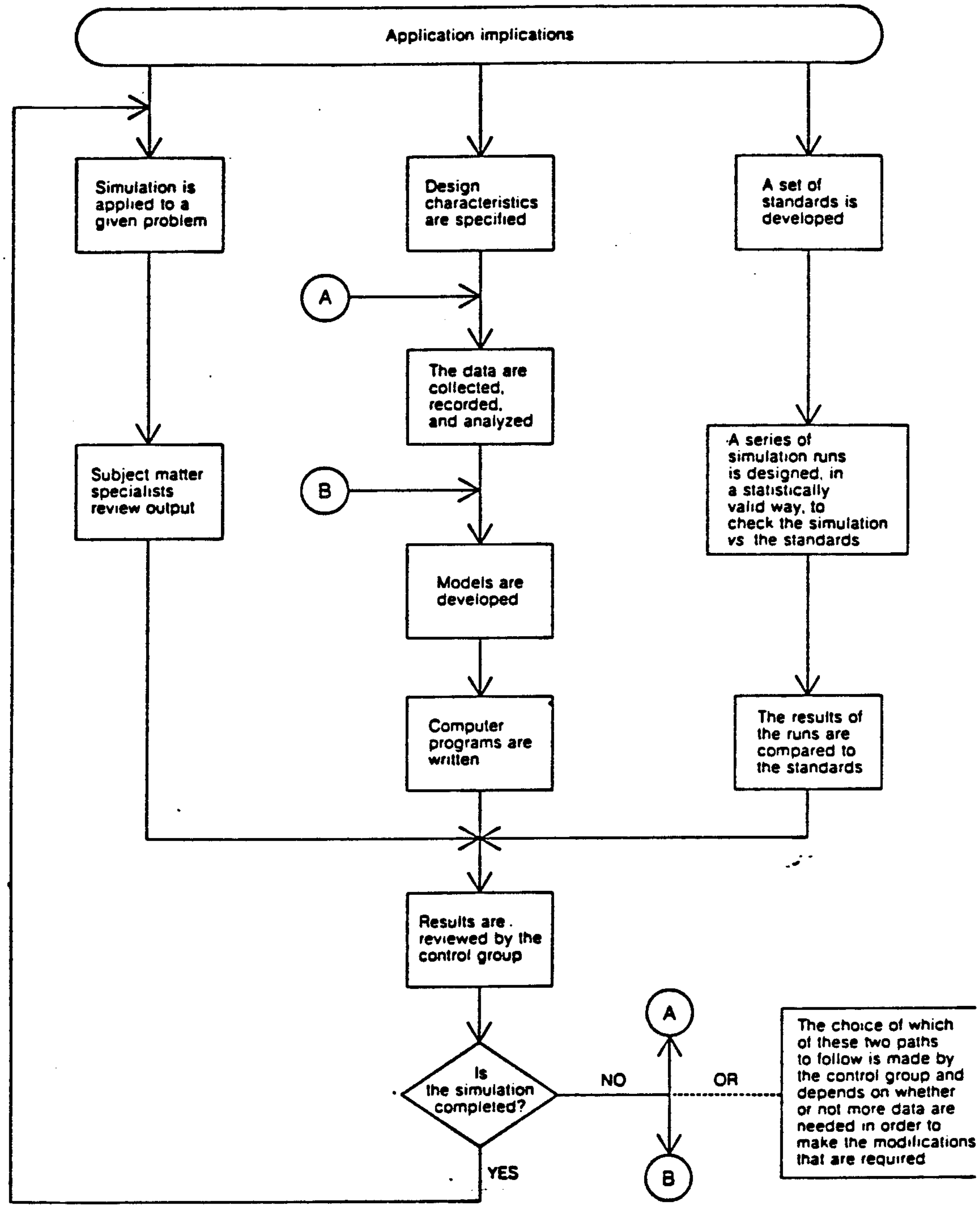
PRESENTATION OF THE MODEL

Figure 3 shows the general procedures used in the development and formulation of the model. The presentation of the problem in Chapter I provided the objective relationship with an indicator of performance by which alternative solutions to the problem could be evaluated. It is now required to identify all relevant variables, those whose behaviour and values affect the performance of the system; controllable, noncontrollable and parameters.

MODEL FORMULATION

In order to formulate the model detailed information about the system was required. This information should be adequate enough to provide a complete and concise representation of the state of the farm operation at any time regardless of what simulation run is being processed. The farm operation is a complex one warranting its representation in the form of subsystems. Conceptually, it involves the description of the dynamics of the system as viewed through photographic snapshots of the farm operation, at very small intervals of time throughout the time of operation, giving in effect, a continuously operating system with changes in state and processes, in all directions and even subject to conditional events.

Figure 3: FLOW CHART OF STEPS IN THE USE OF SIMULATION



Source: H. Maisel and G. Gnugnoli, Simulation of Discrete Stochastic Systems, Science Research Associates, Inc., Chicago, 1972, p. 34.

Such an accomplishment demands information about the detailed behaviour of the system from very many sources. These sources of information included research literature, other publications, news from communication media, discussions with knowledgeable people including professors, advisors, farm experts and farmers. Data are required to estimate parameters and variable values currently and in the future and to be used to validate the model.

The next step deals with the combinations of the components and subcomponents into the simulation model. This phase is facilitated procedurally by use of flowcharting. The flow chart indicates the logical rules with which information submitted as data are treated, and represents the sequencing aspect of a simulation.

Next, the logic of the flowchart is translated into a computer language and becomes the computer program. The computer model comprises the various subroutines representing the various events or processes operating in the perceived system. Subroutines are very important since they display the model builder's hypotheses about how the system operates.

The subroutines are independently debugged, verified, and tested for validity in output performance. When all subroutines are debugged, they are amalgamated into the complete program which is debugged, verified, and validated.

Subsequently, the model is run, statistical experiments are designed using the model as the experimental plot, output is generated, analysed and results established. Finally recommendations are made.

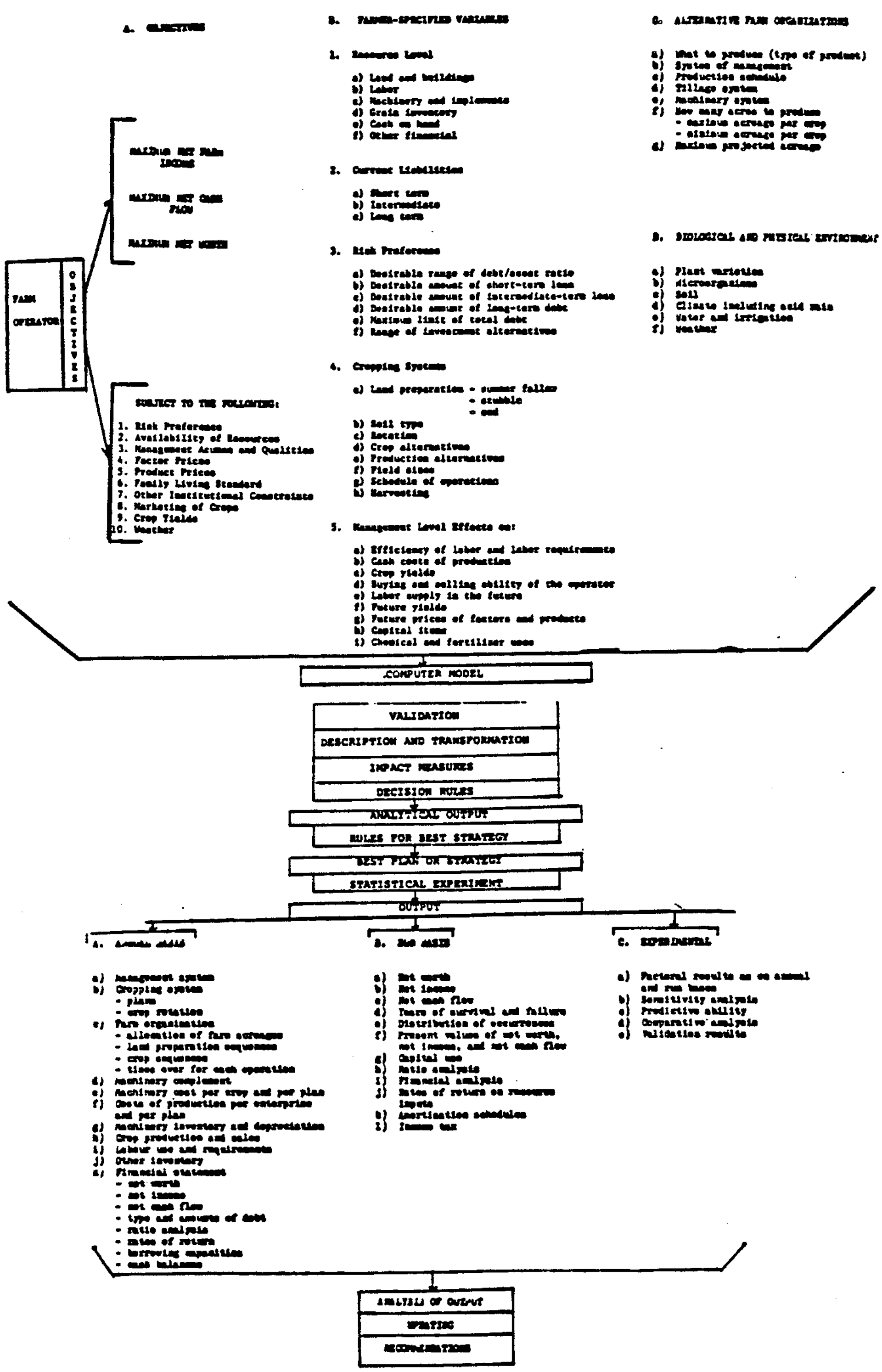
The objective in formulating the model is to be able to describe the state of the system every time changes within the system occur and to use the informations to deduce future output and future behaviour of the system.

DESIGN OF THE MODEL

The model is constructed to simulate the growth and operation of a crop farm producing wheat, oats, barley, rye, flaxseed, rapeseed, hay and forage seed in a dynamically uncertain decision-making environment. The principal goal is the maximization of farm net income, net worth, and net cash flow with secondary goals of meeting the specified consumption needs of the family and other restrictions.

Figure 4 displays the objective of the model components, the conditions, parameters and variables to be specified, the decisions made by the farm manager and/or the model, the information provided by the computer. The remainder of this chapter will discuss the essential characteristics of the farm firm involved in this study.

Figure 4: THE CROP FARM MODEL



THE COMPONENTS OF THE SIMULATION MODEL

Parametric Coefficients

The model uses two types of parameters. Type one parameters represent the particular situation being investigated. Among these are coefficients representing the initial situation of the operation under investigation and may include the type of farm, farm acres, acreage under crop, acreage under summerfallow, machinery complements, initial debt and financial situation, tenure status, and decision parameters such as number of years to be simulated and output tables required. The initial values of the parameters in this group may be submitted by the user.

The other type of parameters are given values by the computer model. The model does not allow the user to modify the values of these parameters which have been developed based on all available research work and written literature. While the model may be criticised for this rigidity, it is assumed that the data in this group are sufficient to encompass most possibilities. In addition to which it significantly reduces the core storage demands of the model, and therefore, the cost involved.

Operational Modes

The model operates both deterministically and stochastically. In the deterministic mode the user assumes that the values of all coefficients are exactly known. Use of the model in the stochastic mode recognizes the dynamic uncertainty prevailing in the economic environment. The values of the coefficients used are derived from random distributions of values to which subjective probability and confidence are attached. Subroutines PROBAB, GAUSS and RANDU (Appendix A) deal with the process of generating probability distributions and drawing random variates representing values of stochastic variables mentioned earlier in Chapter 1.

Goals of the Model

Economic theory assumes that man is a rational being capable of consistent rather than inconsistent ordering of preferences. This is done primarily for convenience in studying economic phenomena in an orderly pattern instead of the chaotic state that will exist if each individual's behavioural pattern was allowed to vary. The behaviour exhibited by individuals is oriented towards specific satisfactions or goals; their wants and their desires have been the nuclei of economic actions and decisions. In turn, the economy of any social unit is designed primarily to satisfy the demands of its members.

Generally speaking, Canadian agriculture and in particular Manitoba agriculture, is dominated by the owner-operator type of farm organization.[168] Consequently, one can identify the following primary goals:[169]

i) Increasing farm net income.

ii) Increasing and positive net cash flow.

iii) Increasing farm net worth.

iv) Meeting a certain basic family consumption level.

v) Reducing the debt of the farm business as reflected by farm equity.

Ancillary goals may include the desire to increase leisure time, to achieve a certain liquidity level at retirement age, to provide a certain level of education for the operator's children, and growth to a maximum acreage. It is to be noted that the goals are not only likely to be conflicting, or to be met simultaneously, but are to a great degree mutually inclusive. The farmer may find it very difficult to achieve an increase in earnings as well as to devote a greater number of hours to leisure; so too might be the conflict when he attempts to decrease risk and debt at the same time as increasing the farm net income. Because of occurrence of multiple conflicting goals, the process of

[168] See Table 6, page 105: 59.5% of all farms in Manitoba in 1976 were operated by full-owners and 33.8% were part-owner-part-tenant.

[169] These terms are defined in Chapter II and discussed at length in Chapter VII.

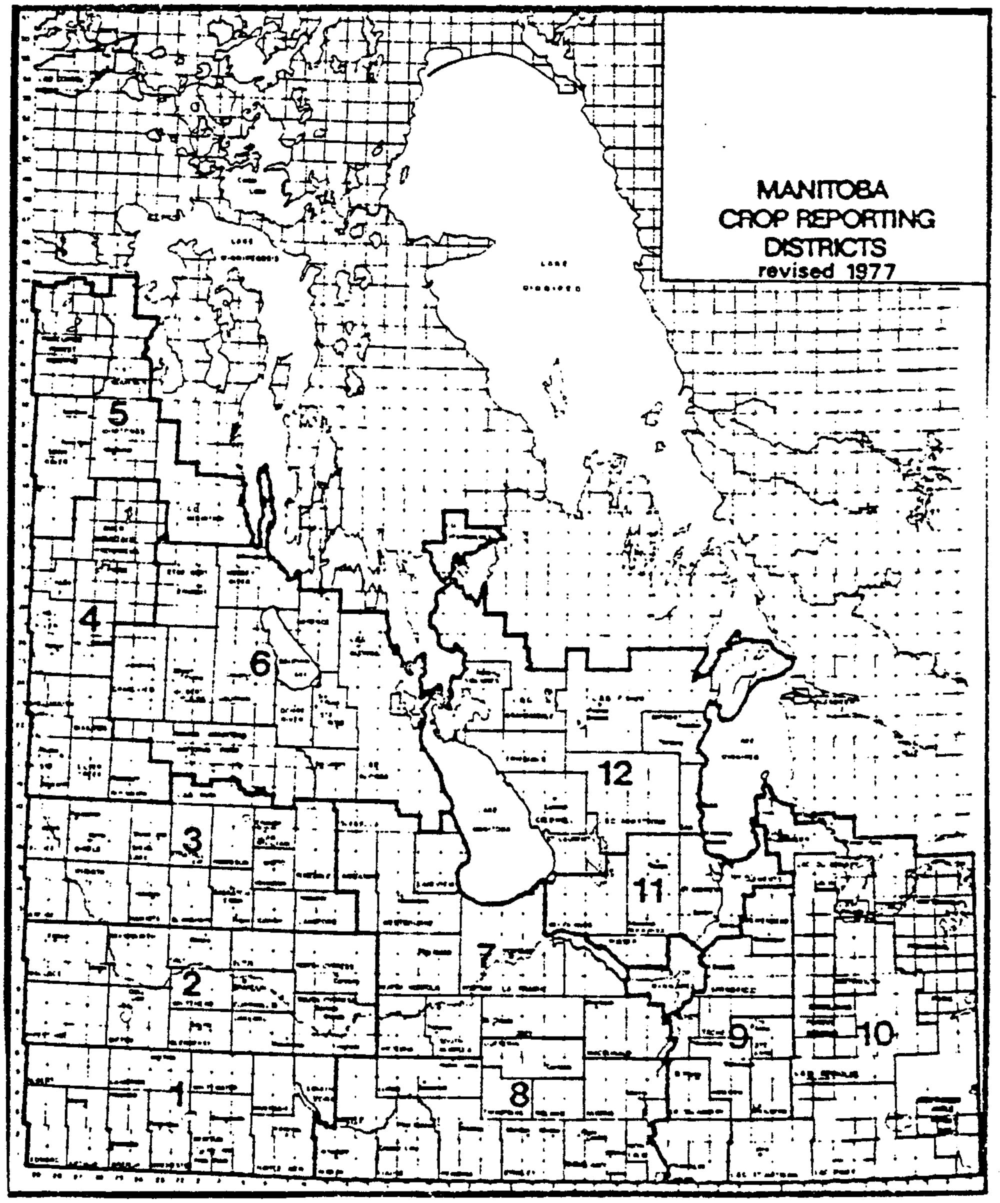
growth to attain the highest income level is very intricate and complex. Simulation provides a means of realistically portraying a farm operation where multiple mutually inclusive goals are involved.

Study Area

The study is relevant to the Province of Manitoba. Figure 5 shows the twelve crop reporting districts for the Province. Prior to 1977, there were fourteen districts as shown in Figure 6. Figure 7 shows the crop variety zonation map with details of growing season, degree days, water deficits, and constraints to crop production. Figure 8 shows the soil associations of the province. The average annual precipitation for the Province is 523.9 millimeters with an average of 63.6 millimeters falling between April and July and about 39.1 millimeters falling between August and October.

Crop farms in general and grain farms in particular are predominant. In 1976, almost 50 percent of the total agricultural land was in crops. This figure represents roughly 73 percent of the total improved land. Approximately 65 percent of the farm production value in 1979 was contributed by crops while farm cash crop income contributed 98.66 percent of the realized gross income in 1979. Of the 9,964,100 acres of crop production acres in 1979, wheat used

Figure 5: MANITOBA CROP REPORTING DISTRICTS REVISED 1977

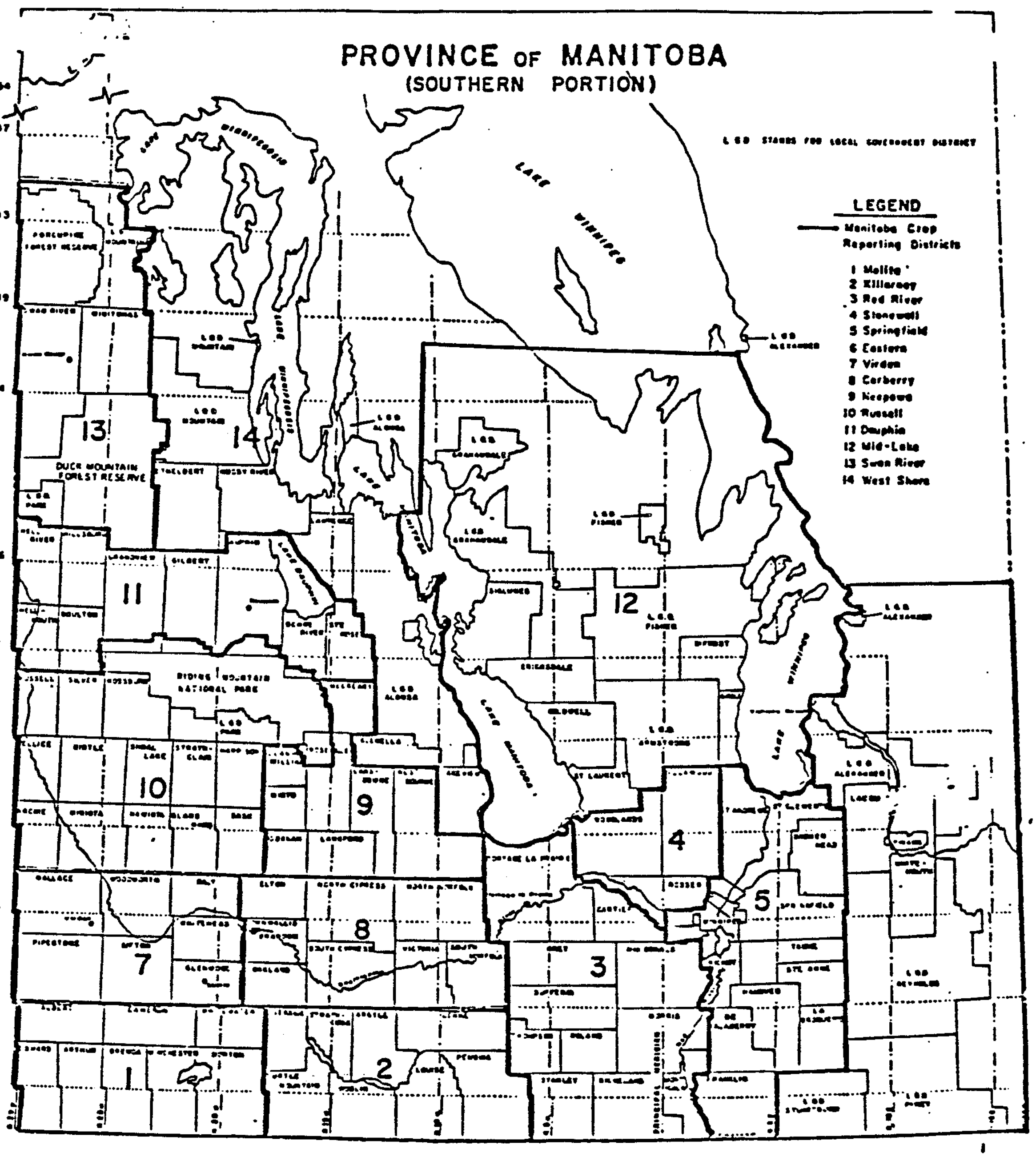


SOURCE: Manitoba Department of Agriculture, 1979 Manitoba Yearbook of Agriculture, Queen's Printer, Winnipeg, Manitoba, Canada.

30 percent, oats 4.5 percent, barley 14.6 percent, flaxseed 12.5 percent, rapeseed 13.5 percent and rye 1.3 percent.[170]

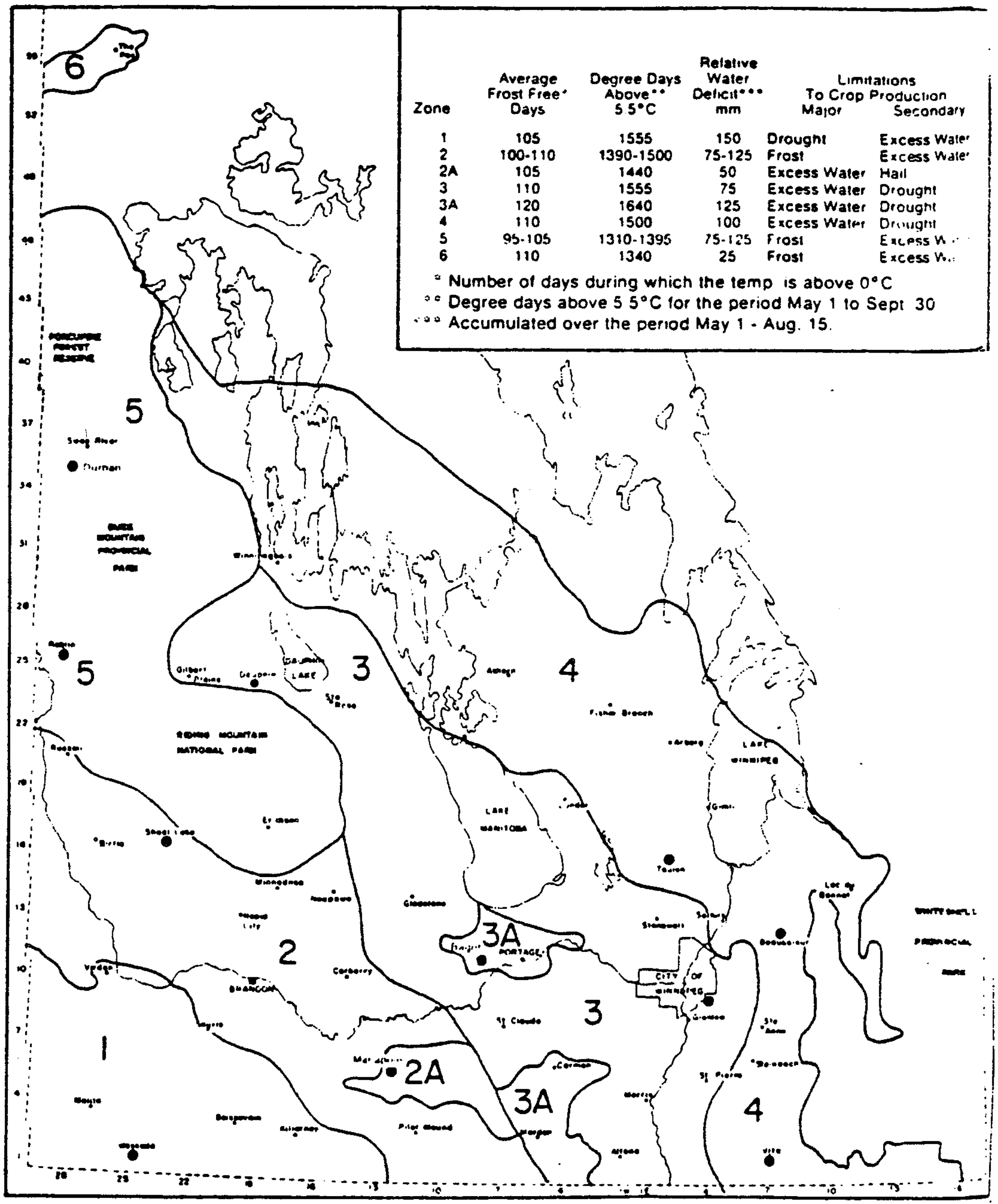
[170] The above statistics were calculated from information and agricultural statistics found in Yearbook of Manitoba Agriculture, 1979.

Figure 6: MAP OF SOUTHERN MANITOBA SHOWING PRE-1977 CROP DISTRICTS



SOURCE: Manitoba Department of Agriculture, 1979 Manitoba Yearbook of Agriculture, Queen's Printer, Winnipeg, Manitoba, Canada.

Figure 7: CROP VARIETY ZONATION MAP FOR MANITOBA



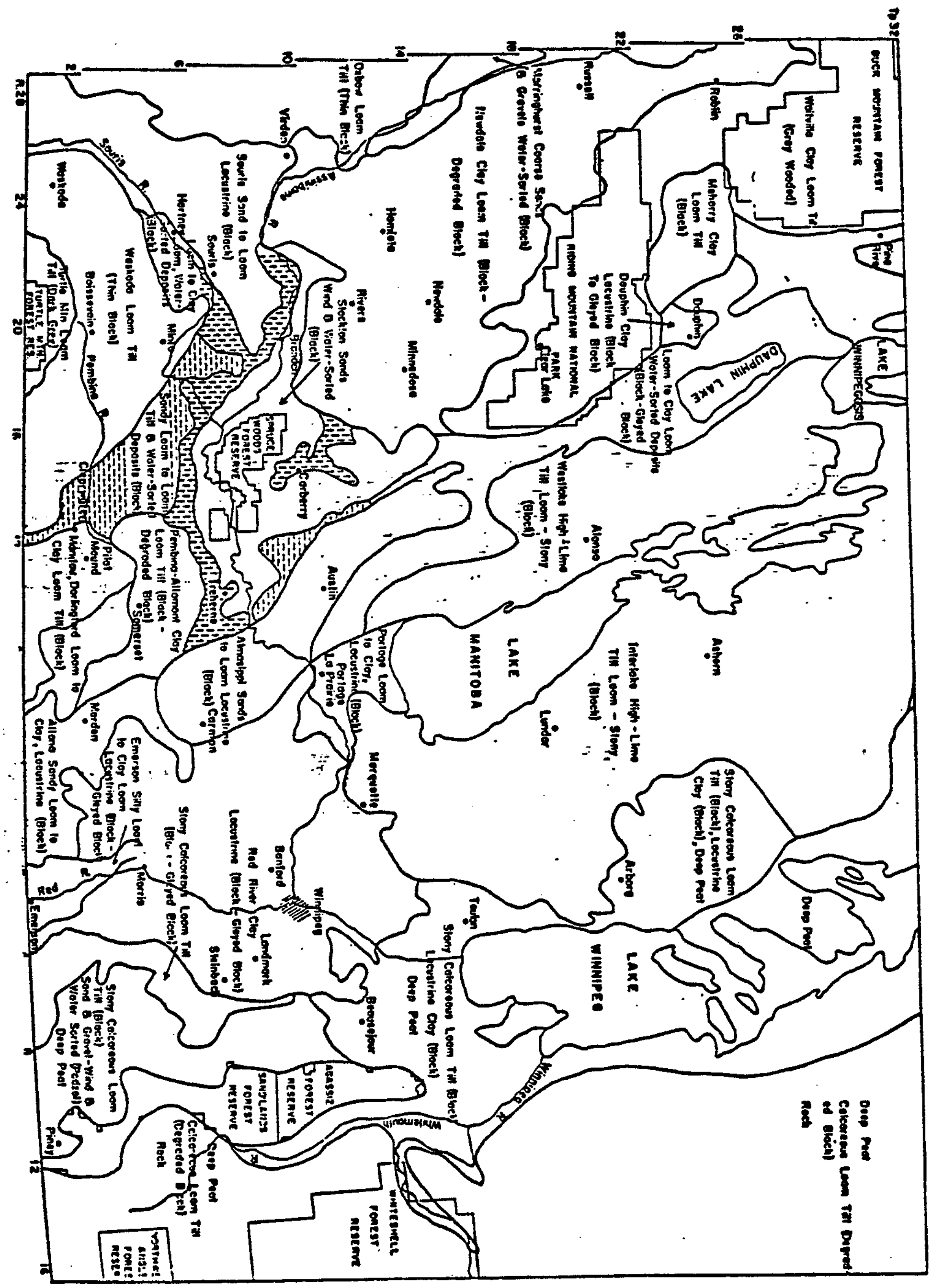
Zone	Average Frost Free* Days	Degree Days Above** 5.5°C	Relative Water Deficit*** mm	Limitations To Crop Production Major	Secondary
1	105	1555	150	Drought	Excess Water
2	100-110	1390-1500	75-125	Frost	Excess Water
2A	105	1440	50	Excess Water	Hail
3	110	1555	75	Excess Water	Drought
3A	120	1640	125	Excess Water	Drought
4	110	1500	100	Excess Water	Drought
5	95-105	1310-1395	75-125	Frost	Excess W...
6	110	1340	25	Frost	Excess W...

* Number of days during which the temp is above 0°C
** Degree days above 5.5°C for the period May 1 to Sept 30
*** Accumulated over the period May 1 - Aug. 15.

● CROP VARIETY ADAPTATION TRIALS

SOURCE: Field Crop Recommendations - Manitoba Department of Agriculture.

Figure 8: MAP OF MANITOBA SHOWING SOIL ASSOCIATIONS



SOURCE: Principles of Commercial Farming, 1974, p. 24.

Marketing of Products

For simplicity the model dos not differentiate between sales to the Canadian Wheat Board and sales on the open market.

All products are sold both to the Canadian Wheat Board and on the open market. The model assumes that all crops need not be all sold at the end of the crop year. The maximum quantity marketed of any crop is given by multiplying the crop seeded acreage and the yield per acre. The yearly quota, or normal allowable marketable amount is given by multiplying the seeded acreage of the specific crop by the quantity marketed per acre in the relevant year. If quantity marketed is not available then the allowable amount that can be marketed is the quantity produced which is calculated as the difference between the quantity harvested and the landlord's share.

The quantity harvested is the acreage harvested times the yield per acre. If the harvested acres are unknown, the model assumes that the quantity harvested is the seeded acreage times yield per acre, and that the quantity produced is the quantity harvested. The landlord share is given by multiplying the landlord share acreage equivalent and the yield. The quantity not marketed is stored. Storage and marketing procedures are described in subroutine STOCST (Appendix A), which also handles marketing of crops, while the data is described in Appendix B. The quantity marketed per acre per year was obtained by dividing the total quantity of the crop marketed in that year by the crop seeded acreage. If the model is operating in the stochastic mode marketing values are generated probabilistically in subroutine PROBAB (Appendix A).

Regression analysis of historical data was used to deduce the quantity of crop marketed per acre for the years 1980-85. The generated equations and statistical coefficients are presented in subroutine TREND (Appendix A).

One criticism of the marketing component is the nonuse of delivery quotas. However, due to problems in reading the quota levels (0 - open bushels per needed acre) in the computer program, it was decided to use the present approach. This represented the actual calculated quantity marketed of each crop per area. For the purpose of this thesis the marketing quotas and delivery quotas are synonymous.

Crop Production Alternatives

Three soil types are assumed in the model, namely: (1) Type 1 is the light soil, (2) Type 11 is the medium soil, and (3) Type 111 is the heavy soil. Light soils range in textural class from sand to loamy sand, medium soils range in textural class from loams to sandy clay loams while the heavy soils consist of the clay loams and heavy clays. The classifications used here are more practical and convenient than other land classifications.

The model does not operate without crop production alternatives. The crop production alternatives permitted in the model consist of the following:

i) The production of (a) wheat, (b) oats, (c) barley, (d) rye, (e) rapeseed, (f) flaxseed, (g) hay, (h) forage seed, and (i) summerfallow.

ii) Any combination of the above enterprises constrained by (a) the relative profitability of the crop vis a vis its contribution to farm net income, and (b) the acreage allocation limitation of the farm plan. In this connection ninety seven plans from six types of rotations are given as input. These rotations were expertly selected in terms of the benefits of rotation (i.e. green manure, seedbed, disease control, nitrogen). No other rotation is permitted in the model.

iii) Three land preparations (soil conditions) are allowed: summerfallow, stubble and sod. Each crop may be grown on none, any, all or in combinations. In general, wheat is always grown on summerfallow.

iv) The following tillage arrangements are permitted in the model: (a) no plowing, (b) all fall plow, (c) two-third fall-plow-one-third spring plow, (d) one-third fall plow - two-third spring, (e) all spring plow, and (f) one-half fall plow - one-half spring plow.

v) There are twenty sequences of operation, comprised of the sequence of operation and the number of times over. These have been selected on the basis of past research, consultation with farmers, crop production specialists and extension specialists. No alternative but those specified as data is allowed in the model. The user is required to select one of the sequences or the one that more closely represents his sequence. The type and sequence of operations carried out before seeding of crops depend on the crop and the land condition in spring. The land condition in spring can be summerfallow, stubble or sod. Each crop may be grown on any or all of the above situations. There are three sequences for the preparation of summerfallow land. The model allows one sequence of operation for each crop on stubble and sod. It allows one sequence for seeding wheat on summerfallow once the summerfallow preparation sequence is determined.

Field operations are separated into preharvest and harvest. The preharvest operations for all crops on summerfallow and sod are assumed to be the same. The preharvest operations for wheat, oats, barley and rye on stubble are the same but differ from that of flax on stubble. Preharvest operations for rapeseed on any land condition is the same. Harvest operations for all major crops are assumed to be the same. Summerfallow field operations are carried out in the summer and fall of the previous year.

A no-tillage sequence is permitted in which case the fall operations involve the use of a straw-spreader and sprayer. In spring, the operations include the use of a sprayer and triple disk-drill. Cultural operations are also divided into preseeding, seeding and postseeding categories.

vi) The schedule of operations is specified in the model. It is based on the fourteen periods into which the farm operation year is divided. The basis for the division is the seasonality of the farm operation. Period one covers the interval September 15 to September 30, while period fourteen lasts from September 1 to September 15. The model assumes that no field operation takes place between October 31 and March 31. During this period the farm manager is mainly concerned with the planning process.

More details on the above are found in subroutines FMPLAN (Appendix A) and in the computer program available from the author.

Each period consists of the number of days, the number of days possible to work on the farm, the operations to be done during the period, and the percentages of the operation completed for each crop. Failure to operate as specified results in a penalty to the operator. The manager specifies when there are delays in seeding and/or harvesting for each crop by the number of days delayed. This is then translated into a reduction in bushels yielded per acre on the basis of formulated equations in subroutine BUSHEL (Appendix A and the Computer Program).

For example, the reduction in bushels yielded per acre for seeding delay and harvesting delay is: (DESHRV(I,J,K)). The calculation is:

SDFR(L,J,I) * PNLSED(NI,ISD) + HRVDF(L,J,I) * PNLHRV(NI)

SDFR(I,J,K) = SDEL(IP)-SCONST(IP).

HRVDF(I,J,K) = HRVDEL(IP)-HCONST(IP).

where:

DESHRV(I,J,K) = sum of reduction in bushels per acre for seeding and harvesting delays on a given rotation for a given plan and a given crop.

SDFR(L,J,I) = number of days that seeding is delayed for a given crop in a given plan on a given rotation.

PNLSED(NI,ISD) = specific seeding delay penalty in bushels per acre per day per crop per land condition.

HRVDF(L,J,I) = number of days that harvesting is delayed for a given crop, in a given plan on a given rotation.

PNLHRV(NI) = specific penalty for delay in harvesting per crop.

SDEL(IP) = number of days each crop is delayed in seeding.

SCONST(IP) = a fixed parametric value established by Agriculture Canada - Brandon station that is deducted from seeding delay.

HRVDEL(IP) = number of days each crop is delayed in harvesting.

HCONST(IP) = a fixed value to be deducted as a correction factor in establishing harvesting delays.

Essentially, the crop production alternatives and their components make up the farm plan or cropping system being investigated. The operator may specify the farm plan in detail given the above alternatives or allow the model to select the best plan.

Fertilizer Use

The proper use and management of fertilizer is important to the production of crops. The model permits the user either to name the fertilizer or allow it to be determined within the model. The model permits up to five different fertilizers per crop. Three fertilizer situations are catered for, namely;

i) The amount of a fertilizer material used can be specified, for example, 200 pounds of ammonium phosphate per acre.

ii) The amount of each nutrient can be specified, for example, 20 pounds of nitrogen per acre, 30 pounds of phosphorous oxide per acre, and 10 pounds of potassium oxide per acre.

iii) The model selects the appropriate fertilizer from the recommended rates of application for each crop, soil type and land condition. Fertilizer decisions are executed in subroutine FERTLZ.

Financial Arrangements

The financial aspect is shown in Figure 9. The model permits three types of indebtedness within the model:

i) long term indebtedness with a term of repayment greater than ten years.

ii) medium term indebtedness with a term of repayment from eighteen months to ten years, and

iii) short term indebtedness with a repayment period up to eighteen months.

The security on long term loan is real estate, that for intermediate term loan can be real estate, machinery, grain or chattel, and the security on short term loan may be grain in storage on the farm, and the general business standing of the firm.

For each loan type, a minimum predtermined amount of collateral is required as security. This is given as input in the CAPSOR table (Appendix A). The model incorporates the sources of capital, the period of amortization, interest rates charged on credit from different sources, the borrowing ceiling and the maximum debt-equity ratio required. For initial loans, the user specifies the sources of loans by lenders, from those specified as input. He also specifies the number of conversion periods over which the loan is paid. Amortization schedules are also incorporated. Two schedules are used; the equal payment of principal and

Figure 9: THE FARM FINANCES AND WITHDRAWALS

- Financing the Operation
  - Long Term Inputs
    - Cash Balances
      - Machinery & Equipment
      - Land
    - Debt
      - Intermediate Term (18 months to 10 years)
        - Machinery & Equipment
        - Land & Buildings
      - Long Term (over 10 years)
        - Land & Buildings
        - Machinery
      - Mortgage
        - Land
  - Short Term Inputs
    - Cash Balances
    - Short Term Loans
- Cash Disbursements
  - Nonfarm Investment
    - Savings
    - Stock & Bonds
    - Others
  - Taxes
    - Income Tax
      - Provincial
      - Federal
    - C.P.P. & U.I.
    - Property Tax
  - Family Living
    - Size of Family
    - Age of Head
    - Poverty Level
    - Net Disposable Income
  - Off-Farm Cash Expenses

interest, and equal payment of principal with interest paid on the remaining balance. These schedules are presented in detail in subroutine FINANCE (Appendix A).

Borrowing and Borrowing Capacity

The ability to borrow in order to finance the acquisition of control of resource use is constrained by the total borrowing capacity of the farmer and his risk aversion as represented by his credit reserve requirement, debt-asset ratio and maximum debt structure ratios. This topic is discussed in subroutine FINDEC (Appendix A).

Present Asset, Liabilities and Resources

The model requires that the user specify his current assets, liabilities and other resources. Figure 10 itemizes what these may be. Inventory value for machinery, buildings and grain in storage are calculated by the model but the user is required to furnish values of other resources. The initial inventory of machinery is specified by the type, age, year of purchase, and initial purchase price. The land available for crop production is specified by the tenureship, that is, as fully owned, cash rent, rent-to-purchase, and share rent. The user is also required to specify the total farm acreage and the acreage to be cropped to individual crops. The value of land, land rental and acreage in summerfallow are calculated by the model if the user does not specify what the values are.

The present supply of available labor and the maximum amount of labour from family, temporary and permanent sources are specified for bi-weekly periods. All other assets such as building and equipment, and grain must be specified by the operator. The operator is also required to detail his current debts by length of loan, and his principal and interest payments for both intermediate and long term loans.

Figure 10: FARM RESOURCES

- Resources
  - Machinery & Equipment
    - Type
    - Size
    - Age
    - Salvage Value & Length of Useful Life
  - Land
    - Owned Acreage
      - Value
    - Rented Acreage
      - Share - Value
      - Cash - Value
    - Rental Purchase
  - Labor
    - Farm Family
    - Hired
      - Permanent
      - Temporary
  - Inventory
    - Cash on Hand
    - Machinery
    - Miscellaneous
    - Crops
      - Wheat
      - Oats
      - Barley
      - Flax
      - Rye
      - Rapeseed
      - Hay

Land Resource

Land is the most important resource in agricultural production and is the focal point of decision-making in this study. Details about land decisions are presented in subroutines ALLOC, LANDEC, LANINV and FSTAR (Appendix A). Here, only a few remarks are introduced.

The model permits acquisition of control of the land resource by outright purchase, rent-to-purchase option, share-rent and cash-rent. Decisions on any one of these methods of control are made in subroutine LANDEC. Decisions on whether land is to be released are made in RELESE (Appendix A). Land investment decisions are made in subroutine LANINV. In this subroutine, the maximum bid price is calculated together with the debt-carrying capacity and debt needed to acquire control. Subroutine FSTAR is a function doing the actual bid price calculation and when called by LANINV returns LSTAR (=maximum bid price). Subroutine ALLOC carries out decisions on the actual land allocation.

Model Restrictions

Figure 11 shows the restrictions on the model. The model requires the user to present information on the maximum size he wishes to control, the total cash available and the labour available (subroutines LABMAC, LABOUR (in Appendix A). The maximum acreage is the indication of the size achieved but both labour and capital availability affect the size, rate of accretion and farm organization.

The user may indicate what his capital restraints are in any one of the following ways: (1) debt-asset ratio, (2) maximum total debt, (3) intermediate debt, (4) long term debt, and (5) maximum short term debt per period and (6) debt structure ratios. The farmer's labour restriction is the total labor available per period but he hires permanent and temporary labour as the cropping acreage and machinery complement require.

Financial Withdrawals

The model allows cash to be withdrawn in addition to that for crop production for the following:

1. Family living expenses.

2. Investments.

3. Other cash expenses.

4. Taxes.

Figure 11: RESTRICTIONS ON THE MODEL

- Constraints
  - Debt
    - Debt/Asset Ratio
    - Short Term Loan
    - Intermediate Term Loan
      - Principal
      - Payments
    - Long Term Loan
      - Principal
      - Payments
    - Total Indebtedness
  - Rate of Growth
    - Acreage Added/Year
  - Size
    - Cropping Acreage
    - Total Farm Acreage
  - Land
    - Land Use Capability
      - Class I
        - Owned
        - Rented
          - Cash
          - Share
      - Class II
        - Owned
        - Rented
          - Cash
          - Share
      - Class III
        - Owned
        - Rented
          - Cash
          - Share
  - Planning Horizon (20 years)
  - Labor
    - Family Labor
    - Field Time Available
    - Temporary Hired Labor
    - Permanent Hired Labor

Family Living Expenses

Cash withdrawal for family living expenses is based on the consumption function suggested by Patrick and Eisgruber,[171] Three other Consumption functions were estimated, namely, the linear, log-linear and Brake's[172] Both the linear and log linear were poor explanatory functions and were rejected. Brake's was a very good explanatory function, accounting for ninety-three percent of the variation in consumption. However, Patrick's function was chosen for use in the study due to its superior explanatory power. The function is expressed as:

$$C = a + bY + dF + eA - PF^2 - gA^2 + u$$

where

C = the farm family current consumption expenditures in dollars

Y = farm family total net income after deductions for social contributions and taxes.

F = farm family size, less than or equal to five.

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[171] G. F. Patrick and L.M. Eisgruber, "The Impact of Managerial Ability and Capital Structure on Growth of the Farm Firm," American Journal of Agricultural Economics, Vol. 50, No. 3, August 1968.

[172] Ibid.

A = farm operator's age.

The evaluated equation is:

$$\hat{C} = -90.19 + \underset{(.0025)}{.018Y} - \underset{(21.12)}{710.36F} + \underset{(0.43)}{85.98A} + \underset{(2.36)}{72.83F^2} - \underset{(.0035)}{.023A^2}$$

$$R^2 = .999$$

The difference between the function estimated by Patrick and Eisgruber and the evaluated one is that whereas the former arbitrarily weighted average farm income in time periods t, t-1, and t-2 to introduce a lag and to smoothe the consumption expenditures the latter does not. Additionally, the latter function deducts contribution for social security, the former does not.

In order to achieve the satisfactory consumption expenditure requirements for any year, total family net income must be greater than the value of farm family consumption expenditures by at least the rise in the cost of living index. The minimum levels of consumption for families of given sizes are:[173] (1) a family of two, \$3,600, (2) a family of three, \$4,300, (3) a family of four, \$5,000, and (4) a family of five, \$6,500.

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[173] C. L. Barber Welfare Policy in Manitoba, A Report to the Planning and Priorities committee of Cabinet Secretariat, Province of Manitoba, December, 1972.

In the regression equation, C = current consumption expenditures as defined by Statistics Canada and including cost of social security. Although the R^2 is .999, the true meaningfulness to this is questionable for mean values were used in performing regression instead of individual observations. As such some variations among individual observation were removed prior to estimation. The one meaningful statement as shown by R^2 is that the proposed relationship is an extremely good fit of the means. The standard errors of the regression coefficients are in brackets. The standard error of the estimate is .0596 and Theil's U-Coefficient is .00325.

The specified relationship would be expected to be modified somewhat with changes in the cost of living. When changes in price are taken into account the following relationship is obtained:

$$\frac{\hat{C}}{P} = 90.19 + P\ .018\ \frac{Y}{P} - 710.36F + 85.98A + 72.83F^2 - .023A^2.$$

where P is the consumer price index.

In order to compensate for the above equation, the consumption expenditure is corrected each year for the change in the cost of living.

Taxes

The model computes Federal and Provincial income taxes, self-employed contribution and contribution to Canada Pension Plan. Contributions to Unemployment Insurance and Canada Pension Plan on employees wages are also computed. Taxes are computed in the Tax Subroutine and paid on a cash basis the following year. Farm family net income is the basis for calculating Federal Income Tax and all relevant exemptions as specified in the Farmer's and Fisherman's Tax Guide Income Tax Filing Guide, and Farm Tax Management Today. Farm family net income consists of farm net income plus nonfarm income. Farm net income is the basis for calculating self-employed contribution.

Farm net income consists of those receipts and expenses which are submitted on the Federal Income Tax Return Form TD4. Depreciation on machinery, building and implements are part of the expenses. After tax income consists of farm net income minus all taxes. Consumption expenditure is based on the after-tax income for the previous year.

Nonfarm Investments and Other Cash Expenses.

The model permits cash withdrawals for operating expenses, and downpayment on intermediate loans and long term loans. The capital available for investment consists of savings in the bank, yields on nonfarm investments and net receipts up to the time that the investment is to be made and surplus retained earnings. Nonfarm investments include securities (stocks, bonds).

User Data Changes.

The user of the model may change certain input values including labor requirements, labor availability, share-renting percentage and most of the input data for the case farm plan.

Yield and Prices

If the model is operating in the stochastic mode values for yields and prices are generated probabilistically by subroutine PROBAB.

When the model is operating deterministically, the actual yield is given by the historical average yield. In this mode the average yield and prices are those submitted as data for 1960-1979 or are the value after correcting for trends for the years 1979 to 1986. Figure 12 shows some of the prices specified in the model.

Figure 12: SPECIFIED PRICES

- Prices
  - Products
  - Durable Inputs
    - Machines
      - Custom Rental
      - Tractors
      - Seeding
      - Tillage & Cultivation
      - Harvesting
    - Buildings
      - Hay
      - Grain Storage
      - Machinery Storage
  - Non-Durable
    - Labor
      - Own
      - Hired
        - Permanent
        - Temporary
    - Crop
      - Seed
      - Fertilizer
      - Herbicides, Fungicides
      - Land Rent
    - Rates of Interest
      - F.C.C.
      - Others
      - M.A.C.C.
        - Young Farmers
        - Others

Machinery and Building

Cost of Machinery is divided into ownership and operating costs. Ownership costs consist of depreciation cost of investment, insurance and housing. The model deals with depreciation on the basis of the purchase price, the total useful life, and on the depreciation class in which the item falls as given in the Income Tax Guide. This classification determines the rate of depreciation on both buildings and machinery. In addition, machinery and implement purchased prior to 1972 are depreciated using the straight line method while those bought after 1972 are depreciated using the declining balance method.

Depreciation is calculated as a function of the purchase price, a specified salvage value, the interest cost and the minimum of either the total useful life or the total hours used. Insurance costs is calcualted as a rate per unit of value of the asset. Housing costs are calculated based on the cost of the housing unit and the storage requirement of the equipment in square feet.

Operating cost consists of repairs, maintenance, lubrication and fuel. Repair cost is calculated by the expression of total annual repairs as a percentage of the initial cost of the item. Cost of maintenance and cost of lubrication are calculated as functions of fuel cost. Cost of fuel was calculated for tractors by regression analysis of the fuel consumption and multiplying fuel consumption by the price of fuel. The cost of rental and custom hiring were calculated by the method given in Rental and Custom Charges for Farm Machinery. Subroutines MACOST, BLDCST, and MACS deal with these in detail.

Machinery Use

Two hundred and ninety items of machinery are input as data. The model user is permitted to either specify the machinery on the farm being simulated or to allow the model to determine this from the input. In order to determine a complement of machinery set, the model initially determines the requirement for the item. If the machine is required, the total capacity of the machine is checked against the acreage to be cropped to ascertain the quantity of the item required. The machinery input data is used to calculate the current depreciated value using the given age, considering the trend in machinery price and using the appropriate depreciation method.

Following this procedure for each machine, a complement of machinery is selected and includes only those machines required by the investigated operation. The complement of machinery consists of the item required to operate the specific farm acreage together with the number of item required. Details of machinery use are amplified in subroutines MACDEC, TRACBY and MACBY (Appdendix A).

THE DECISION PROCESS

The basic objective of the decision process is to select the best cropping plan(s) for implementation. In order to achieve this objective, decision variables are strategically located in the model to effect different courses of action.

The decision-making scenario is as follows. Decisions with respect to the acquisition of control of farmland are described and performed in subroutine LANDEC (Appendix A). The actual acquisition decision and cost of acquisition are done in LANINV and FSTAR in consort with FINDEC (Appendix A). When rent-to-purchase land is acquired, land released is determined in RELESE (Appendix A).

Subroutine ALLOC decides on the allocation of new land while BUSHEL executes decisions on delays and penalties in seeding and harvesting as well the total bushels to be harvested. The decision on relative contribution of each crop to the total profit of a given plan is determined by MODE. Subroutine MASTER renders decision on selecting the most profitable crop in each plan, most profitable plan in each rotation and the most profitable rotation on the farm. This decision is accomplished by looking at the performances of the crops in a tentative manner.

Decisions on the entire machinery and implement processing are handled by MACDEC, MACOST, MACS, MACBUY, SAVER and TRACBY (Appendix A). Labour decisions are made by LABOUR and LABMAC. BLDDEC makes decisions on buildings while STOCST makes all decisions regarding the storage and marketing of products and inventories.

All financial decisions involved in borrowing and availability of funds are dealt with in FINDEC and FINANCE, NEWCDT and SCHEDL (Appendix A). Once all processing during the year is done, the decision as to what is to be printed, analysed and evaluated rest with CRPCST, PLANOP, FAMOP, OUTPUT, INLIST, PRT1, ENDOUT and FINAL (Appendix A). The order of processing is the responsibility of subroutine MAINLINE (Appendix A).

CONTROL VARIABLES

The controlled variables are hypothesized to be of fundamental importance to the long time growth and expansion of the crop farm, and ultimately to the attainment of the highest farm income. The three variables are farmland tenure arrangement, level of indebtedness and the rate of return on farmland. These factors, at the levels of each, are formulated into a complete factorial randomized design and used as the statistical treatments to study their impacts on the performance measures. These variables are detailed in Chapters II and VII.

PERFORMANCE MEASURES

The performance measures are the net farm income, net worth, and net cash flow of the various treatment combinations. Performance is also examined from the present values of these variables.

SUMMARY

The broad objective of the study was to construct a simulation model representing a crop farm in Manitoba and to test its applicability. The previous chapters dealt with the problem, theoretical and empirical aspects use and a comprehensive literature review. All of those were intended to contribute input for the conceptual model. This chapter, utilizing the information contained in the previous four chapters, together with practical experience, and knowledge drawn from diverse sources, has presented the conceptual model.

The methodological objective was continued by detailed descriptions of the components of the model documented in this chapter. These details were then translated into the computer language, FORTRAN, whence it became the computer simulation model. This model in all its detail is presented as appendix A while the computer program is available from the author. Final methodological investigation involved testing, verifying and validating the simulation model which are the contents of Chapter VI.

CHAPTER V

METHODOLOGICAL RESULTS

A major objective of this study was the construction of a simulation model representing a crop farm and testing the model's performance against real world performance. This chapter presents results in support of this objective. It begins by examining some concerns and complications in analysing stochastic runs. Next, the chapter deals with testing, verification and validation. Finally, detail validation results are presented supporting the validity of the model. The chapter terminates with a summary paragraph.

ANALYSIS OF SIMULATION RUN[174]

Definitions

A simulation run refers to the continuous operation of the model under preselected combinations of control variables. Replication of a run refers to the operation of the system using the identical combinations of variables, but with different random values of selected variables. An observation of the system is a portion of a simulation run long enough to determine the value of each of the output measures. In this study an observation is normally

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174 J. R. Emshoff and R. L. Sisson, Design and Use of Computer Simulation Models, Macmillan Company, Inc., New York, 1970, pp. 189-208.

represented by one year.

If successive observations of the performance measures are statistically the same, then no new information about the future behaviour of the system is forthcoming. This situation is referred to as steady-state or stable. Any system which diverges from a steady state is said to be in a transient state.

Steady state conditions are assumed to be the norm in many simulation model in order to make the properties of the experimental design less restrictive. Transient situations occur if the system starts with nontypical values. Should this be the case, the transient period should be made as short as possible. But, preferably, the effects of this phase should be removed in order that the system's output and performance could be evaluated under steady state conditions.[175]

Unless the effects of transients are removed, computation of means and variances will cause incorrect inferences to be drawn.[176] Transient effects are removed by using extraordinary long simulation runs so that observations from the transient period are relatively insignificant to those obtained from a steady state phase. A second way of avoiding the transient phase is to run the simulator until

[175] Ibid., 190-191.

[176] Ibid.

steady state is achieved before recording data.[177]

Complications in Analysing Stochastic Runs

In a deterministic model, the output of the run is the measure of performance on which any inference can be based. There is nothing on which to base confidence in the results. For a stochastic model, however, the mean value of a parameter can be evaluated from the values of the run. In order to have confidence in the ability of the value of the estimated means to represent the population mean, the variance of the observations is needed. The manner of selecting observations affects the variance.

Observations can be selected by:[178]

i) replicating the run many times and taking the mean as the observation. These are then used to deduce confidence measures.

ii) running the simulator longer to avoid the transient state. This gives rise to autocorrelation in replicated runs.

iii) accepting a single run as a sample of observations, calculate the mean of each replicate, and using the fact that the sampling distribution of means is normal, use the variance to estimate confidence

[177] Ibid., 192.

[178] Ibid., 194.

intervals.

The mean performance of the model is given by:

$$\hat{\mu} = \sum_{i=1}^{n} \frac{X_i}{n}$$

where μ = the average performance
X_i's = the individual measurement
n = the number of measurements in the sample

The efficiency of performance is given by the variance:

$$\hat{\sigma}_\mu^2 = \sigma^2/n$$

If there is no autocorrelation, then by increasing the length of run the number of observations will increase resulting in a lower estimated variance. Increased confidence is achieved and statistical inferences can be drawn:

i) If there was no autocorrelation but correlation is introduced between replicates by assuming a common variance σ^2, and the number of observations per replicate equal to $n/2$ and ρ is the introduced correlation,

then $\mu = \sum_{i=1}^{n/2} \left(\frac{S_1+S_2}{2}\right)$ and

$$\hat{\sigma}_u^2 = \frac{\sigma^2}{n}(1+\rho); \quad \text{if } \rho = 0.$$

where S_1, S_2 = sample measurements implies independence of the replicates and the variance is equal to the variance of one replicate of twice the length.

ii) If a negative correlation were to be introduced between replications the variance of the sum of observations will be smaller than the variance of one long run of 'n' observations. When negative correlation is introduced between two variables, antithetic variables obtain.

It is important to note that negatively correlated variates are generated when probabilistic events are the result of the generation of uniform random numbers, R in the interval

$$(0.0 \leq R \leq 1.0).$$

for one series of observation and in the interval (1.0 - R) for the equivalent event in another run.

iii) Comparing two alternative courses of actions, that is, comparing two runs under different controllable conditions. In this case the variance of the sum of the two variances should be as small as possible. This can be achieved by forcing a positive correlation between runs.

The use of the same random numbers for equivalent events permits the analysis of different courses of action with no increase in computer time. This is the equivalent of blocking in physical experiments. Blocking is adapted in this study as the method for dealing with autocorrelated output. The other method is the precise estimation of the autocorrelation and incuding its effect in estimating means and variances.

The blocking procedure was as follows: Each run comprises $X_1, X_2, \ldots X_{20}$ autocorrelated observations. These observations were then grouped into b=4, that is, in effect 4 aggregated blocks of observations of 5 observations each. autocorrelated observations. These observations were then grouped into b=4 consecutive blocks. The new observations were defined as Z_1, Z_2, $\ldots Z_b$ where:

$$Z_1 = \frac{X_1 + X_2 + \ldots + X_m}{m}$$

$$Z_2 = \frac{X_{m+1} + X_{m+2} + \ldots X_{2m}}{m}$$

.

.

.

$$Z_b = \frac{X_{m(k-1)+1} + X_{m(k-1)+2} + \ldots X_n}{m}$$

$$m = \frac{n}{b} = 5$$

This procedure assumed that the block size of five years ensured independence of the means Z_i, so that

$$\hat{u} = \sum_{i=1}^{b} \frac{Zi}{b} = \sum_{j=1}^{n} Zj/n$$

$$\frac{\hat{o}^2}{u} = o^2/bm$$

TESTING THE MODEL

Testing the model essentially entailed debugging the model for compiling and computer logic errors on a subroutine basis, and ultimately on the whole model basis. This procedure continued until the study was finished, and would likely continue into the future as the model is requested to perform under different conditions and for different cases.

Once a subroutine was written, it was compiled and cleaned of errors. As more subroutines were written, all previously debugged ones were included in the next debugging run. This process was done throughout the study. Even in the actual experimental situations compiling errors, which never manifested themselves in earlier runs of the testing procedure, were encountered. Debugging was an ongoing process throughout all phases of model verification, validation and experimentation.

VERIFICATION OF MODEL

Verification refers to the process of ensuring that the model was working correctly. Major concern was that the model performed as the designer perceived and constructed. This simulator was designed to function under very flexible and numerous combinatorial situations. Naturally, verification under all possibilities was unattainable within the time frame for such a project. Only certain selected situations were used in order to be reasonably sure of the model's performance.

The model was operated under the following specific situations to attest to its correct operation:

i) A maximum of 3 rotations per farm with 3 plans per rotation, and six crops per plan. The model can operate with eight crops.

ii) Rotations and plans were given along with the crops.

iii) Model selected rotations and or plans once the crops were given.

iv) Model operated under the land use control arrangements of outright purchase, rental/purchase, cash rental, share rental, either one at a time, all together, or in combinations. When purchase was the option the model released rented land, with cash rented lands released before share rented.

v) Use of seven debt structure ratios either one at a time, in combination or all together as follows:

1. Short term debt/Total debt
2. Short term debt/Medium term debt
3. Short term debt/Long term debt
4. Medium term debt/Long term debt
5. Medium term debt/Total debt
6. Long term debt/Total debt

7. Combinations

8. All

vi) Use of five rates of return paid on farm equity and farm earning assets:

1. rate of return equivalent to the interest charged farmers by the Farm Credit Corporation under the Farm Credit Act (FCAF);

2. rate of return equivalent to the inflation rate as reflected by the consumer price index;

3. rate of return equivalent to the yield on the government of Canada three month (91 day) bonds (GCFTB).

4. rate of return equal to the interest rate that lending institutions charged their best corporate borrowers (PRIME); and

5. rate of return equivalent to the interest charged farmers by the Manitoba Agricultural Credit Act. MACCIO represents rate charged older farmers and MACCIY represents the rate of interest charged younger (under 35 years old) farmers.

vii) Forced use of normal credit reserve and 'risk' credit reserve. The farmer was assumed to hold back a certain reserve dictated by lending institutions, and an additional amount as a hedge against 'extra risk' of failure. Normal credit reserve is synonymous with the amount of funds that the farmer cannot use from his total borrowing capacity. Risk credit reserve refers to the amount of borrowing capacity in addition to that required by lending institutions (normal credit reserve) retained by farmers as a hedge against risk.

viii) Machinery and equipment were custom-hired, purchased and/or rented alone or in combination.

ix) Three land conditions found in model-summerfallow, stubble, sod.

x) Land conditions either specified by the user or determined within the model.

xi) Three soil types - light, medium and heavy.

xii) Use of up to 5 fertilizers, chemicals and seed varieties per crop.

xiii) Either/and/or constant payment of principal and interest, constant payment of principal plus interest amortization schedules.

xiv) Several loans of short, medium and long term types (up to 50).

xv) Model performed under both deterministic and stochastic modes.

Sample results from the tested and verified model are available from the author.

The verification of the model pertained only to the establishment of of the 'correctness' of the model's operation. It was in many ways distinct from validation though sometimes the two are interchanged. The ability of the tested and verified model or its subroutines to produce output statistically similar to real world output was the object of validation.

VALIDATION OF THE MODEL

This topic was discussed at length in an earlier chapter. There it was stated that the validation procedure used in this study included assumptions of theoretical validity and representation of the theories. It remains, therefore, to validate the model by the simulated results with that of the 'real world'. The basic validation procedure towards the matching of results was to visually compare the simulated results with the 'actual' data. In order to effect validation, the model was simulated for eight years, 1960-1968. This period was used because actual net worth and net farm income were available for the case farm. However, no data was available for the net cash flow and consequently the latter could not be validated. The simulated net cash flow results are presented for completeness.

A perennial problem with validating a model by comparing its results with the 'real' world results is that if the validation is to be precise, an exact set of conditions must be operating on the model as that operating on the 'real' situation. Or, the model should operate in exactly the same environment under which the 'real' situation operated.

This is very difficult to achieve. A model can, therefore, only be truly validated on its ability to predict future values of criterion variables. The validation of a simulation model at the time of its presentation has all but been omitted in almost all simulation models that are documented.

The case farm utilized in this model provided eight years of actual data for net worth and net income. These data were used to test the validity of the model. If the model purports to be representative of crop farms in Manitoba, it should be considered as a sample of all farms in Manitoba and Canada, and therefore, able to track a reasonable time path with results closely consistent with the actual data or be able to convincingly explain deviations from the actual data.

Review of Hierarchial Structure And Operational Logic

The results and analysis of the study will be presented in two parts, the first representing the validation results and the second the experimental treatment results. It should be pointed out that the two sections are interrelated and an understanding of the first part is essential to follow through the discussion of the second part. The reason for this is that in the discussion of the validation scenario, both an overview of the program components/subprograms/subroutines and a detailed discussion of the model behaviour are described.

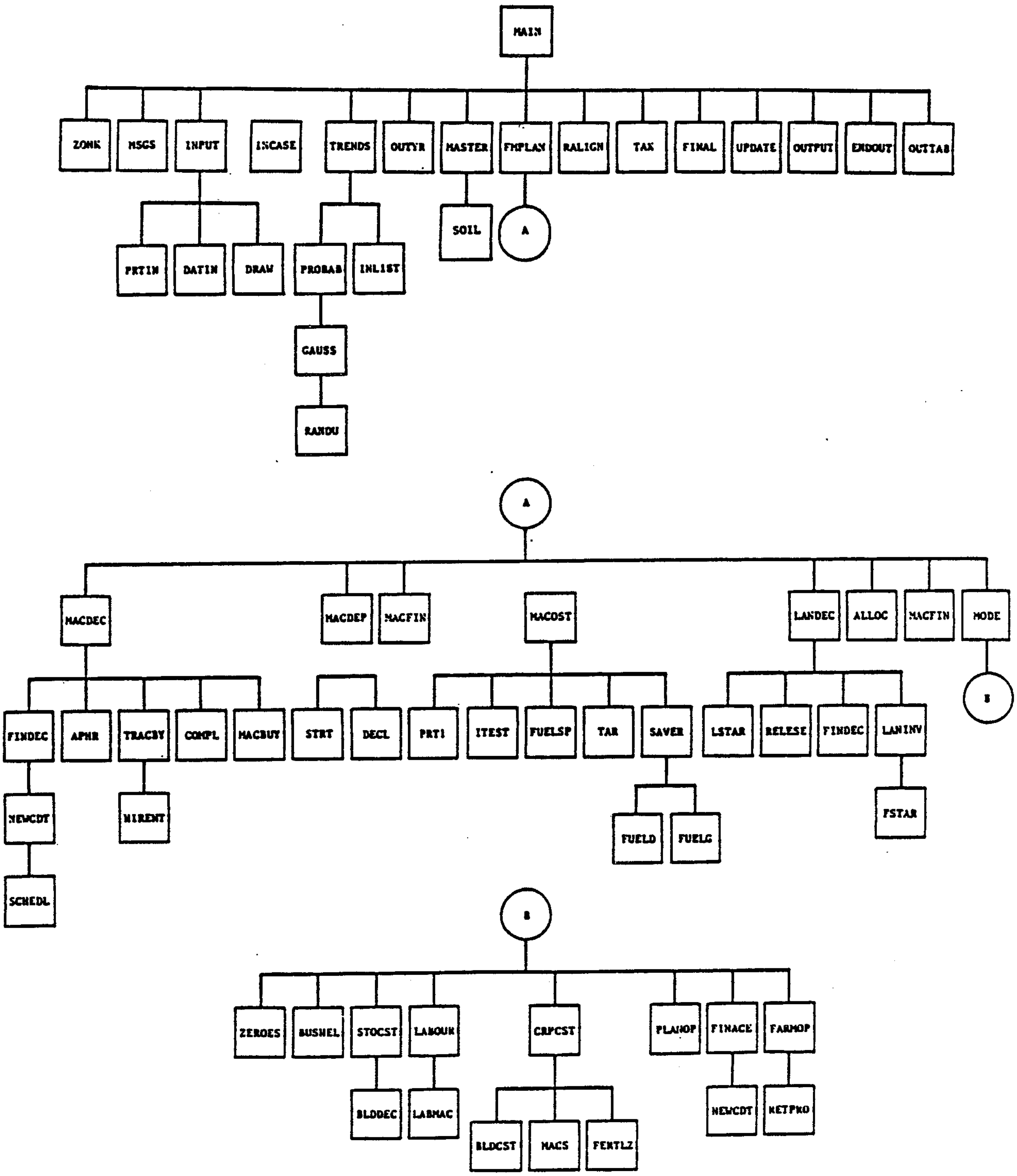
This section presents the first set of results generated by the model and will serve both to validate the model and to provide an overview of its internal working. The model subroutines are detailed in Appendix A while the components were documented in the last chapter.

First, the operational logic of the model as is displayed in the hierarchical structure diagram shown as Figure 13, page 191, Chapter is briefly summarized and reviewed. The MAIN program controls the processing and decision making activities of the model. Firstly, it causes all variables to be initialized (subroutine ZONK) and defaulted values enacted (subroutine MSGS). It calls subprogram INPUT which allows access to all input data on tape by calling subroutines DATAIN and DRAW. All inputs required for a simulation run are printed when subroutine PRTIN is called by INPUT. With this loop completed, MAIN calls subprogram INCASE which includes the data for a specific case (user).

In INCASE, the data include personal information such as ages of farmer and spouse, number and ages of children, location of farm,

FIGURE 13

HIERARCHICAL STRUCTURE OF FARM SIMULATION PROGRAM



weather station area, house rent, initial year of run, duration of run, etc. Other series of information include inventory of crops and supplies, details of machinery inventory, financial information, tax information, fertilizer information, seed and chemicals, cropping systems and other crop area breakdowns, tenureship, crop insurance and other relevant miscellaneous information such as seeding and harvesting delays, employment of labour, etc. Appendix B, shows the incase data for the situation used as the validation case.

Subprogram TRENDS fills in missing values in the input tables by simple time trend regression for the period 1960-1990. In order to complete its function, TREND calls subroutines PROBAB and INLIST.

PROBAB calculates probabilistic values for yields, prices and quantities of crop marketed. In order to facilitate this, means and standard deviations for yield on summerfallow and stubble, prices and quantities marketed of all crops are given, having been derived from regression analysis. PROBAB achieves this by calling subroutines GAUSS, and RANDU. RANDU is a random number generator using a rectangular random number generation technique. It provides subroutine GAUSS with a random number meeting the upper and lower bounds specified - two standard deviations, respectively. GAUSS then calculates these values and sends them to PROBAB. Subroutine INLIST facilitates TRENDS by listing the INPUT needed by TRENDS.

After the above is done, MAIN calls subprogram FMPLAN which evaluates all plans within the cropping system, and selects land preparation and crop sequences. FMPLAN achieves its function by calling several subroutines: MACDEC which handles the necessary inventory of machinery and implement for the coming year, and all machinery decisions required to farm the cropable area in the next crop year.

MACDEC is facilitated in this by subroutines TRACBY which determines which small tractor is to be replaced by what larger size. HIRENT determines if a machine is of a type that should be rented or custom hired. MACBY replaces the information about the old machine with that of the new machine. COMPL calculates the values of variables of the initial complement of machinery and equipment in INCASE - age, lifetime years, hours of work, acres per hour, initial depreciated value, etc.

APHR returns acres per hour for a given machinery or equipment. MACDEP depreciates machinery and equipment using either the straight line or reducing balance methods as is necessary. MACFIN prints out the final inventory of machinery at year end for the next year.

The subprogram MACOST calculates all costs associated with machinery and implement controlled by the farmer. In order to do this, it calls the following subroutines: ITEST - to provide information on the 'repair type' of the machinery or equipment; PRT 1 - prints specifications for the complement of machinery controlled each year by the farmer; FUELSP - determines fuel consumption of self propelled equipment and machinery; TAR - calculates total annual repairs of machinery and equipment; SAVER - calculates hourly cost of fuel consumption for tractors; FUELG - for gasoline engines; FUELD - for diesel engines.

LANDEC makes all decision pertinent to land control acquisition. These decisions are facilitated through accessing FSTAR - determines maximum bid price of land; FINDEC - makes the financial decisions with respect to credit (borrowings, available capital, funding, type of loan, equity in assets, borrowing capacity and credit reserve). LANINV -

makes the land investment analysis and determines the land investment decision.

Subroutine RELESE functions by releasing all rented land on the basis of the release of the same amount of rented land as the farmer buys. Cash rented land is released before share-rented lands. This process operates in purchase options.

When new land is acquired, subroutine ALLOC, shares this out by dividing the quantity of land acquired for control among plans, crops and system on the basis of the relative contributions of each category to profitability. The latter is determined by MODE.

Several subroutines provide MODE with information in order to complete its task. ZEROES - to zero variables to be used in FARMOP which does all annual calculations for the entire farm; and PLANOP does all calculations for a plan; BUSHEL - examines for delays in seeding and harvesting due to weather breakdowns, etc., and assesses penalties reflected as a reduction in yield of the crop; STOCST - determines the quantity of grain harvested, amount to be stored on farm or off-farm, costs of storage, and amount sold; BLDDEC - selects a building to purchase, and if bought, adds it to the building complement. A building is bought only if the extra volume of grain is greater than or equal to the bushel capacity of buildings in the complement. In that event, the building purchased is that with the smallest bushel capacity capable of holding the volume of grain.

LABOUR supplies complete information on labour requirement, labour availability, labour use, efficiency ratios, quantity of operator, family and paid and unpaid labour, costs of labour including opportunity costs on a per period and per crop basis. Information on temporary and permanent labour and labour allocation are also determined. LABMAC calculates the labour required for a given class of machinery. It uses alpha coefficients to convert machine time to hours of labour.

CRPCST calculates the costs of production per crop. The intermediate information on building, machinery, and fertilizer costs are obtained by calling subroutines BLDCST, MACS and FERTLZ, respectively. BLDCST determines depreciation, investment and insurance costs of buildings in the farmers inventory. MACS calculates the machinery cost per acre on any of the three land conditions of summerfallow, stubble and sod for any crop. FERTLZ determines the type of fertilizer use and costs per acre per crop for any or all of the three allowable situations: material given, quantities of nutrients given, and model selection of the fertilizer.

PLANOP is called by MODE to provide the costs of production per plan. PLANOP does this by summing up the individual crop costs from CRPCST and then itself aggregating these to the plan costs.

FINACE accounts for paying off loans, making loans and calculating SURPLUS, the left-over earnings for investment and for saving. NEWCDT facilitates FINACE by creating a new entry into the loan information table, filling in the loans table and causes the printing out of the loan schedule. SCHEDL prints out the loan schedule table.

FARMOP determines the total financial picture of the whole farm. It calculates total receipts, total expenses, income, net worth, etc., and all other supportive information to provide a complete farm financial picture.

The MAIN line now calls RALIGN to realign the farmers debt structure to coincide with that specified by the user. It does this by first calculating the actual ratios as they exist and comparing them with those desired by the user specified by DEBTSR. If IRALIN = DEBTSR, processing continues, otherwise realignment takes place.

TAX calculates the yearly taxes payable on the basis of total family income (off-farm income, net farm income before taxes, pension income, investment income, other income) based on the proportional income tax system used in Canada.

FINAL summarizes all calculations in the internal program and stores the annual values in the array 'INFO' for use as required. UPDATE updates all values to be used at the beginning of the next year. OUTPUT prints out present values and present value streams of net cash flow, net farm income and net farm worth. ENDOUT prints out the final set of financial and farm summary tables while STATS prints out the mean, standard deviaiton, standard error, and coefficient of variation.

The entire procedure narrated above completes one simulation run, that is, one year of run. For the validation scenario eight years of run were studied; for the experimental scenario, twenty years of run comprised the duration of one experiment.

The previous section presented a limited overview of the logistics of the various subprograms and subroutines comprising the simulation model. Greater details of the internal activities of each subprogram are found both in the previous Chapter but especially in Appendix A, page .

The validation scenario comprises an eight year run 1960-1968. The period was chosen because real farm net income and farm net worth were available for the actual farm thus providing the historical information necessary to attempt an operational validation of the model. This scenario will also be used to provide a relatively detailed look at the type of output generated by the model. Due to the intensiveness and quantities of tables produced in any one year of simulation and the corresponding compounded number generated over any case period, such annual and scenario results are too many and too cumbersome to present.

Therefore, only summary annual values are normally presented at the end of each simulation year. In order to provide the reader with an intuitive look at the internal behaviour and therefore the capabilities of the model, this validation trial will be detailed and specific output for and during one simulation year, year 5 will be presented in Appendix C, page .

Appendix B identifies the Case Farm Input Data as generally indicated earlier but in detailed form: Table 1 shows the general information; Table 2 shows the amount (value) of crops used at home and the inventory position of crops. If the user visualizes the need for expanding the storage capacity of his farm it is indicated by 'BLDG. EXPANSION = 1', or 0 if no such intention is contemplated. In the present case, the latter applies, hence a zero. Should the farmer desire to store grain off- the farm a 'T' is indicated; an 'F' represents the contrary situation. The user identifies the length of time in days that he is prepared to pay for off-farm storage by a numerical value. In the present case, no off-farm storage is allowed.

Table 3 provides the detailed information about the complement of machinery. The program identifies, for any machinery or implement, any variable given by the farmer whose value is inconsistent with the input internal to the program. It automatically prints out an error message showing the variable, the value given in INCASE and the defaulted value, that is the corrected value to make it consistent with the internal input.

Table 4 presents the financial information submitted about the farm business. This includes the current level of farm equity ratio, assets, liabilities, loan information, the reserve percentage on each type of loan and whether or not the user desires the reserved capital to be used. A 'T' indicates a positive choice, an 'F' a negative.

The rate of return on productive assets selected is also indicated by a value for the variable RATIND. Five rates of return on productive assets are specified: a rate of return equal to the cost of borrowing from the Farm Credit Corporation under the Farm Credit Act (FCAF); one equal to the rate of inflation as represented by the consumer price index (IR); one equal to the yield on Government of Canada Five to Ten Year Bond (GCFTB); one equal to the internal rate of return for any year (IRR); one equal to the cost of borrowing from the Manitoba Agricultural Credit Corporation (MACCO/MACCY); and, one where no specific additional rate is desired. In the present case, the rate of return type is given by a '5', implying that no additional rate is in operation. The source of loan (=1) is from the Farm Credit Corporation of Canada.

The user selects from eight debt structure relationships. In this scenario number '8' - no special one is indicated, thus no special debt structure constrains the model.

Table 5 shows the information submitted for the subroutine TAX including a fixed amount of $500 for income-in-kind.

Table 6 shows the fertilizer information including amounts of material and quantities of nutrients. Table 7 identifies the herbicides used for each crop, the chemical used for seed treatment and the seed varieties for each crop.

Farm information is presented in Table 8. It shows the number of rotations, number of crops and defaulted values of '0' indicating that the model is required to select the appropriate rotation. The soil type for each rotation is identifiable and whether the crop is to be harvested is identified ('YES' or 'NO').

The model operates in two modes, the deterministic and the probabilistic: '1' = deterministic; '2' = probabilistic. The number of plans in any one rotation is identified, here, there is only one plan, given by '1' and one rotation. The upper constraint on the size of the model farm is set at 2560 acres. Any size is permissable.

Four land control acquisition methods are permissible: '1' = outright purchase; '2' = rent-to-purchase; '3' = cash rental arrangement; and, '4' = share rental arrangement. No special land procurement is identified by '0'.

The input data contains 97 plans and the user can select from among these. In the present situation, plan number '17' was selected by the user.

The model requires the user to indicate the willingness to purchase buildings by 'T' = yes, 'F' = 0. If the options include rent-to-purchase, the number of these should be identified. The present situation has none.

Table 9 shows the cropping system information including the landlord share of product (=.33), farm size and breakdown of land into improved, unimproved, and tenureship. The cropable land is shown and the total farm area is apportioned by acres in each crop of each area breakdown.

Table 10 provides information on crop insurance coverage and Table 11 identifies any delays in seeding and harvesting. Hired labour, available on a daily, hourly, monthly and yearly basis are indicated. So too is the type of labour - temporary or permanent.

Table 12 presents the historical and projected yield of crops for 1960-1990. Table 13 presents the same data on prices of crops and Table 14, data on quantity of crops marketed.

RESULTS OF VALIDATION SCENARIO

Tables 7-10 present the annual output generated by the model together with the actual case farm data for the year period, 1960-1968. Since the columns reappear continuously throughout this study and are the basis for analysing the experimental results later, each will be discussed in some detail. Recall that the major performance criteria are net farm income, net farm cash flow and net farm worth. Therefore, each of the following three tables provide the annual values of the major aggregated variables necessary to derive each of the above criteria together with values of important criteria indications.

The simulation year is shown. For this validation scenario, it starts at 1960 and terminates in 1968. The last four lines show statistical indicators of precision and trueness. Thus, the mean represents the trueness of the sample average to the population average. Its precision is measured by the standard error. Both standard deviation and coefficient of variation represent the dispersion or variance of the samples observation from the mean. They measure the precision of the sample observation. These will be interpreted later.

Column 1 shows the total receipts generated by operating the farm over the specified number of years. Total receipts are the sum of crop

TABLE 7

SUMMARY INCOME STATEMENT AND INDICATORS
FOR THE VALIDATION SCENARIO

Simulation Year	1	2	3	4	5	6
1960	21,498	16,272	-5,110	5,226	1,108	3,655
1961	17,436	13,805	-4,019	3,361	1,118	2,249
1962	21,714	18,553	8,238	3,160	1,182	2,766
1963	24,210	16,948	2,579	7,262	1,648	2,555
1964	22,637	17,202	5,720	5,435	2,121	2,047
1965	26,419	17,788	5,577	8,631	2,585	2,386
1966	25,636	18,389	7,118	7,247	3,106	1,964
1967	21,993	17,682	1,871	4,311	2,676	1,600
1968	22,770	18,446	-1,981	4,323	3,240	3,363
Mean	22,701	17,232	2,221	5,470	2,087	2,509
Standard Deviation	2,631	1,493	4,928	1,864	857	664
Coefficient of Variation	0.12	0.09	2.22	0.34	0.41	0.26
Standard Error	877	498	1,643	621	286	221

TABLE 7 (continued)

Simulation Year	7	8	9	10	11	12	13
1960	-4,057	0	1,599	0	1.05	0.15	-0.02
1961	-2,436	0	1,986	0	0.79	0.18	-0.01
1962	10,035	1,292	2,343	0	0.85	0.19	0.10
1963	4,372	0	2,323	4,471	0.70	0.20	0.05
1964	8,291	1,081	2,502	0	0.76	0.17	0.08
1965	8,582	1,314	2,605	2,989	0.67	0.19	0.07
1966	10,943	2,300	2,752	3,552	0.72	0.17	0.08
1967	5,534	566	2,736	6,726	0.80	0.13	0.04
1968	2,129	0	2,762	474	0.81	0.13	0.02
Mean	4,821	728	2,401	2,293	0.80	0.17	0.05
Standard Deviation	5,366	822	394	2,387	0.11	0.03	0.04
Coefficient of Variation	1.11	1.13	0.16	1.04	0.14	0.15	0.88
Standard Error	1,789	274	131	796	0.04	0.01	0.01

1. Total Farm Receipts
2. Total Farm Expenses
3. Gross Margin
4. Net Cash Income
5. Non Farm Income
6. Total Depreciation
7. Net Farm Income
8. Taxes
9. Household Consumption Withdrawals
10. Surplus
11. Gross Ratio
12. Capital Turnover
13. Rate of Return on Capital

sales, income from custom hiring of machinery and equipment, claims from crop insurance for crop damage, government payments and patronage dividends, other crop receipts, miscellaneous crop sales, sales of farm machinery, trade-in value and salvage value of machinery and implements, and value of products used at home. The major contributor throughout this study will be crop sales. These receipts are the products of area of crop, yield of crop and price per unit of product sold. To the extent that anyone or more of the latter varies up and down during and for any year to that extent would crop sales receipt vary.

In Manitoba and other prairie provinces, yields are significantly affected by climatic factors especially excessive wetness, drought, hail and frost. Insects and pests also have a significant influence. These factors affect the quality of grain which influences prices received. Area seeded at any time depends on historical trends in seeded area, seeded area of competing crops, initial prices of major grains, prices of other substitutes and world price. Price received by prairie farmers depend on world situations. The above factors alone or in varying combinations have caused receipts from crop sales to vary markedly on the prairies.

Column 2 contains the annual farm expenses of the farm. Farm expenses consist of machinery operating expenses, building operating expenses, crop insurance, spray costs, fertilizer costs, custom work charges, other direct crop expenses, interest paid on farm debts, hydro and telephone charges, miscellaneous overhead expenses, cash land rent, land taxes, building and machinery insurance charges, share rent and hired labour expenses.

Farm expenses will vary as the interest rate on farm credit, and inflation vary. The latter will cause changes, generally increasing tendencies, in input prices for fertilizer, fuel, machinery, seed, pesticides and interest costs. Expenses will also vary as the size and composition of the farm and the organization of the farm vary.

The gross margin of the operation is shown in column 3. This represents the residual after farm cash operating expenses are deducted from the sum of total receipts and change in value of inventory. Farm cash operating expenses is made up of machinery, building, crop operating, current operating and depreciation charges.

Column 4 shows the annual net cash income position of the farm. It is calculated as the difference between total receipts and total expenses. It provides an indication of profitability of the farm operation cash flow situation.

Column 5 identifies the non-farm income component of the farm family business. This aspect of the farm operation, even today, is an essential component allowing the farm business, in many instances to be able to stay operative. The importance of non-farm income to the viability and survival of the family farm structure continues to be dominant even today. It is made up of off-farm income, interest and dividends, income from other non-farm sources and income-in-kind.

Column 6 shows total depreciation values. These are both machinery and building depreciation charges based on either the straight line method or the reducing balance method.

Column 7 provides the annual net farm income position of the farm. Net farm income is obtained as net cash income plus non-farm income plus change in inventory value of crops less total depreciation.

Column 8 presents the annual taxes paid while column 9 indicates annual withdrawal for household consumption. This is based on a modified equation of Patrick and Eisgruber utilizing five poverty levels in existence in Manitoba in 1975.

Column 10 presents the annual surplus values. Surplus represents the retained earnings from the farm operation after all expenses are paid and which are available for investment and savings. The extent of the surplus indicates the success of the farm business, its ability to grow and survive and the strength of its ability to expand, employ economies of scale and provide a high standard of living and wealth accumulation.

Column 11 shows the gross ratio, defined as total expenses divided by crop sales. It is used to measure the input-output efficiency of the farm business and shows the margin by which gross income exceeds costs. Changes in the gross ratio may reflect changes in product prices and yields of crops or changes in input prices.

Column 12 shows the capital turnover ratio. It is defined as the total crop sales divided by the total value of assets. It provides a measure of the effectiveness with which capital is employed in the business.

Column 13 provides values for the rate of return on capital. It is defined as the quotient of net farm income plus interest paid on farm debts and total value of assets.

The foregoing identified, defined and described the variables used in the income summary tables. These variables will recur throughout this study and would be repeatedly referred to. In the following section a closer examination is made of the values of the previously mentioned criterion variable of net farm income shown in Table 7.

In 1960, net farm income starts off negatively and although the situation improves in 1961, it remains negative. The value of net farm income rises steeply in 1962, falls in 1963, rises through 1964-1966, and continues to fall in 1967 and 1968. This alternative upward and downward movements of the net farm income are in keeping with the general observational behaviour in the industry. Weather variability, price movements and yield variations are the major recorded causes.

An insight of how the model functions with regard to this performance criterion is gained by recalling the definition of net farm income and observing the behaviour of those variables that make up the equation: TOTAL RECEIPTS LESS TOTAL EXPENSES = NET CASH INCOME PLUS NON FARM INCOME + CHANGE IN VALUE OF CROP INVENTORY LESS TOTAL DEPRECIATION = NET FARM INCOME (Before Taxes).

Even though total expenses are relatively high in comparison with total receipts in 1960, net cash income stands at \$5,226. But, gross margin which includes change in value of crop inventory is -\$5,110. The suspicion is that crop inventory has been drawn down due to a greater marketing of grain than production. In fact, the change in value of inventory in 1960 is -\$6,736. The major explanation for the size of the net farm income value in 1960 was the drawing down of crop inventory from the original value of \$12,953 (shown in INCASE INPUT). Another important contribution in this year was the depreciation charges. The amount of \$3,655 was the highest for the nine-year period.

This quantum is directly related to the functioning of the model. The depreciation on machinery amounted to 73 percent of the total depreciation charges representing the fact that the model replaces machinery that are obsolete or too small to do the job in time by a newer model or larger sized one. Additionally, if the model examines the complement of machinery and implements and determines the need for another or additional type of item, and providing that the financial position of the farm allows the item is obtained. Since depreciation begins once the item is bought, any one or combinations of the above situations will generate a high depreciation charge. In the particular year of 1960, many of the items of machinery and implements are very old so that the depreciation would be high. This point will also be highlighted as a cause of the difference between the actual farm net farm income and that of the model when the validation is discussed.

The input-output efficiency of the operation is viewed by looking at the expense to income ratio indicators. The gross ratio of 1.05 implies that in 1960, operating expenses were $1.05 per dollar of crop sales, or alternatively that net farm income in 1960 was equal to -$0.05 per dollar of crop sales. The capital turnover ratio of 0.15 implies that only 15 cents of crop sales were generated for each dollar of capital invested in 1960. Further, the rate of return on capital indicator depicts that a negative rate of return of 2% was returned on investment.

Therefore, the expense to income ratio and the income to investment ratios indicate that in 1960 both the operating efficiency and the efficiency of capital investment were disappointing.

In the second year of simulation net farm income shows an improvement but still remains negative. Total farm receipts have dropped by 19 percent but expenses have dropped by 15 percent. Net cash income is dropped by 31 percent and depreciation by 38 percent. The decline in farm receipts was greater than the decline in expenses but still cannot account for the 31 percent drop in net cash income. Obviously, factors other than the functioning of the model are involved.

The economic and physical environment of crop production influenced the returns to farming in 1961. Crop yields in 1961 were very low but so too were acreages. Consequently, total production was down and although prices were quite good, the impact of yield and production overwhelmed the price causing reduced returns to farmers. This reduction in yield and area was due to the drought situation prevailing in Manitoba that year. Gross margin continues to be negative but shows a marginal improvement. Again the effect of reducing inventory stocks causing a value of change in inventory of \$4,938 is revealed. The combination of the latter depreciation charges together with the impact of production explains the income situation.

All three efficiency indicators show improvement suggesting that the efficiency of operation and efficiency with which capital is employed are improving. The gross return ratio of 0.79 implies expenses cost 79 cents for every dollar of crop sales or that net farm income amounted to 21 cents per dollar of crop sales. The capital turnover ratio was 0.18 suggesting that for each dollar of asset in 1961, 18 cents of crop sales were generated. The rate of return was still less than zero but improved over 1960.

In 1962, net farm income rebounded significantly showing a value of \$10,035. It is interesting to note that total farm receipts is only slightly above the level of 1960, that farm expenses are higher than both 1961 and 1960 and that net cash income is lower than in both the latter years. Moreover, depreciation charges, though higher than in 1961, is lower than in 1960. Yet gross margin and net farm income are significantly higher than in the previous two years. The value of crop inventory change is the common factor in these two quantities. In fact, in 1962, the value of inventory change amounted to $8,459. Examination of the efficiency ratios reflect that operational efficiency and capital use efficiency are still not satisfactory. However, the return on investment has improved significantly to 10 percent.

In 1963, net farm income dropped to 44 percent of the 1962 value. Total farm receipts increased by 11 percent but farm expenses decreased by 9 percent from 1962. Consequently, net cash income increased by 130 percent over 1962. However, gross margin decreased by 69 percent. Again, the value of inventory change was important at -$1,984. Combined with depreciation charges, inventory depletion cuased the decline in net farm income. Despite the above situation, gross ratio was .70, implying that net farm income amounted to 30 cents per dollar of crop sales. The capital turnover ratio of 0.20 shows that for each dollar of asset, 20 cents of crop sales were generated. The return on capital investment was 5 percent.

In 1964, net farm income amounted to $8,291, 91 percent higher than in the previous year even though farm receipts declined by 6 percent and farm expenses increased by 1.5 percent. Net cash income and depreciation charges declined by 25 and 20 percent respectively from 1963. Gross margin, however, more than doubled. The appreciation in both net farm income and gross margin resulted from a positive value of $2,781 in value of inventory change. The ratio indicators show that for every dollar of crop sales, 24 cents in net farm were received; for each dollar of asset 17 cents of crop sales were received and the return on investment was 8 percent.

Net farm income increased in 1965 and 1966 and reached its highest value of $10,943 in 1966. In 1965, net farm income reached $8,582, 4 percent higher than the precious year. Total farm receipts were $26,419, 17 percent higher than 1964 and represented the highest level over the nine-year run. Total farm expenses rose by only 3.4 percent resulting in a net cash income, 59 percent higher than in 1964. Net farm income amounted to 33 cents of every dollar of crop sales; 19 cents of crop sales were generated and rate of return was 78 cents.

It should be noted that good prices and yields were obtained for crops in 1965 causing the increase receipts. On the expenses side, machinery and building operations, fertilizer use, interest, hydro and telephone, and share rent dominated. Increasing expenses are directly related to increased purchase of machinery due to obsolescence. The value of inventory change of $248 is reflected in the positive values of gross margin and net farm income.

In 1966, net farm income reached $10,943 despite a 3.0 percent drop in receipts and 3.4 percent increase in expenses from the previous year. The latter combination accounts for the fall of net cash income to $7,247, 16 percent below 1965. Gross margin increased by 28 percent indicating the influence of value of inventory change which was $2,554 in 1966. This influence is also shown in the net farm income value.

During the last two years of the simulation, net farm income declined steeply falling to $5,534 in 1967 and $2,129 in 1968. Again, the influence of changing yields, prices and value of inventory are seen. The continuing influence of expense components directly related to machinery purchase and operation and the need for improved efficient use of fertilizer and plant protection technology are displayed throughout. Share rental cost has a strong influence on expenses. To the extent that share rental is eliminated the income position will be improved.

Moreover, as the farmer stabilizes his machinery complement by replacing obsolete ones and reaching the optimum, to that extent increases in expenses will increase at a slower rate, eventually level off, and decrease. Concurrently, the efficiency and profitability of the farm will improve.

A very important factor affecting the net farm income position in this study is the manner of allocating new land brought under control of the farmer. In the present scenario, this option is non-existent but in later scenarios will appear. It will be discussed more fully therefore, later. Suffice it to say that because the model allocates new land to crops on the basis of crops contribution to the profitability of a plan, how this is done influences the financial picture. For example, to the extent that wheat is the most profitable crop, to that extent will the financial picture improve due to the higher prices for wheat. The cost per acre of production of the crop influences the net farm income picture accordingly.

The mean net farm income during the eight years was $5,158. The great variability of the value for net farm income during the period is clearly reflected in the values of standard deviation, coefficient of variation and standard error. The mean value for farm cash receipts was $22,701 and with smaller vales of standard deviation, coefficient of variation and standard error present much less variability and imprecision than the net farm income.

Similar to total farm receipts, total farm expenses reflect more stability than the net farm income but are even less variable than the total receipts. Net cash income behaves in a similar manner to receipts and expenses and this is to be expected as it is the difference between the two. Similarly, the behaviour of gross margin reflects the variability of the net farm income.

The general upward trend in the gross ratio reflect reduced crop sales emanating from generally declining yields and this was especially so in 1961, 1962, 1967, 1968. The generally upward trends in capital turnover and rate of return signify improvements in operating and capital efficiencies.

Table 8 presents the net worth summary and balance sheet indications. Column 1 shows the short term assets of the farm business. These are items which are easily converted into liquidity. Short term assets are the sum of cash, other personal assets, grain, hay and supplies in inventory and miscellaneous other assets.

Column 2 shows the annual value of the farm medium term assets. These consist mainly of machinery and implements.

Column 3 contains the annual value of long term assets primarily land and buildings.

Assets are valued generally at current market value. Value of grain is based on the unit price reflected in the input table. This price represents the price received for selling the item in the current year. New buildings and machinery are valued at market price and older items at their depreciated value. Land is valued at the current price as shown in the input table which may or may not represent current market prices.

Column 4 shows the total value of all assets.

TABLE 8

NET WORTH SUMMARY FOR THE VALIDATION SCENARIO

Simulation Year	1	2	3	4	5	6
1960	13,232	18,501	68,235	99,969	1,799	7,296
1961	8,294	17,795	71,370	97,459	1,500	6,418
1962	16,753	17,199	79,494	113,446	2,014	5,491
1963	14,769	24,791	79,571	119,131	514	13,900
1964	17,550	24,063	87,869	129,483	1,500	12,031
1965	17,303	26,419	97,504	140,776	514	13,921
1966	19,856	25,800	105,488	151,144	--	12,126
1967	20,004	25,279	118,049	163,331	--	10,206
1968	17,931	31,382	125,775	175,088	1,053	14,689
Mean	16,188	23,470	92,545	132,203	988	10,675
Standard Deviation	3,666	4,721	20,440	27,424	762	3,493
Standard Error	1,222	1,574	6,813	9,141	254	1,164
Coefficient of Variation	0.23	0.20	0.22	0.21	0.77	0.33

TABLE 8 (continued)

Simulation Year	7	8	9	10	11	12
1960	18,200	27,292	72,673	7.35	0.38	--
1961	17,379	25,297	72,162	5.53	0.35	-512
1962	16,502	24,007	89,438	8.32	0.27	17,277
1963	15,566	29,979	89,152	28.73	0.34	-287
1964	14,566	28,097	101,386	11.70	0.28	12,234
1965	13,500	27,934	112,842	33.60	0.25	11,456
1966	12,361	24,486	126,658	--*	0.19	13,816
1967	11,145	21,351	141,980	--*	0.15	15,322
1968	9,847	25,589	149,499	17.02	0.17	7,519
Mean	14,341	26,004	106,199	12.48	0.26	8,536
Standard Deviation	2,859	2,603	28,494	11.92	0.08	7,125
Coefficient of Variation	953	868	0.27	3.97	0.03	2,375
Standard Error	0.20	0.10	9,498	0.96	0.31	0.83

1. Short Term Assets
2. Medium Term Assets
3. Long Term Assets
4. Total Assets
5. Short Term Liabilities
6. Medium Term Liabilities
7. Long Term Liabilities
8. Total Liabilities
9. Net Farm Worth
10. Current Ratio
11. Leverage Ratio
12. Change in Net Worth

*Very large

In columns 5-8, liabilities are identified. Liabilities refer to the claims against the farm business. Short term liabilities are those claims against the business that must be retired in less than eighteen months. These include loans from friends and line of credit. Medium term liabilities are repayable between eighteen months and ten years. These are mainly due to the acquisition of medium term assets. Long term liabilities are indebtedness arising from the purchase of land and buildings or in some cases machinery. They are retired in a time period greater than 10 years.

The structure of assets and liabilities play a very significant role in the net worth accumulation and wealth acquisition of the farmer. The survival and profitability are closely tied to these variables. Total liabilities represent the summation of all outstanding liabilities of the business.

Column 9 shows the net farm worth of the business obtained by deducting total liabilities from total assets. It is a measure of the equity the farmer holds in the farm business.

Column 10 gives the current ratio which is defined as total current assets divided by total current liabilities. The current ratio is a measure of the financial state of the business reflecting the ability of the business in case of bankruptcy to meet the current liabilities. It reflects the liquidity position during a short time period of eighteen months.

Column 11 shows the leverage ratio or debt to equity ratio. It is a general measure of the solvency of the farm business and is defined as total liabilities divided by net worth or equity.

Change in net worth is shown in column 12. It is a measure of the growth and financial success of the business. The changing financial structure of the business is indicated by the above three ratios.

Having briefly described the variables in the table, the analysis will focus on the second performance criterion, farm net worth, which indicates the financial structure of the farm over the period under examination. As was previously done under net farm income, ancilliary use will be made of the indicator variables to explain shifts and to point out how the model behaves with regard to net farm worth.

In 1960, short term assets were valued at $13,232, medium term assets at $18,501, and long term assets are $68,235, for a total asset value of $99,969. In 1961, the value of short term assets dropped 37 percent, medium term assets dropped by 4 percent and long term assets increased by 5 percent. The combined effects resulted in a 3 percent decline in the value of total assets.

Correspondingly in 1961, short term liabilities declined by 17 percent, medium term liabilities by 12 percent and long term liabilities by 5 percent respectively from 1960. Total liabilities declined by 7 percent below the 1960 value. Intuitively, the declines in short term and medium term asset values in 1961 relative to 1962 suggest that some assets have been dispensed with and probably used to purchase some long term assets since the latter accreted in value. Since total assets also declined in value, the counter effects did not balance out, that is, the dispensation of short term and medium term assets did not balance out with the value of the acquired long term assets.

In reality, however, the explanation lies in the functioning of the model. The reduction in short term assets was due to the depletion in the value of grain and hay brought about by the need to market all hay and forage, and to market quantities of grain based on the specification outlined in STOCST and in the marketing component described earlier whereby a certain amount of the crop is marketed each year, namely the equivalent of the seeded area times the yield minus the landlord share. This has the effect of reducing inventory in any year when the above value is less than the quantity produced.

The difference between medium term assets in 1960 and 1961 merely reflects decreases due to depreciation while the difference between the values of long term assets reflect the appreciation in land prices. The changes in liabilities just reflect the reduction due to meeting the required payments on each type of indebtedness.

Farm net worth in 1960 was $72,673 but decreased only marginally to $72,162 in 1961, reflecting no attained financial growth. The current ratio declines from 7.35 to 5.53 in 1961 implying that the current asset value per dollar of current liability dropped from $7.35 in 1960 to $5.53 in 1961. But, financially, the farm operation was well endowed. The leverage ratio or debt to equity ratio likewise dropped from .38 in 1960 to .35 in 1961. This means that the debts of the farm dropped from $38 per $100 of equity in 1960 to $35 per $100 of equity in 1961, reflecting the improved financial situation shown by the net worth and current ratio.

During the next seven years the farm net worth continuously increased reaching a maximum of $149,499 in the final year of simulation. The mean value during this time was $106,199 and the value of the standard error $9,498, relatively small indicates the precision of the mean. Moreover, the smallness of the standard deviation and coefficient of variation indicates that the spread in the measured values of net worth is small.

Based on the behaviour and precision of the values of net worth during the run, the farm displays sustained financial progress throughout the eight years.

Short term assets more than doubled between 1961 and 1962. As was earlier mentioned, in this run, only the value of grain and hay is likely to vacillate as changes in yield, production and marketing quantity allowed vary annually. In viewing the detailed run (with the author), the value of grain and hay was $9,736 in 1962, while in 1961 the value was $1,278, the difference between short term assets in 1961 and 1962.

Again, the differences between medium term assets and long term assets reflect changes due to depreciation in the former, and depreciation and price changes in the latter. The variation in total assets obviously follows.

The decline of short term assets to $14,769, a decline of 11 percent from 1962 is again explained because the value of grain and hay in inventory dropped by 20 percent from 1962. This behaviour of short term assets, especially the changing value of grain and hay in inventory, affects the net farm income through the influence of changes in value of inventory.

Medium term assets were valued at $24,791 in 1963 representing a 44 percent increase over 1962. This was due to the replacement of obsolete machines by new machines. Long term assets value was essentially the same as 1962 due to little appreciation in the value of farm land in 1963 above 1962. Again, the increase in value of total assets in 1963 over 1962 follows from the above.

Short term asset values, in general increased between 1963 and 1967 but finally decreased in 1968. This behaviour is explainable as indicated before. Similarly, the behaviour of medium term assets, long term assets and total assets throughout the rest of the simulation follow the explanations given earlier.

An examination of the mean, standard deviation, coefficient of variation and standard error reveal that short term asset averaged $16,188, medium term assets $23,470, long term assets $92,545 and total assets $132,203. The precision of these means is reflected by the small values for their respective standard errors while the precision of the individual annual values is reflected by the small values for the coefficients of variation and standard deviations.

The behaviour of the values for the three forms of liabilities are tied in with the corresponding value of asset behaviour. Thus, the model pays off short term debts first, then medium term debts and finally long term debts as the financial situation warrant. This pattern of behaviour is not significant in this run but will be of great importance in the experimental runs. In this part of the analysis, the depletion of short term debts is simply due to the retirement of the debt.

The latter observation also applies to medium term liabilities except that in those years that the model replaces and/or purchases additional machinery and implement, not only would the asset situation improve, but the level of indebtedness would rise. Purchase of assets require a minimum down payment of 25 percent of the cost of the item. Thus, while the asset value accretes by the difference between the value of the additional or new machine, the indebtedness accretes by less than the full value of the item. A similar situation arises for long term assets and indebtedness.

Liabilities will also be strongly influenced by the debt structure ratio which applies in the experiments to follow later. Similar comments to those addressed to the asset types apply to the liability types in so far as the precision of the mean and individual annual values are concerned.

The very nature of short term liability, that is, they are incurred for operating activities, permit for great variation in individual values. This is reflected by the coefficient of variation of .77 and the relatively high standard deviation of $762 compared to the mean of $988. It is interesting to note that in every year the asset type has a greater value than the corresponding liability types, eg. medium term asset value in 1965 of $26,419 is greater than the medium term liability of that year of $13,921. The reason for this was explained earlier. The financial strength of the farm business is clearly displayed by the table. The current ratio has shown a general upward trend reflecting the already observed strong financial situation. The sudden change from $28.73 of current assets per dollar of current liabilities in 1963 to $11.70 of current assets per dollar of current liabilities in 1964 is reflective of the rise in current liabilities from $514 in 1963 to $1500 in 1964 due to the unavailbility of cash for operating expenses as reflected in a surplus value of 0 in Table 7. The mean value of the current ratio shown is 12.48, shown to be low because the model adds zeroes as values for

1966 and 1967 in determining the mean. The real value of the mean is higher at 16.04 if 1966 and 1967 are excluded.

Given that financial institutions look for a value no less than 2.0 for the current ratio, the average value represents a superior financial situation.

In general, the leverage or debt/equity ratio has continuously declined from $38 of debts per $100 of equity in 1960 to $15 of debts per $100 of equity in 1968 except in 1963 when the ratio was 0.34 and when it rose from .15 in 1967 to 0.17 in 1968. The sudden rises in both years were due to purchases of machinery which increased the outstanding medium term liabilities, and consequently the total liabilities.

The change in net worth is a function of the net worth and ultimately dependent on the asset and liability situation. It is likely to show a wide variation in values as total assets vary with purchases, sales of grain and hay, price of land and retirement of loans. Between 1960 and 1961, the change in net worth amounted to -$512 due to the decline in total assets resulting primarily from the drawing down of grain and hay inventories causing a drop in the value of short term assets. Contrarily, between 1961 and 1962, the change in net worth was $17,277, reflecting the change in short term assets from $8,294 in 1961 to $16,753 in 1962. The change in net worth is a measure of the farm attained financial growth. The data reveals a general positive trend in the annual change in net worth although the rate of change varies between years. The average change in net worth over the eight year period was $8,536.

Table 9 shows the cash flow summary during the nine years of the trial. Although, no data was available for the actual case farm, the model

TABLE 9

CASH FLOW SUMMARY FOR THE VALIDATION SCENARIO

Year	Total Inflow	Total Outflow	Net Cash Flow
1960	27,126	28,921	-1,795
1961	19,436	22,109	-2,673
1962	23,769	24,666	897
1963	35,405	24,983	10,423
1964	25,615	24,615	1,000
1965	32,543	25,782	6,761
1966	28,061	26,214	1,847
1967	23,937	24,648	-711
1968	33,265	26,204	7,061
9 Year Mean	27,684	25,349	2,335
Standard Deviation	5,202	1,822	4,626
Standard Error	1,734	607	1,542
Coefficient of Variation	0.19	0.07	1.98

results are presented for the sake of completeness of the model behaviour. Column 1 shows the value of total inflows. Total inflow consists of crop sales, machinery sales, income in kind, quantity of funds borrowed, off farm income and other income. Column 2 shows the total cash outflow. This comprises purchased crops, share rent, crop operating expenses, machinery operating expenses, building operating expenses and current expenses, interest paid on farm debts, other farm purchases, principle paid on farm loans and cash withdrawn for household uses. Column 3 represents the net cash flow. Net cash flow is the difference between total inflow and total outflow.

The table reveals that net cash flow starts off negatively, falls in 1961, rises in 1962, rises through 1963, falls in 1964, rises in 1965 and declines in 1966 and 1967, before rising again in 1968.

Total inflow declined by 28 percent between 1961 and 1960 while total outflow declined 24 percent. This combination caused net cash flow to decline as earlier mentioned. On the inflow side, while the value of crop sales increased from \$15,486 in 1960 to \$17,436 in 1961, machinery sales dropped from \$6,012 in 1960 to zero in 1961. At the same time, money amounting to \$5,127 was borrowed to purchase machinery in 1960 while borrowing in 1961 amounted to only \$1500 to finance operating costs. The net result of the above was the decline in inflow.

On the outflow side, share rent declined from \$1,674 in 1960 to \$491 in 1961, total crop operating expenses increased from \$4,805 in 1960 to \$5,741 in 1961, total machinery operating expenses increased from \$3,084 in 1960 to \$3,201 in 1961, total principle paid on loans and cash withdrawn for household uses increased from

$5,051, and $1,599 respectively in 1960 to $5,349 and $1,986 respectively in 1961. At the same time, total current expenses, interest paid on farm debts and value of capital purchases declined from $2,372, $2,035 and $5,127 respectively in 1960 to $1,980, $1,738 and 0, respectively in 1961. Building expenses declined from 1960 to 1961.

Changes in all variables are consistent with the specification of the model. Receipts from crop sales rose in 1961 partly due to the price increases. In 1960 obsolete machines were replaced by new ones, the obsolete ones having been sold for 90 percent of their depreciated value and shows up as value of machinery sales. No such sales occurred in 1961. Purchase of new machines required the borrowing of funds in 1960 while no such borrowing was required in 1961. However, in 1961, because of cash flow problems in 1960 and the drawing down of cash reserves, borrowing amounting to $1,500 was made in order to meet operating crop expenditures.

Share rent, as previously explained is a function of crop production and the quantity of land share rented. For the same quantity of share rented land, the lower the yield and price the lower the share rent costs. The decline of the share rent between 1960 and 1961 was partly due to the lowered yield and production in 1961. Increases in crop and machinery operating expenses are due to increased prices of farm inputs including hydro and electricity, fuel, herbicides, fertilizer and machinery repairs, and labour. Interest paid on farm debts declined between 1960 and 1961 due to the combined reduction in interest cost and total liabilities in 1961. No capital purchase was made in 1961 as was done in 1960 and the total principle paid on loans increased in 1961 over 1960 because the new loans taken out in 1960 had their first principal payment made in 1961. Cash withdrawn for household uses is directly related to the inflation rate and income. It is expected to increase as the latter appreciate.

Throughout this trial the pattern of behaviour of inflow, outflow and net cash flow are in agreement with the explanations advanced previously. Thus, the increase in inflow value from $23,769 in 1962 to $35,405 in 1963 compared with the marginal change in outflow from $24,666 in 1962 to $24,983 in 1963 explain the significant change in net cash flow from $897 in 1962 to $10,423 in 1963.

Moreover, the jump in inflow is traceable to changes in crop sales, amount borrowed and off farm income. Off farm income is defined as a percentage of farm income. Thus, in 1963, total inflow increased by 50 percent over 1962 as crop sales increased 11 percent, amount borrowed increased by 559 percent and off farm income increased from $55 to $517. On the outflow side, significant changes occurred in share rent since this varies with crop sales, building operating expenses due to depreciation increases with age, and greater costs for heating and hydro etc., due to age plus the need to house more machinery. Interest paid on farm debts increased due to additional indebtedness incurred in purchasing machinery and increased principle paid resulting from increased debts.

The mean inflow over the duration of the runs was $27,684, the mean outflow was $25,349 and the mean net cash flow was $2,335. The standard errors for total inflow and total outflow indicate that the means of these two variables are precisely measured. The relative smallnesses of the standard deviations and coefficient of variation indicate the relatively small spread among the data.

Contrarily, the mean standard deviation, coefficient of variation and standard error of the net cash flow attest to the spread or variability among the data and the dispersion of the data from its mean. This observation follows from the risks and uncertainty accompanying agricultural production.

Up to this point, the discourse has addressed the net farm income, net worth and net cash flow individually except for sparse mention of an implied relationship and coordination among the three to give the total financial picture and evaluation of the farm business. In the following section, the interrelationships between and coordination among the three as perceived by the model, are reviewed.

The balance sheet or net worth statement presents a snapshot view of the farm financial situation at any point in time. Both the net income statement and cash flow summary provide information on income and expense flows, and cash and credit transactions over time. As such, the latter statements allow a comparison of the farm financial operation through time, while net worth allow for comparison at definite points in time.

The balance sheet at the end of one year becomes the starting balance sheet for the beginning of the next year. Thus, the assets in the net worth statement of one year is made up of net worth and liabilities at that time. During the course of operating the farm in the year the value of capital purchases found in the cash flow. statement adds to the value of assets; the value of inventory changes found in the income summary statement adds or deducts from the asset value. Depreciation charges from the income statement summary reduces the value of assets. Increases in the price of land increases the asset value of land. These values are reflected in the balance sheet for the next year.

The liabilities in the one net worth statement are modified during the year as indebtedness is retired and new amounts borrowed to purchase machinery and to operate the farm. The net worth stated in the one balance sheet is modified by activities during the year. Thus, net farm income from the income statement, cash withdrawn for household uses, and taxes influence the net worth in the following net worth statement.

In summary, the behaviour of the model has been followed through to explain the values of the three performance criteria of net farm income, net cash flow and net worth generated annually in this validation scenario. An intuitive insight of the model's behaviour was given by focussing not only on the changes in the performance criteria but into the details of the variables that comprise the equations generating the values of the performance variables. Finally, a short indication of how the model links up the three criteria statement in a coordinated manner to permit a complete financial evaluation was given.

The final section seeks to compare the values or the performance criteria generated by the model with the actual values obtained from the case farm. Because no values for the net cash flow was given, only the net farm income and net worth will be examined.

To expect exactness in the values from the two sources is impractical but similarities in behaviour are expected if the model is to be scrutinized as a representation of the actual farm. While exactness of values is not necessary or desirable, divergence in magnitude and/or direction of behaviour should be reasonably accounted for. That is the task of this section.

Table 10 presents the net farm income and net farm worth information produced by the case farm and those generated by the simulation model. Figure 14 follows the values through the period 1960 to 1967 and portrays the differences more vividly. The net farm income is examined first. Although the pattern of behaviour and rational thereof for the model net farm income results during this trial were addressed earlier in the discussion, it is necessary for the elucidation at hand, where necessary, to repeat the important points.

The 'actual farm' net farm income declined in 1961 and 1962, rose in 1963, 1964 and 1965, declined in 1966 and rose again to $25,709 in 1967, its maximum for the eight year run. By contrast, the model values begin negatively and though increasing stayed negative in 1961. It rose dramatically in 1962, declined in 1963 before rising in 1964 and continuing to increase in 1965 and 1966 before declining in the final year of the run.

Before proceeding further a few points about the 'actual farm' are important. Firstly, while the model was developed to represent a real world crop farm, the 'actual farm' was not a completely crop operation. Livestock was part of the operation and contributed cash sales to receipts. Likewise, some costs would have been incurred. However, the 'actual farm' was a dominant crop farm having more than 75 percent of production and income generated by crops. That was the criterion of a crop farm in this study.

Although, the details of the variables making up the net farm income and net farm worth of the specific case farm used are unavailable, the basic details are those found in Appendix C, page . The first

TABLE 10

NET INCOME AND NET WORTH VALUES GENERATED BY THE SIMULATION MODEL AND THOSE ACTUALLY GIVEN IN THE CASE FARM FINANCIAL STATEMENTS

	Net Farm Income					Net Farm Worth				
Simulation Year	1	2	3	4	5	6	7	8	9	10
	$	$	$	$	$	$	$	$	$	$
1960	8,975	--	-4,057	--	13,032	66,237	--	72,673	--	6,436
1961	6,329	-2,646	-2,436	-6,493	8,765	71,249	5,012	72,162	-511	913
1962	6,086	-243	10,035	7,599	3,949	74,091	2,842	89,438	17,276	15,347
1963	9,603	3,517	4,372	-5,663	855	81,100	7,009	89,152	-286	8,052
1964	11,792	2,189	8,291	3,919	3,501	90,205	9,105	101,386	12,234	11,181
1965	16,914	5,122	8,582	291	8,332	116,104	25,899	112,842	11,456	-3,262
1966	10,220	-6,694	10,943	2,361	723	125,318	9,214	126,658	13,816	1,340
1967	25,709	15,489	5,534	-5,409	20,175	148,523	23,205	141,980	15,322	-6,543
Mean	11,953	2,391	5,895	-484	-1,132	96,603	11,755	100,786	9,901	4,781

1. Actual Case Farm
2. Yearly Change in Actual
3. Model
4. Yearly Change in Model
5. Model - Actual

6. Actual Case Farm
7. Yearly Change in Actual
8. Model
9. Yearly Change in Model
10. Model Actual

implication of the above is that total receipts of the 'actual farm' included values for 'Labour and Custom Work Incomes', 'Wheat Board Payments', 'Other Miscellaneous Receipts', and 'Receipt from Sales of Livestock.' Farm Expenses would probably also include purchases of livestock and feed and 'increased' interest paid on loans due to the latter. A change in inventory value of livestock would have been included and would have influenced the value of net farm income. Asset values would have been augmented by the value of livestock. Crop insurance claims would also have been included in the 'actual farm' income statement.

While the model provides for many of the above, such values are to be provided by the user or the model defaults them to zero. The model income statement includes as receipts sales, trade-in values, and salvage values of machinery unlike the 'actual farm'. Off farm income is assumed to be 0.33 of net farm income and defaults to zero if net farm income is negative. Dividends are assumed to be 0.17 times off-farm income and income-in-kind is assumed to be $500.

In the 'actual farm' accounts, depreciation is by the reducing balance method only whereas the model uses both the straight line and reducing balance methods. The straight line method is used up to 1972 and the reducing balance method after 1972. The straight line method attaches a fixed percent of the item as depreciation cost during its useful life while the reducing balance attaches a percent of the remaining value of the asset yearly as cost of depreciation. In the early years of the life of the item, the reducing balance writes off a larger amount as depreciation and this amount decreases as the useful life decreases.

Prices of products in the actual farm are based on actual prices and yields are based on actual yields. Receipts are based on actual production and delivery. In the model prices, yields, and marketings are partly historical and partly trended values.

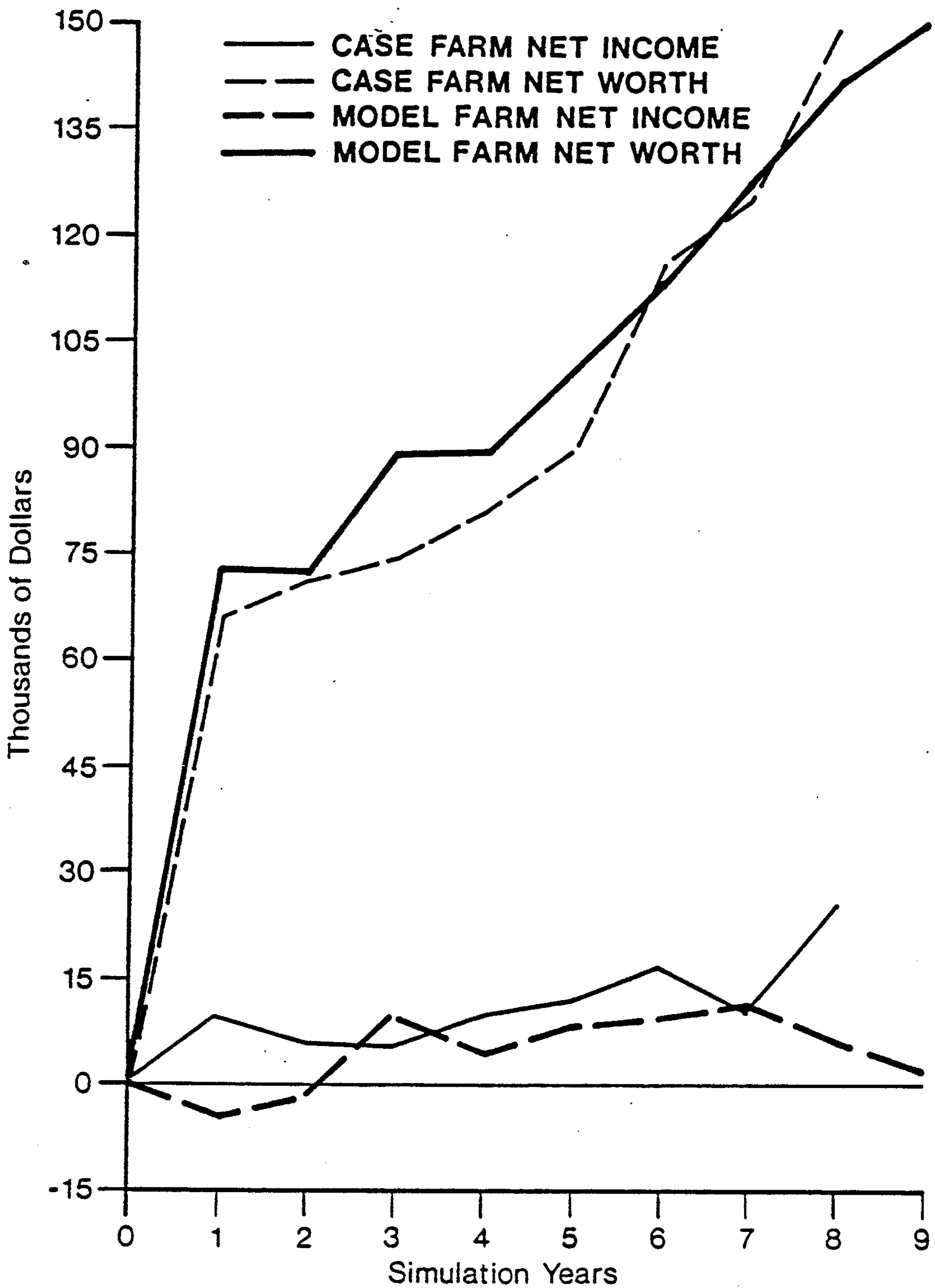
The net worth of the 'actual farm' includes livestock, livestock feed supplies and farm accounts receivable. These will tend to increase the value of assets and net worth. In the 'actual farm', crops are valued at the initial Canadian Wheat Board prices for grains to be sold to the Canadian Wheat Board and at the expected selling prices for grain to be sold as feed and seed. The model uses the price received by Manitoba farmers which is a weighted price of the different grades and types of grain. New buildings and machinery are priced at market price or cost, and older items at the book price, with adjustment made for quality differences.

In the model, new machinery and buildings are valued similarly. However, because the reducing balance method of depreciation depreciates an item more rapidly the value is likely to be underestimated. In the 'actual farm', land is valued at the current market value. This was the ability to discriminate for quality, location and other intrinsic factors that determine the market price. The model uses an average price as published in the Yearbook of Manitoba Agriculture. These prices need not be representative of the market value. To the extent that they do not, land value would be underestimated by the model. Net worth will also be underestimated and income will be influenced through changes in interest and dividend income.

In comparing the two sets of net farm income values, it is to be expected that the previously cited differences between the

FIGURE 14

NET FARM INCOME AND NET FARM WORTH COMPARISONS OF MODEL AND CASE FARM UNDER VALIDATION SCENARIO



composition of these are partly responsible for the divergence. Part of the explanation is found in the behaviour of the model as explained in the first part of the chapter.

In order to reemphasize the last point aspects of the behaviour of the model will be restated. The difference between the two net farm income values in 1960 was $13,032, that is, the net farm income value given by the model was $13,032 less than that given by the actual farm. The value of $8,975 given by the farmer is given after the fact. However, the model operates by looking at the case input data such as land, labour, machinery, crops, soil type, etc. Using these data and decision variables programmed throughout the model, the model checks to see if the given resources could operate the type of farm organization the user identifies.

In the present case, for example, when it checks the machinery complement given, it finds obsolete machines and gets rid of them after ascertaining the availability of funds. Two machines are sold off and replaced by larger and newer ones. This action generates machinery sales which adds to receipts, and amount borrowed, increasing medium term liabilities and total liabilities, increases the value of medium term assets and total assets and increases equity since 25 percent of the cost of the item is mandatory down payment.

Interest charges are increased and principle paid increases. Operating costs increase due to larger items and depreciation charges increase also. In addition, all operating costs are trended through the Farm Input Price Index. These values will probably differ from those of the 'actual farm'. Additionally, because of the marketing procedure built into the model inventory of crops is depleted. The change in value of crop inventory was $16,737 in 1960. The above factors explain the divergence in the two values of net farm income. The above combination of factors, model behaviour and different items in equations will also explain the divergence in the two values of net farm income throughout the eight-year run.

Again, the divergence in values of net worth from the two sources are explainable by the same two sets of factors above. For example, the model does not include stocks in its asset values in 1960, whereas the 'actual farm' includes a value of stocks equal to $12,406. The model augments its value to medium farm assets by purchase of two new machines. Land is appraised at $91,982 by the farmer but the model appraises it at $59,422. Despite all these differences, the difference between the two net worth values in 1960 of $6,426 is not very significant.

The second part of the objective was achieved by identifying differnces between the three statements as generated by the model and the 'actual farm', values of net income and net worth. Although the detailed statements of the specific case farm was unavailable, Appendix C, page represents an example of the exact content of those statements. Having identified the differences in the statement, the differences between the performance criteria of net farm income and net farm worth were perused from which the conclusion was deduced that the two sets of data, though superfically different are reasonably explainable by the 'differentness' of the variables included and/or excluded in both sets of statement and by the operational behaviour of the model.

In the next chapter, the experimental results will be presented, described and analysed and in doing so will draw extensively on the discussion of this chapter.

The purpose of this chapter was two fold, firstly, it was to provide the reader with an insight into the functional behaviour of the model, and secondly, to compare the output of the model to that of the 'actual farm'. In order to attain the former, a brief overview of the hierarchical logic of the model was reviewed. This showed the computer program, subprograms and subroutines when they were called and in what order and how each part functioned in order that the program became a whole farm simulation model. This was followed by a detailed examination of the validation scenario run for the period 1960-1968 with discussions of the model's behaviour as it generated the three major financial statements of net income, net cash flow and net worth with explanations of the values.

CHAPTER VI

ANALYSIS OF EXPERIMENTAL RESULTS - PART I

Chapter VI examined problems encountered in analyzing stochastic simulation runs, presented the results of validation, and analyzed those results to display their support for the validity of the model. This chapter discusses the experimental procedure, presents the factors and levels of factors used, and presents and discusses the experimental results. The results are presented both in terms of scenario and on a treatment basis in that for each treatment the performance criteria are examined in terms of the objectives of the study. The final section presents and discusses results of a general analytical and supportive nature.

METHODOLOGY

The Simulation Experiment

The principal objective of the experimental design was to establish the best solutions to the problem at the lowest cost. This was achieved by studying the response surface at selected points of interest in the sample space. The response surfaces represented the performance of the firm with respect to net income, net worth and annual net cash flow. The controllable factors were farmland use control arrangements, debt-structure ratios, and rates of return on productive assets.

Statistical Design

The statistical design was a randomized complete block design with a factorial arrangement of treatments in three replicates.[185] In this way the factors were combined to give alternate courses of action to be tested. The controllable variables assumed discrete values, thus permitting only a finite number of alternatives. There were four 'levels' of farmland use control arrangements: purchase, rent-to-purchase, share rent, and cash rent. There were two 'levels' of debt structure ratios: short term to long term ratio of .1429 and medium term to long term ratio of .2857. There were two 'levels' of rate of return on productive assets: the yearly inflation rate and the actual rate of interest charged by the Farm Credit Corporation under the Farm Credit Act (FCAF).

The design was, therefore, a 4x2x2 factorial with 16 treatment combinations. The deterministic model involved only seventeen treatments including the basic case farm 'in situ' or control.

Experimental Procedure

The experimental procedure comprised the following. The simulator was run with the representative case farm situation and each of the land procurement options and performance measures evaluated. For the deterministic model, the output at the end of the run of twenty years gave the performance measures.

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[185] W.C. Cochran and G.M. Cox, Experimental Designs, Second Edition, John Wiley & Sons, Inc. 1957 Chapters 2-4. B. Ostle, Statistics in Research, Second Edition, Ames, Iowa: Iowa State University Press, 1963, Chapters 10-12.

The case farm situation was now run under the deterministic model with treatment conditions. Output was gathered and evaluated. Finally, results for the case farm under the deterministic model and under control and experimental conditions were analysed, and compared. Then results were obtained, interpreted and findings stated.

FACTORIAL DESIGN

It was previously mentioned that factorial analysis was the most common and probably most meaningful method with which to study effects of changes in other variables on criterion variables. Earlier, the design was stated, factors identified and levels noted. The experimental procedure was mentioned in the last paragraph.[186]

In this section the factors are again presented and the treatments are identified. Perusal of the literature and discussions held with professors, bankers and farmers led to the choice of factors and levels used in this research. In addition, there were no well-documented instances of the quantitative differential impacts of strategic combinations of factors and/or levels of factors on the farmers welfare.

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[186] Readers interested in the intuitive basis for factorial analysis and how it is used should review texts by O.D. Davies (ed.) Design and Analysis of Industrial Experiments, 2nd. ed., Hafner, New York, 1960. R.A. Brownlee, Statistical Theory and Methodology in Science and Engineering, Wiley, New York, 1960, O. Kempthorne, The Design and Analysis of Experiments, Wiley, New York, 1952, Cochran, and Cox, op.cit, and Ostle, op.cit.

Factors and Levels of Factors

Table 11 shows the factors and levels of factors use in the experiment. Land control arrangement refers to the methods of acquisition of controlling the use of land for productive agriculture. Outright purchase represents the situation where the farmer purchases the land immediately and obtains immediate ownership rights. With rental-purchase arrangement, the farmer is cash-renting the land but has an option of purchasing at a future date and at a prespecified price per acre. Share renting involves the renting of land under a lease arrangement with the operator paying the landlord one-third the quantity of crop harvested while the landlord contributes one-third the operating costs. Cash rent allows the farmer to use the land for a straight cash rent per acre.

Debt-structure ratio is the relationship between individual debts in the farmer's debt portfolio and reflects capital structure or restraint. For this study the two ratios were short term indebtedness to long term indebtedness (STD/LTD), and medium term indebtedness to long term indebtedness (MTD/LTD). These debt classifications were described earlier.

Rates of return on productive assets were equivalent to the current year's rate of inflation as represented by the consumer price index for the year of simulation, the other was equivalent to the cost of credit charged by the Farm Credit

Table 11

Factors and Levels Used in Factorial Experiments

Factors	Levels 1	2	3	4
Land Control Arrangement	Outright Purchase	Rental-Purchase	Share Rent	Cash Rent
Debt-Structure Ratio	Short Term: Long Term i.e. STD:LTD	Medium Term: Long Term i.e. MTD:LTD		
Rate of Return on Productive Assets	Current Rate of Inflation	Cost of Credit Charged by Farm Credit Corporation i.e. FCAF		

Corporation under the Farm Credit Act for the year of simulation (FCAF). More details for land control are found in subroutine LANINV, LANDEC and FSTAR (Appendix A). Debt structure details are found in subroutine NEWCDT, SCHEDL and FINDEC (Appendix A). Details on rate of return are found in subroutine RETPRO (Appendix A).

Table 12 describes the sixteen treatments tested in the study. The treatment number was used to identify the treatments which are referenced by these numbers throughout the thesis. The code was used to set up the factorial system and these identify the treatment combinations in the computer program. The description of the treatments are self-explanatory except for BASE. This refers to the case farm situation without being subjected to manipulation. It is the statistical physical equivalent of 'control'. Four other base controls were run, one contained outright land purchase, one rent-to-purchase option, one incorporated cash rental and the last contained share rental land control option.

The last set became essential if the base experiment was to be compared with the other experiments. In this case, the farm must be allowed to grow to the maximum of 2,560 acres. Each scenario set was then compared with the relevant base. The bases were also compared to each other.

EXPERIMENTAL RESULTS - PART 1

This study concerns the farm income problem. The objectives of the study include the observation and quantification of impacts of different combinations of land control arrangement, debt-structure ratios and rate of return on productive assets on farm income attainment. For

TABLE 12

DESCRIPTION OF TREATMENTS USED IN FACTORIAL ANALYSIS*

Treatment Number and Code	Description
00 - 000	Base (Control) Treatment
00 - 100, Base 1	Outright Purchase x NONE x NONE
00 - 200, Base 2	Rent-to-Purchase x NONE x NONE
00 - 300, Base 3	Cash Rent x NONE x NONE
00 - 400, Base 4	Share Rental x NONE x NONE
01 - 115	Outright Purchase x Interest Charged by Farm Credit Corporation for Farmers Loans x Short Term Debt/Long Term Debt (STD/LTD)
02 - 116	Outright Purchase x Interest Rate Charged by FCC x Medium Term Debt/Long Term Debt (MTD/LTD)
03 - 135	Outright Purchase x Interest Rate Equal to the Consumer Price Index (RI) x STD/LTD
04 - 136	Outright Purchase x RI x MTD/LTD
05 - 215	Rent-to-Purchase x FCAF x STD/LTD
06 - 216	Rent-to-Purchase x FCAF x MTD/LTD
07 - 235	Rent-to-Purchase x RI x STD/LTD
08 - 236	Rent-to-Purchase x RI x MTD/LTD
09 - 315	Cash Rent x FCAF x STD/LTD
10 - 316	Cash Rent x FCAF x MTD/LTD
11 - 335	Cash Rent x RI x STD/LTD
12 - 336	Cash REnt x RI x MTD/LTD
13 - 415	Share Rent x FCAF x STD/LTD
14 - 416	Share Rent x FCAF x MTD/LTD
15 - 435	Share Rent x RI x STD/LTD
16 - 436	Share Rent x RI x MTD/LTD

*Meanings of abbreviations have been explained before.

the purposes of this study, income was reflected by traditional farm net income, net cash flow and farm net worth. Intuitively, the fundamental concern was one of farmers' welfare. An implied objective was to determine the relative performance, strength or accuracy of net income, net cash flow and net worth as measures of farmers welfare (income position).

THE BASE TREATMENTS

It was mentioned earlier that a total of four Base Runs, 'Controls', were executed. After running the Base 00, it was noted that unless the farm was allowed to expand it would be unreasonable to do a scientifically objective assessment of the treatments and the non-expanding base. The only method of expansion was through land control arrangement. Accordingly, four base experiments were run to ascertain the nature of the differences between the Base 00 and Bases 1, 2, 3, 4. There were some differences and these will be dealt with later.

The experimental procedures were modified in such a way that for each set of four experiments with each of the four land control options. one Base would apply. Thus Base 00 is a non-expanding base with no additional decision variables. Base 1 is the base rune where the farm expands to the maximum through utilizing the outright purchase land control option. Base 2 used the rent-to-purchase option, Base 3 used the cash rental option and Base 4 used the share rental option. None of the bases included additional rate of returns or debt-structure constraints.

In this chapter of the thesis, the experimental results are presented, described and analysed. In order to focus completely on the treatment results a detailed analysis is done on the Base Simulation Treatments. The Base represents the original case farm as used in the validation scenario but run through the twenty-year simulation run 1965-1984. The only difference between the base and the simulation experiments is the absence of values for two treatment variables, rate of return and debt-structure ratio. The base serves as a benchmark or control to which the treatments in a scenario can be compared for the purpose of determining changes in the values of the performance variables. A total of 21 cases were looked at, that is, the 16 treatments and five Bases. The model's behaviour is precisely as was described in the earlier chapter. Where, however, the need arises, additional details will be provided to clarify changes from the normal.

It should be reiterated that the main reason for examining the base runs are to ensure that the results are in unison with the model behaviour detailed in the last chapter. With this in mind, it is also reiterated that only abnormal behaviour wil be detailed and explained. In the main, the examination will concentrate on looking at randomly selected annual data and the overall results. These will appropriately interpreted in terms of the performance measures.

The base run with outright land purchase is used here to present a detailed analysis. Recall, however, that there were three more bases, one for each of the land control arrangements.

Table 13 shows the statement of net farm income for the period 1965-1984. In order to facilitate the analysis, five year averages, annual changes together with the overall mean, standard deviation, standard error and coefficient of variation are also presented.

TABLE 13

FARM INCOME STATEMENT AND INDICATORS FOR THE BASE TREATMENT 1

Simulation Year	Total Farm Receipts	Annual Change In Total Farm Receipts	Total Farm Expenses	Annual Change In Total Farm Expenses	Gross Margin	Annual Change In Gross Margin
1965	27180.79	0.0	20039.32	0.0	-1196.83	0.0
1966	23717.47	-3463.31	20594.85	555.53	8818.44	10015.27
1967	34023.37	10305.89	30888.06	10293.21	4246.86	-4571.59
1968	47107.82	13084.45	41154.86	10266.80	4480.21	233.36
1969	57481.03	10373.21	53051.02	11896.16	3517.48	-962.73
5 YR AVG	37902.09	7575.06	33145.60	8252.93	3973.23	1178.58
1970	55938.53	-1542.50	63972.25	10921.23	-1686.08	-5203.56
1971	80199.62	24261.09	72781.56	8809.31	17809.02	19495.10
1972	121647.62	41448.00	79234.50	6452.94	44395.76	26586.74
1973	275195.75	153548.12	83067.69	3833.19	199814.00	155418.19
1974	223691.50	-51504.25	92429.87	9362.19	126262.62	-73551.37
5 YR AVG	151334.56	33242.09	78297.12	7875.77	77319.06	24549.01
10 YR AVG	94618.31	21834.51	55721.39	8043.39	40646.14	14162.15
1975	267589.00	43897.50	97838.31	5408.44	167284.62	41022.00
1976	297472.19	29883.19	101762.00	3923.69	191639.50	24354.87
1977	391272.69	93800.50	104427.31	2665.31	283689.94	92050.44
1978	395034.62	3761.94	105940.44	1513.12	286139.87	2449.94
1979	340214.25	-54820.37	107615.25	1674.81	221965.69	-64174.19
5 YR AVG	338316.37	23304.55	103516.62	3037.07	230143.75	19140.61
15 YR AVG	175851.00	22359.52	71653.12	6255.42	103812.00	15940.17
1980	359571.94	19357.69	129969.06	22353.81	226874.62	4908.94
1981	384684.06	25112.12	131965.00	1995.94	250777.94	23903.31
1982	411186.00	26501.94	136821.44	4856.44	263500.56	12722.62
1983	438776.62	27590.62	139573.69	2752.25	294948.69	31448.12
1984	467271.12	28494.50	145282.37	5708.69	299707.31	4758.62
5 YR AVG	412297.75	25411.37	136722.31	7533.42	267161.75	15548.32
20 YR AVG	234962.69	23162.64	87920.37	6591.73	144649.44	15837.05
STD DEV	161597.56		39769.69		120692.37	
STD ERR	36134.32		8892.77		26987.64	
C. V.	0.69		0.45		0.83	
MINIMUM	23717.47		20039.32		-1686.08	
MAXIMUM	467271.12		145282.37		299707.31	

TABLE 13 (continued)

Simulation Year	Net Cash Income	Annual Change In Net Cash Income	Non Farm Income	Annual Change In Non Farm Income	Change In Value of Inventory	Annual Change In Value of Inventory
1965	7141.46	0.0	2585.11	0.0	-5538.39	0.0
1966	3088.58	-4052.89	3106.16	521.05	4551.66	10090.06
1967	2964.80	-123.77	2675.95	-430.21	-1523.16	-6074.82
1968	4322.84	1358.03	3240.42	564.47	-3882.25	-2359.09
1969	1909.73	-2413.10	3713.89	473.47	-6072.64	-2190.39
5 YR AVG	3885.48	-1307.93	3064.31	282.20	-2492.95	-133.56
1970	-10841.66	-12751.39	4226.26	512.36	912.25	6984.89
1971	4205.25	15046.91	3869.97	-356.29	1429.07	516.82
1972	39436.75	35231.50	3943.40	73.44	-2203.80	-3632.87
1973	188944.50	149507.75	4922.51	979.10	610.01	2813.81
1974	128048.62	-60895.87	5513.97	591.46	-278.36	-888.37
5 YR AVG	69958.69	25227.77	4495.22	360.02	93.84	1158.86
10 YR AVG	36922.08	13434.12	3779.76	325.43	-1199.56	584.45
1975	166364.25	38315.62	6572.72	1058.75	238.87	517.22
1976	192066.81	25702.56	7285.80	713.08	-456.39	-695.26
1977	283150.50	91083.69	7920.85	635.05	-729.92	-273.52
1978	285484.00	2333.50	8980.46	1059.61	-9.97	719.95
1979	229059.37	-56424.62	9575.95	595.49	0.0	9.97
5 YR AVG	231224.75	20202.15	8067.15	812.40	-191.48	55.67
15 YR AVG	101689.56	15851.27	5208.89	499.35	-863.53	395.60
1980	226194.87	-2864.50	10068.46	492.51	0.0	0.0
1981	249646.81	23451.94	10560.98	492.52	0.0	0.0
1982	271581.87	21935.06	11053.49	492.52	0.0	0.0
1983	296650.50	25068.62	11546.01	492.52	0.0	0.0
1984	319901.31	23250.81	12038.52	492.52	0.0	0.0
5 YR AVG	272795.00	18168.39	11053.49	492.51	0.0	0.0
20 YR AVG	144465.94	16461.04	6670.04	497.55	-647.65	291.49
STD DEV	124131.12		3290.44		2364.76	
STD ERR	27756.56		735.77		528.78	
C. V.	0.86		0.49		-3.65	
MINIMUM	-10841.66		2585.11		-6072.64	
MAXIMUM	319901.31		12038.52		4551.66	

TABLE 13 (continued)

Simulation Year	Total Depreciation	Annual Change In Total Depreciation	Net Farm Income (before taxes)	Annual Change In Net Farm Income (before taxes)	Taxes	Annual Change In Taxes
1965	3330.40	0.0	857.78	0.0	0.0	0.0
1966	2699.82	-630.58	8046.58	7188.80	1294.29	1294.29
1967	2913.43	213.61	1204.16	-6842.41	0.0	-1294.29
1968	4678.25	1764.82	-997.24	-2201.40	0.0	0.0
1969	4481.41	-196.84	-4930.42	-3933.18	0.0	0.0
5 YR AVG	3620.66	287.75	836.17	-1447.05	258.86	0.0
1970	6440.85	1959.44	-12143.99	-7213.57	0.0	0.0
1971	4547.32	-1893.52	4956.96	17100.96	486.77	486.77
1972	10377.48	5830.16	30798.87	25841.91	20669.00	20182.23
1973	5243.70	-5133.79	189233.25	158434.37	129566.94	108897.94
1974	12962.30	7718.60	120321.87	-68911.37	93318.75	-36248.19
5 YR AVG	7914.33	1696.18	66633.37	25050.45	48808.29	18663.73
10 YR AVG	5767.49	1070.21	33734.77	13273.78	24533.57	10368.74
1975	10297.73	-2664.57	162878.00	42556.12	116706.75	23388.00
1976	10823.50	525.77	188072.62	25194.62	135999.37	19292.62
1977	8209.66	-2613.83	282131.69	94059.06	197329.69	61330.31
1978	7168.58	-1041.08	287285.81	5154.12	206264.06	8934.37
1979	15252.79	8084.21	223382.50	-63903.31	169667.12	-36596.94
5 YR AVG	10350.45	458.10	228750.00	20612.12	165193.37	15269.67
15 YR AVG	7295.14	851.60	98739.75	15894.61	71420.12	12119.07
1980	5471.87	-9780.92	230791.44	7408.94	171146.00	1478.87
1981	3323.46	-2148.41	256884.25	26092.81	189594.50	18448.50
1982	11763.10	8439.64	270872.19	13987.94	201563.62	11969.12
1983	5435.60	-6327.50	302760.87	31888.69	224437.19	22873.56
1984	23987.88	18552.29	307951.87	5191.00	231343.87	6906.69
5 YR AVG	9996.38	1747.02	273851.75	16913.87	203617.00	12335.35
20 YR AVG	7970.45	1087.24	142517.75	16162.84	104469.31	12175.99
STD DEV	5244.51		125305.44		91706.50	
STD ERR	1172.71		28019.15		20506.20	
C. V.	0.66		0.88		0.88	
MINIMUM	2699.82		-12143.99		0.0	
MAXIMUM	23987.88		307951.87		231343.87	

Simulation Year	Consumption Withdrawal for Household Expenses	Annual Change In Consumption Withdrawal for Household Expenses	Return On Capital Investment	Annual Change In Return On Capital Investment	Surplus	Annual Change In Surplus
1965	1687.73	0.0	0.0	0.0	0.0	0.0
1966	2204.50	516.76	0.0	0.0	0.0	0.0
1967	2159.17	-45.32	0.0	0.0	0.0	0.0
1968	2210.65	51.48	0.0	0.0	0.0	0.0
1969	2225.93	15.28	0.0	0.0	0.0	0.0
5 YR AVG	2097.60	134.55	0.0	0.0	0.0	0.0
1970	2172.70	-53.23	0.0	0.0	0.0	0.0
1971	2626.88	454.18	0.0	0.0	0.0	0.0
1972	3263.44	636.56	0.0	0.0	0.0	0.0
1973	6667.28	3403.84	0.0	0.0	12336.58	12336.58
1974	5326.13	-1341.15	0.0	0.0	180842.87	168506.25
5 YR AVG	4011.29	620.04	0.0	0.0	38635.89	36168.56
10 YR AVG	3054.44	404.27	0.0	0.0	19317.94	20093.64
1975	6311.37	985.25	0.0	0.0	109049.50	-71793.37
1976	6934.21	622.84	0.0	0.0	152965.31	43915.81
1977	8994.25	2060.04	0.0	0.0	175464.81	22499.50
1978	9198.72	204.47	0.0	0.0	275765.56	100300.75
1979	7961.84	-1236.88	0.0	0.0	288255.19	12489.62
5 YR AVG	7880.08	527.14	0.0	0.0	200300.06	21482.46
15 YR AVG	4662.98	448.15	0.0	0.0	79645.25	20589.65
1980	8213.26	251.42	0.0	0.0	222366.19	-65889.00
1981	8854.58	641.32	0.0	0.0	230885.31	8519.12
1982	9243.20	388.62	0.0	0.0	260334.69	29449.37
1983	10005.37	762.18	0.0	0.0	275059.31	14724.62
1984	10210.29	204.91	0.0	0.0	310691.06	35631.75
5 YR AVG	9305.34	449.69	0.0	0.0	259867.19	4487.17
20 YR AVG	5823.57	448.56	0.0	0.0	124700.75	16352.16
STD DEV	3174.72		0.0		123497.50	
STD ERR	709.89		0.0		27614.88	
C. V.	0.55		0.0		0.99	
MINIMUM	1687.73		0.0		0.0	
MAXIMUM	10210.29		0.0		310691.06	

TABLE 13 (continued)

Simulation Year	Gross Ratio	Annual Change In Gross Ratio	Capital Turnover	Annual Change In Capital Turnover	Rate Of Return On Capital	Annual Change In Rate Of Return On Capital
1965	0.95	0.0	0.20	0.0	0.03	0.0
1966	0.87	-0.08	0.15	-0.04	0.08	0.05
1967	0.91	0.04	0.16	0.01	0.04	-0.04
1968	0.91	-0.00	0.17	0.01	0.04	-0.00
1969	0.97	0.06	0.20	0.02	0.03	-0.00
5 YR AVG	0.92	0.01	0.18	0.00	0.05	-0.00
1970	1.19	0.23	0.18	-0.01	0.02	-0.02
1971	0.95	-0.25	0.24	0.05	0.08	0.06
1972	0.68	-0.27	0.36	0.12	0.15	0.08
1973	0.31	-0.36	0.63	0.28	0.48	0.33
1974	0.43	0.11	0.40	-0.23	0.25	-0.23
5 YR AVG	0.71	-0.11	0.36	0.04	0.20	0.04
10 YR AVG	0.82	-0.06	0.27	0.02	0.12	0.02
1975	0.38	-0.05	0.47	0.07	0.32	0.07
1976	0.35	-0.02	0.50	0.03	0.35	0.03
1977	0.28	-0.08	0.64	0.14	0.50	0.15
1978	0.28	0.00	0.64	-0.01	0.49	-0.00
1979	0.33	0.05	0.53	-0.11	0.38	-0.11
5 YR AVG	0.32	-0.02	0.56	0.03	0.41	0.02
15 YR AVG	0.65	-0.04	0.36	0.02	0.22	0.02
1980	0.37	0.04	0.55	0.02	0.38	0.00
1981	0.35	-0.02	0.57	0.03	0.41	0.03
1982	0.34	-0.01	0.60	0.02	0.42	0.01
1983	0.32	-0.02	0.62	0.02	0.45	0.03
1984	0.32	-0.01	0.64	0.02	0.45	-0.00
5 YR AVG	0.34	-0.00	0.60	0.02	0.42	0.01
20 YR AVG	0.57	-0.03	0.42	0.02	0.27	0.02
STD DEV	0.31		0.19		0.18	
STD ERR	0.07		0.04		0.04	
C. V.	0.54		0.46		0.69	
MINIMUM	0.28		0.15		0.02	
MAXIMUM	1.19		0.64		0.50	

In 1965, net farm income was $858. It rose to $8,047 in 1966, declined to $1,204 in 1967 and continued falling in 1968, 1969 and 1970 where it reached a value of -$12,144, its minumum value during the 20 year period. The value of net farm income began to rise again in 1971 and accelerated its rise quickly to $189,233 in 1973. Although positive, the value dropped in 1974 only to begin rising dramatically in 1975 and continuing to reach $287,286 in 1978. There was a drop to $223,382 before beginning to rise in 1980 and continued through to 1984 where it reached its maximum of $307,952.

At first glance, the net farm income value in 1965 of $858 is surprising especially when one examines the values of the variables from which it is derived. Total farm receipts were $27,181 and total expenses were $20,039. The difference between the two gives the value of net cash income of $7,141. With non-farm income of $2,585, the only two variables that could cause the net farm income value to be very low are depreciation and the change in value of crop inventory. Depreciation was $3,330 but the major factor was the change in value of crop inventory of -$5,538.

The amount of farm expenses was as high as it was due to the combined effects of expenses associated with farm machinery. These were generated due to the replacement of six items of machinery and implement. Total machinery operating expenses were $3,512, building operating expenses was $3,765, and interest on farm debts due to new borrowings to purchase new machinery and implements. In addition, fertilizer and spray costs were $1,544 and $2,766 respectively, hydro and telephone was $2,288 and share rent was $2,256. In the last chapter, it was pointed out how the operation of the model explained these changes hence the reasons will not be repeated here.

The high proportion of expenses in 1965 is emphasized by the gross ratio of .95, implying that 95 cents of expenses were incurred per dollar of crop rates, or, net farm income in 1965 amounted to $0.05 per dollar of crop sales.

The capital turnover ratio of 0.20 indicates that for each dollar invested 20 cents of crop sales were generated. However, the rate of return on investment was only 3 percent.

In 1966, net farm income rose to $8,047. Again, the behaviour of the model is the primary reason for this. Farm receipts of $23,717 were due to crop sales. Farm expenses were $20,629 and net cash income was $3,089 only 43 percent of the value in 1965. Yet, net farm income is 938 percent higher than in 1965. Depreciation decreased to 10 percent of 1965, therefore, the change in value of inventory is the major explanation for the massive increase. It amounted to $4,552. The improvement in the operational efficiency of the business is shown by the gross ratio of .87, that is 87 cents of expenses per dollar of crop rates compared to 95 cents per dollar of crop sales in 1965. The capital turnover ratio was 0.15 but the rate of return on investment rose to 8 percent.

In 1967, net farm income fell to $1,204. An examination of the data for 1967 indicates that farm receipts increased by 43 percent and farm expenses increased by 48 percent from 1966. However, net cash income fell by 4 percent. The increase in receipts was caused by the combinations of many factors. Yields of wheat in 1967 decreased below 1966, while that of flax incrased. Oats yield decreased from 40.60 bushels/acre to 40.00 bushels per acre. Barley yield increased to 31.80 bushels from 28.20 bushels. Flax yield increased to 14.60 bushels per acre from 11.00 bushels per acre in 1966.

Prices of crops changed also. The prices of wheat, oats and barley dropped but the prices of flax and hay increased in 1967 relative to 1966. Also, the quantities marketed varied from 1966 to 1967. The quantity of wheat marketed per acre dropped from 21.19 bushels per acre in 1966 to 18.59 bushels in 1967. Oats dropped from 14.14 bushels per acre to 8.62 bushels per acre, while barley marketings dropped from 14.97 bushels per acre in 1966 to 14.81 bushels per acre in 1967. However, flax showed increases from 11.80 bushels per acre in 1966 to 11.86 bushels per acre in 1967.

More significantly, however, is the increased area now farmed. It was explained both in the model presentation and in the program that acquisition of control of land was one of the decision variables. It was also pointed out that the choices included outright purchase of land, rental purchase agreement, cash rent and share rent. In addition, any one or all of the choices are possible or none at all.

The acquisition of land is based on the availability of funds including credit capacity, ability of the investment to carry the debt load, the bid price and the availability of the land. Once the model examines the acreage to be cultivated, ascertains the proper complement of machinery and implement, it will acquire control of up to 320 acres per year in 64 acre parcels. Twenty-five percent down payment is mandatory and one payment is made per year on either of two amortization procedures described elsewhere. If the model operates in such a way that it can acquire control of land through any one of the options mentioned, the preference ranking is outright purchase, rent-to-purchase, cash rent and share rent.

On the case of rental purchase, the farmer will agree to purchase the one parcel or nine not exceeding 320 acres per year and 2560 acres over the entire plan.

In this case if the rental purchase option matures in 5 years time, for 5 parcels, the farmer is required to set aside an amount equal to the value of one parcel in savings each year so that the amount of the purchase will have been set aside when the five years end. The savings generate income through interest. These are added into investment income and the rental purchase savings add into surplus.

Where the model is using all control option it determines which form it uses in any year based on the amount of available credit and funds available, but it goes through the sequential ranking indicated. When the model is operating in either purchase or rental purchase option year, if the operator is renting land, the model gives up an amount of land from rent equal to the amount of land purchased. Therefore, even though land is acquired through purchase there need not be an equivalent increase in cultivated area.

It was also noted that allocation of the new land takes place after the amount of land equal to the rental amount is released. Then, the land left is allocated to the different crops based on the contribution of each to the productivity of the business. Any combination of the above together with vacillations in yield, price and quantity marketed and harvested will influence the receipts.

The base farm scenario was studied under conditions permitting all four land acquisition of control options. The model bought land in both 1966, 1967. However, because of the release of 312 acres of rented land, there were only 8 acres of additional land to be allocated and cropped in 1966. Additional land did not contribute significantly to changes in crop receipts in 1966. In 1967, 320 acres were bought and with no rental lands the total acreage was allocated to the crops.

Wheat's contribution to production was 45 percent, flax 17 percent, barley 16 percent, forage 11 percent, oats 6 percent and hay 4 percent in 1966. Land was allocated to the crops in three ratios. The above charges generated changes in production quantities.

The consequences of changes in yields, quantities marketed prices and acres seeded were that the amount of wheat sold increased from 5,138 bushels valued at $9,146 in 1966 to 7,213 bushels valued at $11,830 in 1967. The amount of oats sold increased from 772 bushels valued at $579 to 2,464 bushels valued at $1,700. Barley and flax also sold increased amounts resulting in increased value of sales in 1967 over 1966. Barley marketings were increased from 4,615 bushels valued at $5,076 in 1966 to 8,725 bushels valued at $7,766 in 1967. Flax marketings increased from 1,737 bushels valued at $4,689 in 1966 to 3,093 bushels valued at $9,526.

These changes in individual crop marketings yields, production, prices and area planted were responsible for the increase in receipts from 1966 to 1967. Moreover this increase is explained by the behaviour of the model as was indicated in the last chapter. Yields, prices and quantities marketed per acre are determined by the model from historical trends and time projection. The maximum total quantity marketed as determined by the model depends on the seeded area and quantity marketed per acre. But the allowable quantity marketed is the quantity marketed (quota) times the assigned acreage less the landlord share. However, the amount sold is also dependent on the storage capacity of the farm and whether the user has authorized the model to rent storage off the farm. Grain not stored is marketed.

If there is no off-farm storage, then all grain in excess of storage capaicty at the farm is sold. If there is use of off-farm storage then the amount marketed is adjusted accordingly. In any event all hay and forage are always sold.

Variations in total expenses occur as farm input indexes change throughout the simulation period, as borrowings increase and as debts are retired, as machinery repairs increase or decrease and as share rent changes. Share rent is related to total production and the share of acreage in each crop and each plan that is share rented.

Increased total expenses were due to increased cultivated land in crop causing increase in all categories of farm operating expenses. Interest paid on farm debt caused by borrowing to purchase land and machinery rose to $7,338, an increase of 48 percent over 1966. Fertilizer expenses increased from $2,696 in 1966 to $4,074 in 1967, an increase of 51 percent. But, even with the above changes, net cash income, the difference between receipts and expenses, amounted to $2,905 in 1967, much more than the net farm income of $1,204. The difference between net cash income and net farm income involves, addition of the change in value of inventory and deducting depreciation from net cash income. The difference between depreciation in the two years is only $213, whereas the value of inventory charge in 1967 amounted to -$1,523,compared to the value of $4,552 in 1966, a difference of $6,075. This has been the major difference in the net farm income values throughout the discussion.

Nonfarm income is comprised of off-farm income, interest and dividends, income-in-kind and other income. But, as was indicated in the last chapter, off-farm income is a function of net farm income as well as interest and dividends where no values are given by the user. Income-in-kind is fixed.

In 1968, net farm income declined to the low value of -$997 from $1,204 in 1967 even though net cash income (total receipts less total expenses) rose to $4,323 in 1968 from $2,965 in 1967. Although non farm income increased by 21 percent over 1967, total depreciation also increased by 61 percent during the same period. The change in value of crop inventory goes from -$1,523 in 1967 to -$3,882 in 1968. Again, the influence of this change in value of inventory on the net farm income measure is shown.

The behaviour of the model is also gleaned at by looking at the five year averages of the major variables. The average net farm income for the period 1965-1969 was $836, that of the second five year period 1970-1974, increased to $66,633, that of the third five year 1975-1979 was $228,750 and of the fourth five year period was $273,852. The ten year, 1965-1974 average net farm income was $33,735 while the 15 year average, 1965-1979, was $98,740 and the 20 year mean was $142,517. Thus the overall tendency of the farm business was increasing in net farm income as a function of time.

Total farm expenses averaged $34,017 for the first five year period 1965-1969. This value was less than that of farm receipts.

The average net cash income was $3,885. The rationale for these values rests with the model operation and the variations in values generated for the determinant variables. For the second five-year period, 1970-1974, the average total farm expenses increased to $81,376, a 139 percent increase over the first five-years. The average farm receipts rose by almost 400 percent causing the average net cash income to rise to $69,959 from $3,885. Although the average five-year total farm expenses continued to increase throughout the run, the increase in average total farm receipts was more significant with the result that net cash income continued to increase as did the average five-year non-farm income.

The average '5 year' total depreciation increased up to the third period but decreased in the fourth period. The values of taxes, household consumption uses, and surplus, all of which depend on the farm income situation show an increasing tendency throughout the run.

The progressively increasing operational efficiency of the base farm is supported by the decreasing tendency in the gross ratio which decreased from 0.9 for the first five-year average to 0.71 for the second five-year average to 0.32 in the third five-year average. It was 0.34 for the fourth five-year average. Contrarily, the capital turnover ratio and rate of return on capital displayed increasing tendencies. For the first five-year period, capital turnover was 0.18 and the rate of return on capital was 0.05. These values increased to 0.36 and 0.20; 0.56 and 0.41; and 0.60 and 0.42, respectively in the second, third and fourth five-year periods.

The average mean net farm income was $142,518 while those for total farm receipts and total farm expenses were $234,963 and $90,497, respectively. The mean net cash income was $144,466. The mean gross ratio of 0.57, the mean capital turnover of 0.42 and mean rate of return of 0.27 emphasize the progressive strength in efficiency of operation and capital utilization.

The values of the standard deviation, standard error and coefficient of variation indicate significant variability in the receipts, expenses, net farm income and net cash income, taxes and surplus. It is also observed that total expenses have less variability than receipts, net farm income and net cash income. The rate of return on investment also display less variability than both the gross ratio and capital turnover.

Table 14 presents the net worth statement picture. Annual net worth generally increased continuously from $66,145 in 1965 to $545,027 in 1984. The reason for these will be examined later. The manner of behaviour of the net farm worth was examined in the last chapter and shown to be a function of how the model treats individual items in each of the variable that make up the equation for net farm worth. Values of these variables will now be examined for the base case '0', and where major deviations from the behaviour given in the last chapter arise, these will be re-examined.

In 1966, net worth increased to $84,427. Total assets increased to $156,112 while total liabilities increased to $72,174. The categories of assets are now examined. Short term assets include input supplies, crops in inventory, cash on hand, personal assets and other things of value that can be transformed into cash during the year.

Medium term assets include resources facilitating production but which will not be converted to cash during the year; these are mainly

TABLE 14

NET FARM WORTH AND BALANCE SHEET INDICATORS FOR THE BASE TREATMENT 1

Simulation Year	Short Term Assets	Annual Change In Short Term Assets	Medium Term Assets	Annual Change In Medium Term Assets	Long Term Assets	Annual Change In Long Term Assets
1965	14430.80	0.0	30727.39	0.0	63279.35	0.0
1966	18982.47	4551.66	29803.29	-924.11	107326.19	44046.84
1967	17459.31	-1523.16	28897.14	-906.14	164128.19	56802.00
1968	13577.06	-3882.25	33861.84	4964.70	222610.87	58482.69
1969	7504.43	-6072.64	40599.98	6738.15	243525.31	20914.44
5 YR AVG	14390.81	-1731.59	32777.91	2468.15	160173.94	45061.48
1970	8416.68	912.25	42576.21	1976.23	254911.87	11386.56
1971	9845.75	1429.07	42164.97	-411.24	285586.12	30674.25
1972	7641.95	-2203.80	44142.12	1977.14	288543.25	2957.12
1973	8251.96	610.01	44163.95	21.83	382102.69	93559.44
1974	7973.61	-278.36	46048.00	1884.05	503659.44	121556.75
5 YR AVG	8425.99	93.84	43819.01	1089.60	342960.37	52026.82
10 YR AVG	11408.40	-717.47	38298.46	1702.29	251567.06	48931.12
1975	8212.48	238.87	47166.28	1118.29	518254.25	14594.81
1976	7756.09	-456.39	53089.50	5923.21	532890.00	14635.75
1977	7026.17	-729.92	53000.41	-89.08	547560.37	14670.37
1978	7016.20	-9.97	52582.06	-418.35	562260.44	14700.06
1979	7016.20	0.0	59101.15	6519.09	576985.81	14725.37
5 YR AVG	7405.43	-191.48	52987.86	2610.63	547589.75	14665.27
15 YR AVG	10074.07	-529.61	43194.93	2026.70	350241.31	36693.32
1980	7016.20	0.0	57066.44	-2034.71	591732.87	14747.06
1981	7016.20	0.0	57018.33	-48.11	606498.75	14765.87
1982	7016.20	0.0	60405.42	3387.09	621280.75	14782.00
1983	7016.20	0.0	67039.50	6634.08	636076.87	14796.12
1984	7016.20	0.0	71209.50	4170.00	650885.19	14808.31
5 YR AVG	7016.20	0.0	62547.82	2421.67	621294.37	14779.87
20 YR AVG	9309.60	-390.24	48033.15	2130.64	418004.56	30926.62
STD DEV	3699.91		12053.22		194650.12	
STD ERR	827.32		2695.18		43525.09	
C. V.	0.40		0.25		0.47	
MINIMUM	7016.20		28897.14		63279.35	
MAXIMUM	18982.47		71209.50		650885.19	

Simulation Year	Total Assets	Annual Change In Total Assets	Short Term Liabilities	Annual Change In Short Term Liabilities	Medium Term Liabilities	Annual Change In Medium Term Liabilities
1965	108437.50	0.0	2658.88	0.0	21433.05	0.0
1966	156111.94	47674.44	1794.63	-864.25	19316.54	-2116.51
1967	210484.62	54372.69	1854.90	60.27	17078.33	-2238.21
1968	270049.75	59565.12	1959.58	104.68	20567.00	3488.67
1969	291629.69	21579.94	2017.36	57.78	25947.58	5380.58
5 YR AVG	207342.69	45798.05	2057.07	-160.38	20868.48	1128.63
1970	305904.75	14275.06	2019.77	2.41	25890.39	-57.19
1971	337596.81	31692.06	2020.57	0.79	23899.02	-1991.37
1972	340327.31	2730.50	2017.19	-3.37	27594.54	3695.52
1973	434518.56	94191.25	515.46	-1501.73	24112.98	-3481.55
1974	557681.00	123162.44	0.0	-515.46	27072.30	2959.32
5 YR AVG	395205.56	53210.26	1314.60	-403.47	25713.82	224.94
10 YR AVG	301274.06	49915.94	1685.83	-295.43	23291.16	626.58
1975	573633.00	15952.00	0.0	0.0	29552.32	2480.02
1976	593735.56	20102.56	0.0	0.0	41545.40	11993.09
1977	607586.94	13851.37	0.0	0.0	39958.91	-1586.49
1978	621858.69	14271.75	0.0	0.0	36275.83	-3683.09
1979	643103.12	21244.44	0.0	0.0	52493.01	16217.18
5 YR AVG	607983.00	17084.42	0.0	0.0	39965.07	5084.14
15 YR AVG	403510.37	38190.40	1123.89	-189.92	28849.13	2218.57
1980	655815.50	12712.37	0.0	0.0	45281.29	-7211.73
1981	670533.25	14717.75	0.0	0.0	39600.76	-5680.52
1982	688702.31	18169.06	0.0	0.0	43008.43	3407.66
1983	710132.56	21430.25	0.0	0.0	52530.33	9521.91
1984	729110.87	18978.31	0.0	0.0	62469.21	9938.88
5 YR AVG	690858.37	17201.55	0.0	0.0	48577.97	1995.24
20 YR AVG	475347.37	32667.02	842.92	-139.94	33781.34	2159.80
STD DEV	203058.81		1024.11		12797.67	
STD ERR	45405.33		229.00		2861.65	
C. V.	0.43		1.21		0.38	
MINIMUM	108437.50		0.0		17078.33	
MAXIMUM	729110.87		2658.88		62469.21	

TABLE 14 (continued)

Simulation Year	Long Term Liabilities	Annual Change In Long Term Liabilities	Total Liabilities	Annual Change In Total Liabilities	Net Worth	Annual Change In Net Worth
1965	18200.42	0.0	42292.34	0.0	66145.12	0.0
1966	51062.92	32862.50	72174.06	29881.72	83937.87	17792.75
1967	87381.75	36318.83	106314.94	34140.87	104169.69	20231.81
1968	127098.19	39716.44	149624.75	43309.81	120425.00	16255.31
1969	168527.12	41428.94	196492.00	46867.25	95137.69	-25287.31
5 YR AVG	90454.06	37581.67	113379.56	38549.91	93963.06	7248.14
1970	203648.62	35121.50	231558.62	35066.62	74346.12	-20791.56
1971	232618.19	28969.56	258537.56	26978.94	79059.25	4713.12
1972	238718.50	6100.31	268330.00	9792.44	71997.31	-7061.94
1973	228590.87	-10127.62	253218.94	-15111.06	181299.62	109302.31
1974	218375.69	-10215.19	245447.62	-7771.31	312233.37	130933.75
5 YR AVG	224390.19	9969.71	251418.37	9791.12	143787.12	43419.14
10 YR AVG	157422.06	22241.69	182399.00	22572.80	118875.06	27343.14
1975	208067.00	-10308.69	237618.94	-7828.69	336014.06	23780.69
1976	197658.37	-10408.62	239203.12	1584.19	354532.44	18518.37
1977	187143.25	-10515.12	227101.44	-12101.69	380485.50	25953.06
1978	176514.37	-10628.87	212789.69	-14311.75	409069.00	28583.50
1979	165764.50	-10749.87	218256.87	5467.19	424846.25	15777.25
5 YR AVG	187029.50	-10522.23	226994.00	-5438.15	380989.37	22522.57
15 YR AVG	167291.19	10540.29	197264.00	12568.89	206246.50	25621.51
1980	156934.56	-8829.94	202215.19	-16041.69	453600.31	28754.06
1981	148104.69	-8829.87	187704.87	-14510.31	482828.37	29228.06
1982	139274.81	-8829.87	182282.56	-5422.31	506419.75	23591.37
1983	130445.00	-8829.81	182974.75	692.19	527157.81	20738.06
1984	121615.06	-8829.94	184083.69	1108.94	545027.19	17869.37
5 YR AVG	139274.81	-8829.89	187852.19	-6834.64	503006.37	24036.19
20 YR AVG	160287.06	5442.87	194911.00	7462.70	280436.50	25204.32
STD DEV	59642.63		61218.18		180895.25	
STD ERR	13336.50		13688.80		40449.41	
C. V.	0.37		0.31		0.65	
MINIMUM	18200.42		42292.34		66145.12	
MAXIMUM	238718.50		268330.00		545027.19	

TABLE 14 (continued)

Simulation Year	Current Ratio	Annual Change In Current Ratio	Leverage Ratio	Annual Change In Leverage Ratio	Change In Net Worth	Annual Change In Net Worth
1965	5.43	0.0	0.64	0.0	0.0	0.0
1966	10.58	5.15	0.86	0.22	17792.75	17792.75
1967	9.41	-1.16	1.02	0.16	20231.81	2439.06
1968	6.93	-2.48	1.24	0.22	16255.31	-3976.50
1969	3.72	-3.21	2.07	0.82	-25287.31	-41542.62
5 YR AVG	7.21	-0.43	1.17	0.36	5798.51	-6321.83
1970	4.17	0.45	3.11	1.05	-20791.56	4495.75
1971	4.87	0.71	3.27	0.16	4713.12	25504.69
1972	3.79	-1.08	3.73	0.46	-7061.94	-11775.06
1973	16.01	12.22	1.40	-2.33	109302.31	116364.25
1974	7973.61	7957.60	0.79	-0.61	130933.75	21631.44
5 YR AVG	1600.49	1593.98	2.46	-0.26	43419.14	31244.21
10 YR AVG	803.85	885.35	1.81	0.02	24608.82	14548.19
1975	8212.48	238.87	0.71	-0.08	23780.69	-107153.06
1976	7756.09	-456.39	0.67	-0.03	18518.37	-5262.31
1977	7026.17	-729.92	0.60	-0.08	25953.06	7434.69
1978	7016.20	-9.97	0.52	-0.08	28583.50	2630.44
1979	7016.20	0.0	0.51	-0.01	15777.25	-12806.25
5 YR AVG	7405.43	-191.48	0.60	-0.05	22522.57	-23031.30
15 YR AVG	3004.38	500.77	1.41	-0.01	23913.41	1126.95
1980	7016.20	0.0	0.45	-0.07	28754.06	12976.81
1981	7016.20	0.0	0.39	-0.06	29228.06	474.00
1982	7016.20	0.0	0.36	-0.03	23591.37	-5636.69
1983	7016.20	0.0	0.35	-0.01	20738.06	-2853.31
1984	7016.20	0.0	0.34	-0.01	17869.37	-2868.69
5 YR AVG	7016.20	0.0	0.38	-0.04	24036.19	418.42
20 YR AVG	4007.33	368.99	1.15	-0.02	23944.10	940.49
STD DEV	3727.30		1.05		36557.90	
STD ERR	833.45		0.23		8174.59	
C. V.	0.93		0.91		1.53	
MINIMUM	3.72		0.34		-25287.31	
MAXIMUM	8212.48		3.73		130933.75	

machinery and implements. These items normally have an economic life of up to ten years and constitute part of the business physical plant. Long term assets are part of the physical plant, are long lasting and comprise farmland and buildings.

Short term liabilities are indebtedness that must be paid during the crop year or in up to one year. Short term liabilities comprise operating line of credit, accounts payable and taxes. Medium term liabilities include loans for farm improvements and purchase of machinery and implements and have a term of up to 10 years. Long term liabilities comprise of debts outstanding for real estate purchases.

The increase in total assets from $108,437 in 1965 to $156,112 in 1966 was due to a 32 percent increase in short term assets and a 70 percent increase in long term assets. Medium term assets declined by 3 percent in 1966 from 1965. The increase in short term assets was due to the increase in value of grain in inventory from $7,415 in 1965 to $11,966 in 1966. How the model behaved to account for this was explained earlier. The decline in medium term assets was due to depreciation and the appreciation in long term assets was due to increase in land price and purchase of land.

The increase in total liabilities was due to changes in each category of liabilities. Short term liability dropped from $2,659 in 1965 to $1,795 in 1966, medium term liability dropped by 10 percent but long term liability increased almost three-fold in 1966 from 1965. These changes were due to retirement of debts but increased indebtedness due to land purchases was the major reason.

The current ratio, indicating the ability of current assets to retire current debts, was 5.43 in 1965. That the business has $5.43

of current assets per dollar of current liabilities indicates the financial strength of the business. A minimum ratio of 2.00 is normally required by lending institutions. The leverage ratio or debt/equity ratio indicates the solvency position of the business. In 1965, it was 0.41 meaning that the farm debt was 0.41 times its equity. In 1966, the change in net worth was $17,793 representing the financial progress of the business.

In general, short term assets varied from year to year but tended to decrease and remained stable after 1976. Before beginning to decline, short term assets rose 32 percent over 1965 in 1966 then progressively decreased to $7,756 in 1976 and $7,026 in 1977. Thereafter it remained constant at $7,016 for the duration of the run. This behaviour of short term assets is directly related to the value of crop in inventory. The latter, in turn, is determined by the operation of the model with respect to marketing and storage as done in subroutine CRPCST. The value of inventory paralleled the behaviour of short term assets.

The value and behaviour of the value of medium term assets are tied to the age and type of machinery and implements in the complement in inventory. When the inventory of machinery and implements contain old, obsolete and inadequately sized items, they are replaced by newer and different sized items more appropriate to carry out the farm operations given the existing time and weather constraints. In those years in which the complement of items in inventory is of the right vintage and appropriate sizes, medium term assets will vary only to the extent that machinery and implements are depreciated. The changes in asset value are expected to be normal.

In addition, in the early years of the business, as the farm undergoes expansion it would be the case that medium farm assets not only increase and decrease from year to year but the rate of increase in assets will slow as the maximum size of the operation is reached.

Thus, medium term assets are generally increasing from $30,727 in 1965 to $71,209 in 1984. Interyear changes are due to additional purchases necessitated by the need to add new items, to replace old items or smaller items. Some inflation as reflected in the general rise in the price index is also included in the value of medium term assets. Behind all these changes is the operational behaviour of the model with regard to machinery. This has been well documented in the model descriptions both in the presentation of the model earlier and in the detailed description of the subroutines in Appendix .

The value in 1965 is greater than the initial value in INCASE because as the model examined the inventory of machinery and implements, six items were found obsolete. These six items were replaced by six new ones. The decline of 3 percent in 1966 merely reflects the depreciated value of items. The decline in 1967 is similarly explained. The increase from $28,897 om 1967 to $33,862 in 1968 was the result of purchasing a new item of machinery while the increase in value in 1969 came about because two new items were bought.

Long term assets increased throughout the 20 year run starting with $63,279 in 1965 and reaching a maximum of $650,885 in 1984. This behaviour represents the expansion of the farm business brought about by annual land purchases until the maximum of 2,560 acres are being farmed. It also reflects capital gains due to price inflation that are incorporated in the value of land.

Total assets, as to be expected, showed the same behavioural pattern as the long term assets.

On the liability side of the net worth statement, it would be expected that parallel behaviour to each category of assets would be exhibited by each category of liability. Short term liability declined from its value in 1965 to $1,795 in 1966, began increasing in 1967 and continued to $2,021 in 1971 before falling to zero in 1974 at which value it remained throughout the rest of the run. The model dictates that so long as there are extra funds in surplus, short term liabilities are to be completely retired first, followed by medium term and long term liability.

Additional to borrowing for purchasing machinery and land, the model indicates that short term loan can be made to maintain the level of savings, checking and cash minima at $500 each. Thus, in 1967, a short term loan of $1,500 was made in order to maintain the above minima. Similar amounts of loan were taken out in 1968, 1969, 1970, 1971 and 1972. Short term liabilities were zero in each year beginning in 1974 up to 1984 because the financial strength of the business allowed the minima to be self-maintained.

Medium term liabilities behaved essentially as did medium term assets. Thus, medium term liabilities dropped from $21,433 in 1965 to $19,316 in 1966 to $17,078 in 1967. It rose to $20,567 in 1968 then to $25,948 in 1969, dropped in 1970 and 1971, rose to $27,595 in 1972, dropped to $24,113 in 1973 but increased to $27,072 in 1974. and followed this pattern to 1976, fell in 1977, and in 1978 and rose again in 1979, fell in 1980 and 1981, rose in 1982, 1983 and 1984.

Medium term liabilities varied as medium term assets. In years when machinery and implements are bought, liabilities increase; in years in which no machinery and implement is bought the decrease reflects reduction in value due to principal and interest paid. In some years, for example, in 1971 where purchase of an item of plant occurs, the liabilities need not increase if the amount borrowed is small enough not to increase liabilities. Implements cost less than tractors, therefore, in years in which tractors are bought liabilities will increase and more so than if items of implements are bought. In general, total liabilities, mirror the behaviour of medium and long term liabilities as these dominate the value of liabilities. However, long term liabilities were completely retired by 1979.

The current ratio, reflecting a measure of financial condition of the farm business, that is the ability of short term assets, if liquidated to cover short term liabilities, mirror the behaviour of short term assets and liabilities. Current ratio starts off at 5.43, increased to 10.58 in 1966, declined to 9.41 in 1967, and to 6.93 in 1968 and to 3.72 in 1969. It was 4.17 in 1970, 4.87 in 1971, 3.79 in 1972 and 16.01 in 1973. Throughout the remainder of the run it was very large. The greater the difference between short term assets and short term liabilities, the greater is the ability of short term assets if liquidated to meet the short term liabilities. The greatest difference exists in years in which short term liabilities are zero.

The leverage ratio or debt/equity ratio shows the solvency position of the business. It shows how much liabilities exist in relation to the farmer's net worth. The smaller the ratio the more solvent is the firm. Overall, this ratio displayed a decreasing trend auguring well for the ability to withstand bad economic times and bankruptcy and to survive and grow. The smaller the total liabilities and the higher the net worth, the more solvent is the farm business and the smaller the leverage ratio.

The highest leverage ratios were obtained inbetween 1969-1972 when farm debt amounted to many times the farm equity. Changes in the ratio are caused by incurring medium and long term debts. In this treatment, long term and medium term borrowings are the major causes of higher ratios while debt retirement causes the lowering of the ratio.

The change in net worth reflects the attained financial progress and growth of the firm. It is the difference between the year end net worth and, therefore, represents an annual growth. This value will be expected to vary as the asset and liability position of the business change. In general, the change in net worth displays an increasing tendency even though the change may be negative in some years. This is the case between 1968 and 1969 where the change in net worth was -\$25,287 caused by a drop in net worth from \$120,425 in 1968 to \$95,138 in 1969. These were due to an increase in total liabilities of \$46,867 and a decline in total assets of \$21,580. The decline in asset value was due primarily to a reduction in short term assets and for long term assets for reasons explained earlier.

A glance at the five year averages of the variables in Table 15 reinforces the points made during the above discussion. Short term assets averaged \$14,391 for the first five-years, \$8,456 for the second five-year period period, to \$7,405 for the third five-year period before stabilizing to \$7,016 in the fourth five-year period.

Both the ten-year averages and the five-year incremental averages show the growth tendencies of the business.

The average short term assets for the 20 year run is \$9,310 with a standard deviation of \$3,700 and coefficient of variation of 40 percent. The standard error is \$1,827. These statistical measures imply that there is a fair degree of spread among the annual values of short term assets and that individual values vary widely from the means. This is as the model operates and, infact, represents the nature of the agriculture industry in Manitoba.

Medium term assets averaged \$32,778 in the first five-years, \$43,819 in the second five-years, \$52,988 in the third five-years and \$62,547 in the fourth five-years showing the generally steadily increasing growth of the farm.

The overall mean value of medium term assets was \$48,033 with a standard deviation of \$12,053, coefficient of variation of 25 percent and standard error of \$2,695. These imply more precision of the estimate, less spread among the annual values and generally reflect the greater stability and permanence of medium term assets in the farm structure.

The value of long term assets averaged \$160,174 in the first five-years, rose to \$342,960 in the second five-years, was \$547,590 in the third five-year and ended at \$621,294 in the fourth five-year. The growth is obvious and represents appreciation due to inflation and purchases and improvement of land. The overall mean value for the twenty year period was \$418,005, the standard error was \$43,525 and the coefficient of variation was 47 percent. These statistical measures show that the spread among the annual data and between the mean and data is better than those for the short term assets but not as good as medium term assets.

Total assets averaged $207,343 in the first five-years, rose to $395,206 in the second five-years, was $607,983 in the third five-years and ended at $609,858 in the fourth five-years. The pattern is obvious now and the precision and stability are reflected in the standard deviation, standard error and coefficient of variation.

On the liabilities side, short term liabilities average $2,057 in the first five-years, $1,315 in the second five-years and with no short term debts since 1974, the second and third five-year values were zero. Medium term liabilities averaged $20,869 in the first five-years, decreased to $25,714 in the second five-years, increased to $39,965 in the third five-years and reached $48,578 in the fourth five-years. These values again emphasize the behaviour mentioned earlier.

The mean value over the twenty year period was $33,781; the standard deviation $12,798 and standard error $2,862 with coefficient of variation of 0.38.

Long term liabilities averaged $90,454 in the first five-years, increased to average $224,390 in the second five-year period and dropped to $187,029 in the thrid five-years. Total liabilities averaged $113,380 in the first five-year period, $251,419 in the second five-year period, $226,994 in the third five-year period and $187,853 in the fourth five-year period. Liabilities showed a generally progressively declining tendency. The overall mean total liabilities was $194,911 with a standard deviation of $61,218, standard error of $13,689 and coefficient of variation of 0.31.

The five year average values of net worth also display the progressively increasing tendency of the annual values and reflect the growth in financial strength and efficiency of operation and investment.

The net worth in the first five-years averaged $93,963, it increased to $143,787 in the second five-years, to $380,989 in the third five-years, terminating at $503,007 in the fourth five-years. The overall mean net worth over the twenty years was $280,436, the standard deviation was $180,895, the standard error was $40,449 and the coefficient of variation was 0.65.

The current ratio averaged 7.21 in the first five-years, and increased progressively since short term liabilities was zero since 1974. The leverage ratio over the five year period also displayed the reducing tendency implicit in growth and financial progress. It was 1.16 in the first five-years, increased to 2.46 in the second five-year period, declined to 0.60 in the third five-year period and culminating to 0.37 in the fourth five-year period. The overall mean value of the current ratio was $4,007, that of the leverage ratio was 1.15.

The average change in net worth over the first five-years was $7,249, rising to $43,419 in the second five-year period, declining to $22,523 in the third five-year period, and ending at $24,036 in the fourth five-year period. The variability in the values of change in net worth is indicated by the coefficient of variation, standard deviation and standard error.

Table 15 shows the net cash flow,total inflow and total outflow. The cash flow statement identifies the cash transaction of the farm business during a year. It allows an examination of the ability of

Simulation Year	Value Of Crop Sales	Annual Change In Value Of Crop Sales	Value Of Machinery Sales	Annual Change In Value Of Machinery Sales	Income In Kind	Annual Change In Income In Kind
1965	21168.80	0.0	6011.98	0.0	500.00	0.0
1966	23717.47	2548.67	0.0	-6011.98	500.00	0.0
1967	34023.37	10305.89	0.0	0.0	500.00	0.0
1968	47107.82	13084.45	0.0	0.0	500.00	0.0
1969	57481.03	10373.21	0.0	0.0	500.00	0.0
5 YR AVG	36699.69	9078.05	1202.40	-1503.00	500.00	0.0
1970	55938.53	-1542.50	0.0	0.0	500.00	0.0
1971	80199.62	24261.09	0.0	0.0	500.00	0.0
1972	121647.62	41448.00	0.0	0.0	500.00	0.0
1973	275195.75	153548.12	0.0	0.0	500.00	0.0
1974	223691.50	-51504.25	0.0	0.0	500.00	0.0
5 YR AVG	151334.56	33242.09	0.0	0.0	500.00	0.0
10 YR AVG	94017.12	22502.51	601.20	-668.00	500.00	0.0
1975	267589.00	43897.50	0.0	0.0	500.00	0.0
1976	297472.19	29883.19	0.0	0.0	500.00	0.0
1977	391272.69	93800.50	0.0	0.0	500.00	0.0
1978	395034.62	3761.94	0.0	0.0	500.00	0.0
1979	340214.25	-54820.37	0.0	0.0	500.00	0.0
5 YR AVG	338316.37	23304.55	0.0	0.0	500.00	0.0
15 YR AVG	175450.19	22788.95	400.80	-429.43	500.00	0.0
1980	359571.94	19357.69	0.0	0.0	500.00	0.0
1981	384654.69	25082.75	0.0	0.0	500.00	0.0
1982	411186.00	26531.31	0.0	0.0	500.00	0.0
1983	438776.62	27590.62	0.0	0.0	500.00	0.0
1984	467271.12	28494.50	0.0	0.0	500.00	0.0
5 YR AVG	412291.75	25411.37	0.0	0.0	500.00	0.0
20 YR AVG	234660.56	23479.06	300.60	-316.42	500.00	0.0
STD DEV	162008.06		1344.32		0.0	
STD ERR	36226.11		300.60		0.0	
C. V.	0.69		4.47		0.0	
MINIMUM	21168.80		0.0		500.00	
MAXIMUM	467271.12		6011.98		500.00	

TABLE 15 (continued)

Simulation Year	Amount Borrowed	Annual Change In Amount Borrowed	Off Farm Income	Annual Change In Off Farm Income	Other Income	Annual Change In Other Income
1965	56139.78	0.0	-867.50	0.0	0.0	0.0
1966	41180.00	-14959.78	-406.00	461.50	0.0	0.0
1967	45964.58	4784.58	55.50	461.50	0.0	0.0
1968	55830.23	9865.65	517.00	461.50	0.0	0.0
1969	53717.52	-2112.71	978.50	461.50	0.0	0.0
5 YR AVG	50566.40	-605.57	55.50	461.50	0.0	0.0
1970	44004.50	-9713.01	1440.00	461.50	0.0	0.0
1971	19596.53	-24407.98	1901.50	461.50	0.0	0.0
1972	9961.30	-9635.23	1444.00	-457.50	0.0	0.0
1973	1715.05	-8246.25	1905.50	461.50	0.0	0.0
1974	9126.61	7411.56	2276.00	370.50	0.0	0.0
5 YR AVG	16880.77	-8918.18	1793.40	259.50	0.0	0.0
10 YR AVG	33723.59	-5223.68	924.45	349.28	0.0	0.0
1975	6784.20	-2342.42	2737.50	461.50	0.0	0.0
1976	17816.40	11032.21	2607.00	-130.50	0.0	0.0
1977	5032.22	-12784.18	2606.00	-1.00	0.0	0.0
1978	2777.88	-2254.34	3533.00	927.00	0.0	0.0
1979	23382.80	20604.92	3988.00	455.00	0.0	0.0
5 YR AVG	11158.70	2851.24	3094.30	342.40	0.0	0.0
15 YR AVG	26201.95	-2339.78	1647.73	346.82	0.0	0.0
1980	0.0	-23382.80	5079.00	1091.00	0.0	0.0
1981	1987.30	1987.30	5704.00	625.00	0.0	0.0
1982	11156.47	9169.16	6411.00	707.00	0.0	0.0
1983	18855.62	7699.15	7354.00	943.00	0.0	0.0
1984	19961.32	1105.70	7815.50	461.50	0.0	0.0
5 YR AVG	10392.14	-684.29	6472.70	765.50	0.0	0.0
20 YR AVG	22249.50	-1904.13	2853.97	457.00	0.0	0.0
STD DEV	19726.40		2511.98		0.0	
STD ERR	4410.96		561.70		0.0	
C. V.	0.89		0.88		0.0	
MINIMUM	0.0		-867.50		0.0	
MAXIMUM	56139.78		7815.50		0.0	

Simulation Year	Total Inflow	Annual Change In Total Inflow	Share Rent	Annual Change In Share Rent	Total Current Operating Expenses	Annual Change In Total Current Operating Expenses
1965	50415.02	0.0	2255.92	0.0	6109.41	0.0
1966	27618.97	-22796.05	0.0	-2255.92	6204.12	94.71
1967	37307.64	9688.67	0.0	0.0	9396.14	3192.02
1968	57343.55	20035.91	0.0	0.0	12697.54	3301.40
1969	70774.50	13430.95	0.0	0.0	15620.87	2923.33
5 YR AVG	48691.91	5089.87	451.18	-563.98	10005.62	2377.86
1970	64780.54	-5993.96	0.0	0.0	18213.00	2592.13
1971	86757.12	21976.59	0.0	0.0	21980.03	3767.03
1972	134714.87	47957.75	0.0	0.0	24005.66	2025.63
1973	280943.75	146228.87	0.0	0.0	27052.55	3046.88
1974	237306.06	-43637.69	0.0	0.0	34438.61	7386.06
5 YR AVG	160900.44	33306.31	0.0	0.0	25137.95	3763.55
10 YR AVG	104796.19	20765.66	225.59	-250.66	17571.78	3147.69
1975	279952.19	42646.12	0.0	0.0	36745.52	2306.91
1976	321492.56	41540.37	0.0	0.0	37994.56	1249.04
1977	403215.87	81723.31	0.0	0.0	39252.31	1257.75
1978	405666.50	2450.62	0.0	0.0	40868.94	1616.63
1979	371912.50	-33754.00	0.0	0.0	42485.59	1616.65
5 YR AVG	356447.75	26921.29	0.0	0.0	39469.36	1609.40
15 YR AVG	188680.00	22964.10	150.39	-161.14	24870.97	2598.30
1980	368348.94	-3563.56	0.0	0.0	44102.22	1616.63
1981	395880.44	27531.50	0.0	0.0	45718.86	1616.63
1982	432042.44	36162.00	0.0	0.0	47335.48	1616.62
1983	467793.69	35751.25	0.0	0.0	48952.13	1616.65
1984	497855.44	30061.75	0.0	0.0	50568.76	1616.63
5 YR AVG	432383.75	25188.59	0.0	0.0	47335.47	1616.63
20 YR AVG	249605.94	23549.49	112.80	-118.73	30487.10	2339.97
STD DEV	166226.75		504.44		15093.14	
STD ERR	37169.43		112.80		3374.93	
C. V.	0.67		4.47		0.50	
MINIMUM	27618.97		0.0		6109.41	
MAXIMUM	497855.44		2255.92		50568.76	

TABLE 15 (continued)

Simulation Year	Machinery Operating Expenses	Annual Change In Machinery Operating Expenses	Building Operating Expenses	Annual Change In Building Operating Expenses	Current Expenses	Annual Change In Current Expenses
1965	3511.97	0.0	3764.96	0.0	2513.17	0.0
1966	3537.13	25.17	4107.74	342.78	2901.89	388.71
1967	5199.05	1661.91	4813.11	705.37	5931.62	3029.74
1968	7067.54	1868.49	5189.52	376.41	9112.52	3180.89
1969	8898.98	1831.44	7102.92	1913.39	11786.73	2674.21
5 YR AVG	5642.93	1346.75	4995.65	834.49	6449.18	2318.39
1970	10878.86	1979.87	8583.17	1480.25	14420.98	2634.25
1971	12614.62	1735.77	7803.07	-780.11	16874.62	2453.64
1972	14643.05	2028.43	7026.67	-776.40	18995.21	2120.59
1973	14550.45	-92.60	7924.09	897.42	21221.06	2225.84
1974	17615.72	3065.27	6739.00	-1185.09	25395.01	4173.95
5 YR AVG	14060.54	1743.35	7615.20	-72.78	19381.37	2721.66
10 YR AVG	9851.73	1567.08	6305.42	330.45	12915.27	2542.43
1975	20121.41	2505.68	6044.07	-694.93	27334.53	1939.52
1976	21796.54	1675.13	6216.29	172.21	28545.48	1210.95
1977	23301.57	1505.03	5785.58	-430.70	30303.77	1758.30
1978	24010.38	708.81	5739.36	-46.22	31097.60	793.82
1979	23912.27	-98.12	5215.49	-523.87	31382.59	284.99
5 YR AVG	22628.42	1259.31	5800.16	-304.70	29732.77	1197.52
15 YR AVG	14110.63	1457.16	6137.00	103.61	18521.11	2062.10
1980	46081.84	22169.58	4889.19	-326.30	32152.36	769.78
1981	47224.14	1142.30	4594.09	-295.10	33045.70	893.33
1982	49897.49	2673.35	4326.69	-267.39	34362.85	1317.15
1983	50144.76	247.27	4083.95	-242.74	35211.67	848.82
1984	52230.57	2085.81	3863.18	-220.77	36913.51	1701.84
5 YR AVG	49115.73	5663.66	4351.42	-270.46	34337.20	1106.19
20 YR AVG	22861.91	2564.14	5690.60	5.17	22475.13	1810.54
STD DEV	16856.60		1454.49		11377.15	
STD ERR	3769.25		325.23		2544.01	
C. V.	0.74		0.26		0.51	
MINIMUM	3511.97		3764.96		2513.17	
MAXIMUM	52230.57		8583.17		36913.51	

TABLE 15 (Continued)

Simulation Year	Interest Paid On Farm Debts	Annual Change In Interest Paid On Farm Debts	Value Of Capital Purchases	Annual Change In Value Of Capital Purchases	Principle Paid On Loans	Annual Change In Principle Paid On Loans
1965	2925.35	0.0	5670.71	0.0	6221.87	0.0
1966	4962.48	2037.13	0.0	-5670.71	8313.96	2092.09
1967	7338.08	2375.60	0.0	0.0	7182.36	-1131.61
1968	10950.89	3612.81	0.0	0.0	9674.58	2492.23
1969	14999.60	4048.71	0.0	0.0	12123.07	2448.49
5 YR AVG	8235.28	3018.56	1134.14	-1417.68	8703.17	1475.30
1970	18049.88	3050.28	0.0	0.0	14273.30	2150.22
1971	20740.61	2690.73	0.0	0.0	15412.23	1138.93
1972	21741.86	1001.25	0.0	0.0	16857.01	1444.78
1973	20788.61	-953.25	0.0	0.0	17361.13	504.12
1974	20320.36	-468.24	0.0	0.0	17429.61	68.48
5 YR AVG	20328.25	1064.15	0.0	0.0	16266.65	1061.31
10 YR AVG	14281.76	1932.78	567.07	-630.08	12484.91	1245.30
1975	19666.61	-653.75	0.0	0.0	14612.90	-2816.71
1976	20112.28	445.67	0.0	0.0	16231.86	1618.96
1977	19311.21	-801.07	0.0	0.0	17133.81	901.96
1978	18238.96	-1072.26	0.0	0.0	17089.89	-43.92
1979	19136.02	897.06	0.0	0.0	17915.95	826.06
5 YR AVG	19293.01	-236.87	0.0	0.0	16596.87	97.27
15 YR AVG	15952.18	1157.90	378.05	-405.05	13855.56	835.29
1980	17700.90	-1435.12	0.0	0.0	16041.55	-1874.40
1981	16576.39	-1124.50	489.99	489.99	16497.75	456.20
1982	16375.89	-200.50	0.0	-489.99	16578.64	80.89
1983	17000.39	624.50	0.0	0.0	18163.61	1584.97
1984	17632.88	632.50	0.0	0.0	18852.35	688.74
5 YR AVG	17057.29	-300.63	98.00	0.0	17226.77	187.28
20 YR AVG	16228.45	774.08	308.03	-298.46	14698.36	664.76
STD DEV	5417.76		1266.97		3859.89	
STD ERR	1211.45		283.30		863.10	
C. V.	0.33		4.11		0.26	
MINIMUM	2925.35		0.0		6221.87	
MAXIMUM	21741.86		5670.71		18852.35	

TABLE 15 (continued)

Simulation Year	Household Withdrawal for Consumption	Annual Change In Household Withdrawal for Consumption	Total Outflow	Annual Change In Total Outflow	Net Cash Flow	Annual Change In Net Cash Flow
1965	1687.73	0.0	34661.09	0.0	15753.93	0.0
1966	2204.50	516.76	32231.82	-2429.27	-4612.85	-20366.78
1967	2159.17	-45.32	42019.53	9787.71	-4711.89	-99.04
1968	2210.65	51.48	56903.24	14883.71	440.31	5152.20
1969	2225.93	15.28	72758.00	15854.76	-1983.50	-2423.81
5 YR AVG	2097.60	134.55	47714.71	9524.23	977.20	-4434.36
1970	2172.70	-53.23	86591.81	13833.81	-21811.28	-19827.78
1971	2626.88	454.18	98052.00	11460.19	-11294.87	10516.40
1972	3263.44	636.56	106532.87	8480.87	28182.00	39476.87
1973	6667.28	3403.84	115565.06	9032.19	165378.69	137196.69
1974	5326.13	-1341.15	127264.31	11699.25	110041.75	-55336.94
5 YR AVG	4011.29	620.04	106801.19	10901.26	54099.25	22405.05
10 YR AVG	3054.44	404.27	77257.94	10289.24	27538.22	10476.42
1975	6311.37	985.25	130836.31	3572.00	149115.87	39074.12
1976	6934.21	622.84	137831.06	6994.75	183661.50	34545.62
1977	8994.25	2060.04	144082.44	6251.37	259133.44	75471.94
1978	9198.72	204.47	146243.75	2161.31	259422.75	289.31
1979	7961.84	-1236.88	148009.56	1765.81	223902.94	-35519.81
5 YR AVG	7880.08	527.14	141400.62	4149.05	215047.19	22772.23
15 YR AVG	4662.98	448.15	98638.75	8096.32	90041.19	14867.79
1980	8213.26	251.42	169181.19	21171.62	199167.75	-24735.19
1981	8854.58	641.32	173001.31	3820.12	222879.12	23711.37
1982	9243.20	388.62	178120.12	5118.81	253922.31	31043.19
1983	10005.37	762.18	183561.69	5441.56	284232.00	30309.69
1984	10210.29	204.91	190271.37	6709.69	307584.06	23352.06
5 YR AVG	9305.34	449.69	178827.12	8452.36	253557.00	16736.22
20 YR AVG	5823.57	448.56	118685.81	8190.01	130920.12	15359.48
STD DEV	3174.72		50871.15		118791.06	
STD ERR	709.89		11375.13		26562.49	
C. V.	0.55		0.43		0.91	
MINIMUM	1687.73		32231.82		-21811.28	
MAXIMUM	10210.29		190271.37		307584.06	

the farm to meet its obligation and shows how funds were obtained and helps to evaluate needs for capital and repayment capability.

Total inflow consists of the value of crop sales, value of machinery sales, income-in-kind, borrowing, off-farm income and miscellaneous other income. Total outflow consists of the value of crops purchased, share rent cost, total crop operating expenses, total machinery operating expenses, total building operating expenses, total current expenses, interest paid on farm debts, other farm purchases, total value of capital purchases, total principle paid on loans and cash withdrawn for household uses. Net cash flow is the difference between total cash inflows and total cash outflows and may be positive or negative.

Although information from the income statement are used in the net cash flow statement, the net cash flow statement includes cash withdrawn for household uses, total principle paid on loans, total value of capital purchases while income statement shows only interest payments. The income statement has expenses associated with capital purchases through depreciation but the cash flow statement reflects the cash transactions associated with purchase/sale. The income statement includes change in value of crop inventory but cash flow includes sales and purchases as they occur with no inventory adjustments.

Total cash inflow started at $50,415, declined in 1966, began increasing in 1967, increased in 1968 and 1969, declined in 1970, increased in 1971, increased again in 1972 and 1973, decreased in 1974 to $237,306, increased to $279,952 in 1975, and continued increasing through 1976, 1977 and 1978. Total cash inflow declined from $405,666 in 1978 to $368,349 in 1980. Its value increased progressively to $497,855 in 1984.

Total outflow started at $34,661 in 1965 but declined in 1966, after which it continued to increase throughout the run to a maximum of $190,271 in 1984.

Net cash flow began with a value of $15,754 in 1965, declined to -$4,613 in 1966 and to -$4,712 in 1967. It stood at $440 in 1968, declined to -$1,983 in 1969 and to -$21,811 in 1970. Although it stayed negative it began rising in 1971 and climbed to $165,379 in 1973 before declining to $110,042 in 1974. During the next four years, 1975-1978, net cash flow increased from $149,116 to $259,423. It declined in 1979 and 1980 but the value again increased in 1981 and continued to increase in 1982 and 1983 before reaching a value of $307,584 in 1984. A closer examination of the table and reference to the detailed run will reveal the significance and behaviour of cash flow.

In 1965, total inflow of $50,415 reflected crop sales of $21,169, machinery sales of $6,012, amounts borrowed of $21,294, off-farm income of $1,440 with income-in-kind fixed at $500. Total outflow in 1965 included the items listed in the farm income statements under expenses plus cash withdrawn for household uses $1,682, total principle paid on loans $6,222, and value of capital purchases $5,671. It is important to observe that the latter is reflected in the income statement only as a depreciation charge. The annual depreciation on the farm income is seen to be relatively stable. This will show a vast contrast with the variability in the value of capital purchases in the cash flow statement. It is because of this inherent wide difference between these values, that the income statement does not necessarily give a good indication of the farm's debt-servicing ability.

For a stable business where no expansion in capital expenditure is taking place, depreciation tends to balance out net capital purchases over time. If the farm is young and vigorous, however, net capital investment expenditures would be ceteris paribus, larger than depreciation allowances and cash flow values would exceed net farm income.

The decline in total inflow from 1965 to 1966 results from the changes in the values of the components of total inflow. Although crop sales increased from $21,169 in 1965 to $23,717 in 1966, and off-farm income increased from $1,440 to $1,902, borrowing in 1966 amounted to $1,500 in short term loan to maintain minimum cash, saving and chequing balances, compared to $21,294 in 1966.

The decline in total outflow was less drastic than that in the total inflow. Again, the combined changes in all variables explains changes in total outflow. In 1966, share rent decreased from $2,256 in 1965 to zero. Crop operating expenses increased from $6,109 in 1965 to $6,204 in 1966, building operating expenses increased from $3,765 in 1965 to $4,107 in 1966. Current expenses increased from $2,821 1965 to $3,230 in 1966. Total principle paid on loans increased from $6,222 in 1965 to $8,314 in 1966. Total machinery operating expenses increased from $3,512 in 1965 to $3,537 in 1966; interest paid on debts increased from $2,925 in 1965 to $4,962 in 1966 and total value of capital purchases decreased from $5,671 in 1965 to zero in 1966.

The negative declines in net cash flow from $15,754 in 1965, to -$4,613 in 1966 and to -$4,712 in 1967 follow from the preceding.

Deficit net cash flow imply that the operator was forced to take out short term loans in those years to meet operating expenses. These were additional to the long term loan to purchase 320 acres of land. The increase in total inflow between 1966 and 1967 was brought about by an increase in crop sales from $23,717 in 1966 to $34,023 in 1967. This was the result of increased seeded land, increased yields and prices and quantity marketed.

The increase in total outflow between 1966 and 1967 resulted from increased expenses generated by the combined effects of servicing new loans to purchase land and to maintain saving, chequing and cash minima and the cultivation of the increased land. Interest paid on farm debt increased by 48 percent, current farm expenses increased by 85 percent, building expenses increased by 17 percent, machinery expenses increased by 47 percent and crop operating expenses increased by 51 percent. The combined effects of the changes above were to produce a value of net cash flow equal to -$4,613 and forcing the farmer to make short term loan to cover the deficit.

Between 1967 and 1968, total inflow increased by 54 percent while total outflow increased by 35 percent. This resulted in net cash flow increasing from -$4,712 to $440 in 1968. The increase in total inflow was the result of crop sales increasing from $34,023 in 1967 to $47,108 in 1968, an increase of 11 percent in off-farm income and an increase of borrowed capital from $1,500 in 1967 to $7,830 in 1968.

The increase in total outflow was caused by increases in crop operating expenses of 35 percent, 36 percent increase in machinery operating expenses, 54 percent increase in current expenses, 49 percent increase in interest paid on farm debts, 25 percent increase in total principle paid on loans.

Additional analytical and interpretive insights about the model behaviour is discovered by looking at the values for the five-year averages. Total inflow averaged $48,692 for the first five-year period, 1965-1969, increased to $160,900 in 1970-1974, again increased to $356,448 for 1975-1979 and averaged $432,384 during 1980-1984. The comparative values for total outflow were $47,715, $106,801, $144,401 and $178,827 respectively.

The average incremental five-year averages of total inflow was greater than those of total outflow with the consequence that the five-year average net cash flow values were not only positive,but continued to increase throughout. The average five-year net cash flow was $977 for the period 1965-1969, $54,099 for 1970-1974, $215,047 for 1975-1979, and $253,557 for 1980-1984.

The twenty-year mean total inflow was $249,606 with a standard deviation of $166,227, a standard error of $37,169 and a coefficient of variation of 0.67. The minimum inflow was $27,618 found in 1966 while the maximum reached amounted to $497,855 in 1984. Total outflow ranged from $32,232 in 1966 to a maximum of $190,271 in 1984. The mean outflow was $118,686 with a standard deviation of $50,871, a standard error of $11,375 and a coefficient of variation of 0.43.

Significant variation exists among both inflow and outflow but the variation among the data is greater for inflow than for outflow. Net cash flow ranges from -$21,811 in 1970 to $307,584 in 1984. The overall twenty-year mean amounted to $130,920 with a standard deviation of \$118,791, a standard error of \$26,562 and a coefficient of variation of 0.91. The above statistical parameters indicate that there are great variations among the annual net cash flow values and between the mean and annual net cash flow values.

Table 16 presents the summary of net farm income, net cash flow and net farm worth together with the annual changes of these variables while Figure 15 presents the graphical representation. Since the relationships between the above variables have been discussed earlier they are not repeated here.

The discussion so far has shown that the major determinants of net farm income have been crop sales, non-farm income, total farm expenses including depreciation charges and change in the value of crop inventories. Moreover, the latter was posited as the dominating factor. Thus, in 1965, the low value of net farm income, \$7,581 is accompanied by a change in value of inventory of -\$5,538.

It was pointed out that apart from normal farm expenses, the value of capital purchases, total principle paid on loans, share rent and cash withdrawn for household expenditures dominated the total outflow of cash, while the amount of capital borrowed, off-farm income and crop sales dominated the inflow of cash. Thus, in 1965, total inflow was \$50,415 of which sales amounted to \$21,169 and borrowings \$21,294. On the outflow side, total principle paid on loans, total value of capital purchases, cash withdrawn for household expenses and interest paid on debts totalled \$16,506 while share rent, crop, machinery, building and current expenses amounted to \$18,463.

The behaviour of net farm worth depended on the behaviour of the types of assets and liabilities all of which are determined by the model. For example, net farm worth was valued at \$66,145 in 1965.

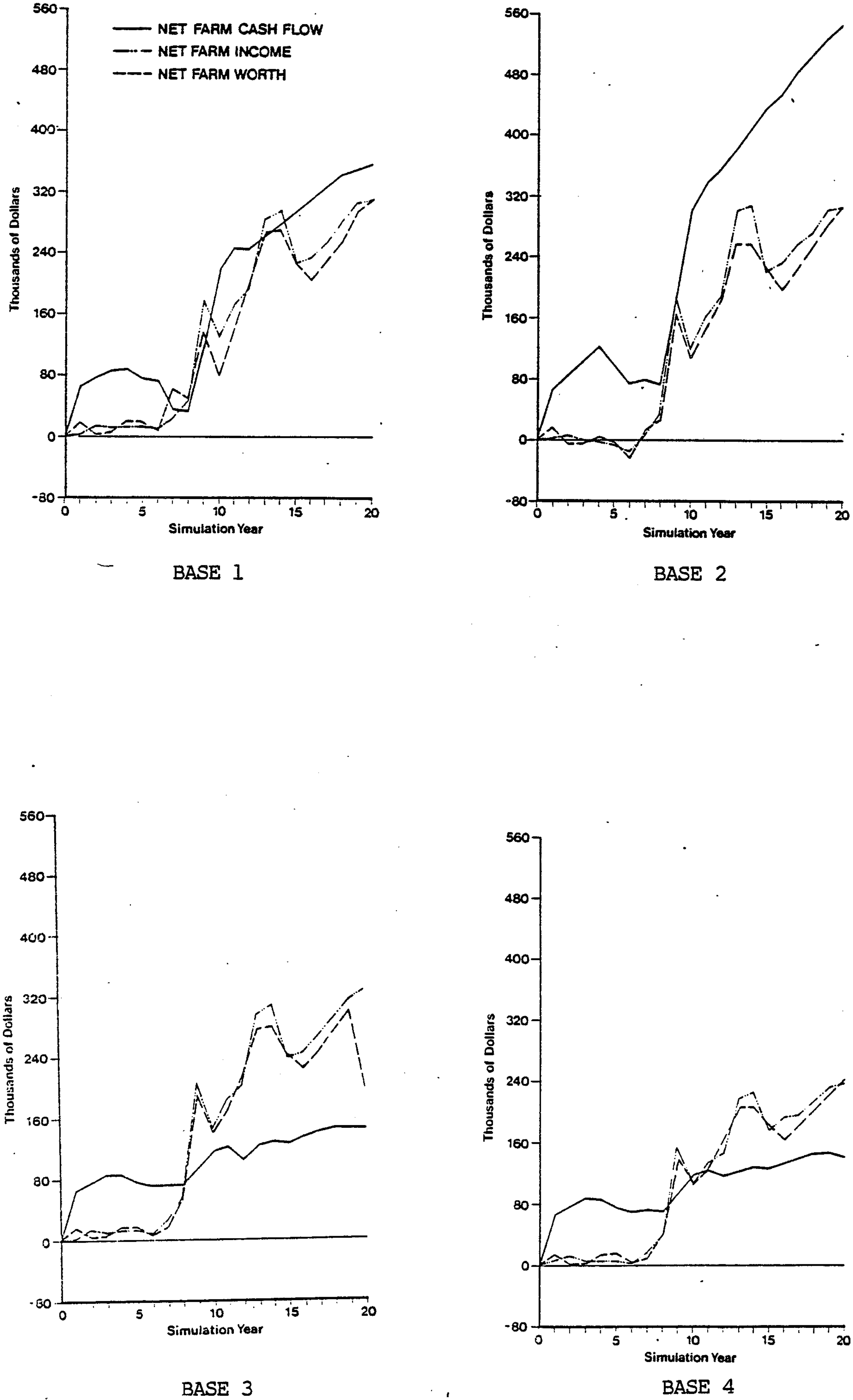
TABLE 16

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR BASE 1

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
YEAR						
1965	857.78	0.0	15753.93	0.0	66145.12	0.0
1966	8046.58	7188.80	-4612.85	-20366.78	83937.87	17792.75
1967	1204.16	-6842.41	-4711.89	-99.04	104169.69	20231.81
1968	-997.24	-2201.40	440.31	5152.20	120425.00	16255.31
1969	-4930.42	-3933.18	-1983.50	-2423.81	95137.69	-25287.31
5 YR AVG	836.17	-1447.05	977.20	-4434.36	93963.06	7248.14
1970	-12143.99	-7213.57	-21811.28	-19827.78	74346.12	-20791.56
1971	4956.96	17100.96	-11294.87	10516.40	79059.25	4713.12
1972	30798.87	25841.91	28182.00	39476.87	71997.31	-7061.94
1973	189233.25	158434.37	165378.69	137196.69	181299.62	109302.31
1974	120321.87	-68911.37	110041.75	-55336.94	312233.37	130933.75
5 YR AVG	66633.37	25050.45	54099.25	22405.05	143787.12	43419.14
10 YR AVG	33734.77	13273.78	27538.22	10476.42	118875.06	27343.14
1975	162878.00	42556.12	149115.87	39074.12	336014.06	23780.69
1976	188072.62	25194.62	183661.50	34545.62	354532.44	18518.37
1977	282131.69	94059.06	259133.44	75471.94	380485.50	25953.06
1978	287285.81	5154.12	259422.75	289.31	409069.00	28583.50
1979	223382.50	-63903.31	223902.94	-35519.81	424846.25	15777.25
5 YR AVG	228750.00	20612.12	215047.19	22772.23	380989.37	22522.57
15 YR AVG	98739.75	15894.61	90041.19	14867.79	206246.50	25621.51
1980	230791.44	7408.94	199167.75	-24735.19	453600.31	28754.06
1981	256884.25	26092.81	222879.12	23711.37	482828.37	29228.06
1982	270872.19	13987.94	253922.31	31043.19	506419.75	23591.37
1983	302760.87	31888.69	284232.00	30309.69	527157.81	20738.06
1984	307951.87	5191.00	307584.06	23352.06	545027.19	17869.37
5 YR AVG	273851.75	16913.87	253557.00	16736.22	503006.37	24036.19
20 YR AVG	142517.75	16162.84	130920.12	15359.48	280436.50	25204.32
STD DEV	125305.44		118791.06		180895.25	
STD ERR	28019.15		26562.49		40449.41	
C. V.	0.88		0.91		0.65	
MINIMUM	-12143.99		-21811.28		66145.12	
MAXIMUM	307951.87		307584.06		545027.19	

FIGURE 15

NET FARM CASH FLOW, NET FARM WORTH AND NET FARM INCOME OF THE FOUR BASE RUNS



The values of short term assets, especially the value of grain in inventory, medium term assets and long term assets determine the total assets value. At the end of 1966, net worth had increased to $83,938. The change in inventory added $4,552 to assets and purchases of land, land appreciation increased asset value by $9,946 while depreciation reduced the value of assets by $2,700.

Net cash flow was -$4,613 in 1966. Total inflow dropped from $50,415 in 1965 to $27,619 as machinery sales fell to zero and farm receipts tumbled from $27,181 to $23,717. The most dramatic influence occurred with the dramatic decline in amount of money borrowed from $21,294 in 1965 to $1,500 in 1966. The drop in outflow of 7 percent was much stickier than the 45 percent drop in cash inflow.

A look at the three performance criteria reveals that the rate and amount of growth in net farm income vary from those of net cash flow and net farm worth. In the first five-years, 1965-1969, the average annual growth in net farm income amounted to -$1,447, that of net cash flow amounted to -$4,434 and that of net farm worth was $7,249.

In the period 1970-1974, net farm income showed an average annual growth of $25,050, that of net cash flow was $22,404 and that of net farm worth was $43,419. During the period 1975-1979, the average annual growth in net farm income was $20,612,a drop of 18 percent below the second five-year period. During the same period, the average annual growth of net cash flow stood at $22,772, 2 percent higher than that of the earlier period. The change in net farm worth averaged $22,523 during this time representing a slowdown of 48 percent from the value of 1970-1974.

For the 1980-1984 period net farm income averaged an annual growth of \$16,914, representing an 18 percent slowdown from the earlier period. Concurrently, net farm cash flow displayed an average annual growth of \$16,736, a 27 percent decline and net farm worth showed an average annual change of \$24,036, a 7 percent increase over 1974-1979.

For the twenty-year period, net farm income experienced an annual average growth of \$3,056, net cash flow an amount of \$2,874 and net farm worth an amount of \$23,944.

The five-yearly mean values are also informative comparisons. For the period 1965-1969, net farm income averaged \$836, net cash flow averaged \$977, while net worth averaged \$93,963. Although the values of means of net farm income and net cash flow accelerated very significantly to \$66,633 and \$54,099, respectively, that of net farm worth accelerated but at a much slower rate to \$143,787, during the 1970-1974 period.

In 1975-1979, net farm income averaged \$228,750, an increase of 59 percent more than the 1970-1974 period. At the same time net cash flow was averaging a 297 percent increase and net worth had an average amounting to \$380,989, a 165 percent increase. Net farm income averaged \$273,852 during 1980-1984, only a 20 percent increase over the value in 1975-1979 and a tremendous slow down in the rate of appreciation; net cash flow averaged \$253,557, a 17 percent increase over the average in 1974-1979, while net farm worth with an average of \$503,007 experienced a 32 percent increase over the value in 1974-1979.

During the twenty-year period, 1965-1984, net farm income ranged in value from -\$12,144 in 1965 to \$307,952 in 1984 with a mean of

$142,518, a standard deviation of $125,305, a standard error of $28,019 and a coefficient of variation of 0.88.

Net cash flow values ranged from -$21,811 in 1970 to a maximum of $307,584 in 1984. The mean value was $130,920 with a standard deviation of $118,791, a standard error of $26,562 and a coefficient of variation of 0.91.

By comparison, the value of net farm worth ranged from a low of $66,145 in 1965 to a maximum of $545,027 in 1984. The mean value of net worth was $280,436, the standard deviation was $180,895 and the standard error was $40,449. The coefficient of variation for the net worth was 0.65.

The foregoing summary indicates that net farm income and net cash flow are more closely related to each other than to the net farm worth. The spread between the inter-year values of net farm income is great as reflected by the standard deviation and coefficient of variation of 0.88. The latter is less than that for the net cash flow implying greater variability among the annual net cash flow values. The coefficient of variation of net cash flow of 0.91 shows that while its values are more variable than those of net farm income, the coefficient of variation of net worth of 0.63 represents a greater degree of closeness and precision of its annual values. Inter-year values of net farm worth are less variable and consequently more stable than those of net farm income and much more stable than those of net cash flow. Thus, the volatility and instability of annual values of net farm income and net cash flow displayed by the variation of the values from their means, the positive and negative inter-year changes of the values and by the differing and uneven growth rates, are in strong contrast to the stability and permanence exhibited by the comparative net worth values.

CHAPTER VII

ANALYSIS OF EXPERIMENTAL RESULTS - PART II

THE EXPERIMENTAL TREATMENTS

In order to facilitate the analysis so that the objectives of the study were addressed, the treatments were aggregated to form the following scenarious, however only the first four are being reported in this study:

Scenario 1. Compares the Total Effects of Outright Purchase of Land, Debt Structure and Return Percentage on Productive Resources (Assets).

Scenario 2. Compares the Total Effects of Rent-to-Purchase Land Procurement Arrangement, Debt Structure Relationship and Rate of Return on Productive Resources (Assets).

Scenario 3. Compares the Total Effects of Cash Rental Land Control Arrangement, Debt Structure Relationship and Rate of Return on Productive Resources (Assets).

Scenario 4. Compares the Total Effects of Share Rental Land Control Arrangement, Debt Structure Relationship and Rate of Return on Productive Resources (Assets).

Scenario 5. Compares the Effects of Outright Purchase of Land and Debt Structure Relationship.

Scenario 6. Compares the Effects of Outright Purchase of Land and Rate of Return on Productive Resources (Assets).

Scenario 7. Compares the Effects of Rent-to-Purchase Arrangement for Control of Land and Rate of Return on Productive Resources (Assets).

Scenario 8. Compares the Effects of Rent-to-Purchase Land Control Arrangement and Debt Structure Relationship.

Scenario 9. Compares the Effects of Cash Rental Land Control Arrangement and Debt Structure Relationship.

Scenario 10. Compares the Effects of Cash Rental Land Control Arrangement and Rate of Return on Productive Resources (Assets).

Scenario 11. Compares the Effects of Share Rental Land Control Arrangement and Debt Structure Relationship.

Scenario 12. Compares the Effects of Share Rental Land Control Arrangement and Rate of Return on Productive Resources (Assets).

Scenario 13. Compares the Effects of Land Control Arrangements and Debt Structure Relationship.

Scenario 14. Compares the Effects of Land Control Arrangements and Rate of Return on Productive Resources (Assets).

Scenario 15. Compares the Effects of Debt Structure Relationship and Rate of Return on Productive Resources (Assets).

SCENARIO 1 - RESULTS AND DISCUSSIONS

The primary purpose of this scenario is to compare the total effects of outright purchase land control arrangements, debt structure relationships and rates of return on productive assets on the levels of attainment and maintenance of net farm income, net cash flow and net worth and on the survival and growth of the farm business. Scenario 1 compries the following four treatments:

Treatment 1. Outright Land Purchase (P), Return on Productive Assets Equal to the Interest Rate Charged Farmers for Loans by the Farm Credit Corporation of Canada (FCAF) and a Debt Structure Ratio of Short Term Debt/Long Term Debt (STD/LTD).

Treatment 2. Outright Land Purchase (P), Return on Productive Assets Equal to the Interest Rate Charged Farmers for Loans by the Farm Credit

Corporation (FCAF), and a Debt Structure Ratio of Medium Term Debt/Long Term Debt (MTD/LTD).

Treatment 3. Outright Land Purchase (P), Return on Productive Assets Equal to the Rate of Inflation as Represented by the Consumer Price Index (IR), and a Debt Structure Ratio of Short Term Debt/Long Term Debt (STD/LTD).

Treatment 4. Outright Land Purchase Control Arrangements (P), Rate of Return on Productive Assets Equal to the Annual Rate of Inflation as Reflected by the Annual Consumer Price Index (IR), and a Debt Structure Ratio of Medium Term Debt/Long Term Debt (MTD/LTD).

A major reason for the detailed discussions of the validation scenario and the Base Cases (Treatments 1-4) was to present the complete picture of the model at work with special emphasis on the explanations for 'differentness' in behaviour of any variable or set of variables in order that the reader understands the operational functioning of the simulation model. With the above accomplished, and given the vastness of the data, the need to discuss each variable in detail on an annual basis for twenty years is diminished.

It is, therefore, proposed to examine the results of the sixteen treatments by analysing the performance variables at five yearly intervals. One benefit of this procedure is that in the presence of trends in the performance variables, treatment means, that is, the mean over the duration of the run, twenty years, is not the most suitable way to study data and that a short 'blocked' procedure will provide a better indication of behaviour and permit a more scientific analysis. Where, however, it is necessary to examine any value in detail to provide some clarification of 'contrary' expected results a detailed working of the treatment will be carried out.

Each treatment is examined one performance variable at a time with clarification and explanation as desired. Then, the four treatments and the base are compared to examine for similarities and differentness in behaviour and rationalizing them. After each Scenario is analysed, a summary is given. When all Scenario's are completed, the overall results and conclusions are presented.

Net Farm Income

The detailed tables for all subsequent treatments are placed in Appendix D. This was deemed necessary becasue the author believes that it was necessary to present them, being integral to the analytical logic and explanation, and at the same time their volume would be too great to include them in the main body of the thesis. It was with the latter in mind, that the detailed tables of the outright purchase base treatment were presented earlier.

However, summary tables are presented later. The tables in the appendix are identified by the appendix letter designation followed by the number identifying the table in that appendix. For example, Table D.1, refers to the first table of Appendix D.

Table D.1 presents the farm income statement and indicators for Treatment 1. The net farm income in Treatment 1, Purchase-FCAF-STD/LTD increased throughout the twenty-years of run except between 1968-1968, 1969-1970, 1973-1974 and 1978-1979. In 1969, net farm income was 93 percent of the value in 1968; in 1974, its value was 77 percent of 1973 and in 1979, net farm income was 84 percent of its 1978 value. It was explained previously that changes in value of crop inventory was the dominant causal factor for changes in net farm income.

When discussing net farm income it was noted that nonfarm income will play an important role in elucidating the behaviour of net farm income. This is because nonfarm income contains the return on investment generated when the controlled rate of return is applied to the annual value of productive assets. Thus, while under normal circumstances nonfarm income is important, the latter takes on added significance. It would be shown that changes in income position especially in the case of Scenario 1 was strongly correlated with the behaviour of nonfarm income. It becomes obvious that the return rate applied to the productive assets works itself through the farm financial accounts via nonfarm income to net farm income, surplus, assets value due to increased purchases and higher values due to appreciation and improvement. These tend to generate increased value of crop sales, more borrowing, more debts, more expenses and changes in net cash flow.

In 1968, the changes in value of crop in inventory was -\$3,882 while it was -\$6,073 in 1969, a difference of -\$2,191. Although, in 1969 total farm cash receipts increased by 22 percent over 1968, total farm expenses increased by 29 percent over 1968. The combination of a decreasing value of crop in inventory and the changes in receipts and expenses was partly responsible for the decline in net farm income from \$21,875 in 1968 to \$20,451 in 1969.

In 1974, net farm income was 77 percent the value in 1973. Total farm receipts dropped to 81 percent of its 1973 value. This was due to a combination of reasons. Changes in yield, prices and quantity marketed together with the allocation of new land to crops based on each crop relative contribution to the profitability of the business in 1973 caused the decline in receipts. At the same time, total farm expenses were growing by 11 percent. Also, nonfarm income increased by 46 percent and total depreciation grew by 147 percent. In 1973, the value of inventory change was $610 and in 1974 it dropped to -$278.

In 1978, net farm income was 19 percent higher than its value in 1979. Total farm receipts were only 86 percent of its 1978 value, total farm expenses were 2 percent higher than in 1978, nonfarm income was 10 percent higher and depreciation was 113 percent higher in 1979. There was no change in the value of inventory.

The continuous general growth in net farm income is indicated by the five-year and ten-year averages. For the first five-years, net farm income averaged $17,551 and an average five-year growth of $3,069. In the second five-year period, 1970-1974, net farm income showed an average of $103,532. The ten-year average net farm income was $60,541 with an average growth of $18,574.

The average net farm income for the period 1975-1979 was $296,238 with a fifteen year average growth of $20,704 while for the period 1980-1984, net farm income averaged $356,363 and an average growth of $20,429 over the twenty years.

The overall mean net farm income for the twenty years was $193,421, the mean growth was $20,429, the minimum was $8,177 reached in 1965 and the maximum was $396,331 in 1984.

Table D.2 shows the farm income statement and indicators for Treatment 2 - Outright Land Purchase (P), Return on Productive Assets Equal to the Farm Credit Corporation of Canada Interst Rate Charged Farmers (FCAF) and a Debt Structure of Medium Term Debt/Long Term Debt (MTD/LTD).

For Treatment 2, the net farm income, in general, displayed a similar pattern to that of Treatment 1. The changes in net farm income are compared here since the rationale for the changes are the same as those indicated under the discussion for Treatment 1. The change in net farm income between 1968 and 1969 was -\$1,424 for treatment 1 and -\$1,437 for treatment 2; that between 1969 and 1970 was -\$2,912 for treatment 1 and -\$3,035 for treatment 2. The change in net farm income between 1973 and 1974 was -\$52,352 for treatment 1 and -\$53,300 for treatment 2, while the changes between 1978 and 1979 were -\$57,930 for treatment 1 and -\$58,009 for treatment 2. In every case except 1968-1969, the magnitude of the differences were greater, for treatment 2 than for treatment 1.

The net farm income at five-year intervals and ten-year intervals display the general increasing trends. In the period 1965-1969, average net farm income was \$17,415 with an average growth of \$3,034. In the second period, 1970-1974, net farm income averaged \$100,005 and the ten-year income growth averaged \$17,940. During the third and fourth five-year periods, net farm income averaged \$289,960 and \$349,355 respectively, with the values for fifteen-year and twenty-year average income growth of \$20,223 and \$20,054 respectively. For the ten-year period 1965-1974, net farm income averaged \$58,960 and growth averaged

$17,940. The net farm income averaged $319,657 for the ten-year period, 1975-1984.

The overall mean net farm income for the twenty-year run was $189,309, with the overall growth averaging $20,054.

The farm income statement and indicators for Treatment 3 is shown in Table D.3. For treatment 3, net farm income also displayed the generally increasing tendency except for declines in 1966-1967, 1967-1968, 1969-1970, 1974-1975 and 1978-1979. Although total farm receipts increased by 43 percent between 1966 and 1967, total farm expenses were also increasing by 47 percent. However, the value of crop inventory change was -$1,524. The combination of changes in expenses, depreciation and change in value of inventory were stronger than the increase in total farm receipts partly causing the decline in net farm income between 1966 and 1967. Similar reasons caused the changes outlined in the other periods.

The five-year average net farm income for the period 1965-1969 was $17,383 and the average growth in net farm income was $2,641. For the 1970-1974 period, net farm income averaged $154,406 while the growth in net farm income for 1965-1974 averaged $37,525. The values of average net farm income was $335,756 for 1975-1979 and $393,921 for 1980-1984. The average net farm income growth for the period 1965-1984 was $22,412. The ten-year average net farm income was $85,895 in 1965-1974 and $364,838 for 1975-1984.

The overall mean net farm income for the twenty-year period 1965-1984 was $225,367 while the average growth for the same period was $22,418. The minimum was attained in 1970 and the maximum in 1984.

Table D.4 shows the farm income statement and indicators for Treatment 4.

Treatment 4 showed the same pattern of behaviour as treatment 3 in terms of both the general increasing tendencies of the net farm income and changes in net farm income though the magnitudes of the values differ.

The net farm income in treatment 4 averaged \$17,329 during 1965-1969, \$151,123 during 1970-1974, \$329,298 during 1975-1979 and \$386,824 during 1980-1984. Corresponding values of average growth in net farm income were \$2,679 at five-years, \$36,864 at ten-years, \$22,994 at fifteen-years and \$22,040 at twenty years. The ten-year averages for net farm income were \$84,226 in 1965-1974, and \$358,061 for 1975-1984. The overall mean for the twenty-year run was \$221,143 and that for the growth in net farm income was \$22,040. The minimum net farm income in this treatment occurred in 1970 and the maximum of \$426,322 was attained in 1984.

Table 17 shows the summary net farm income comparison of the treatments in Scenario 1 and the Base.

The lowest minimum net farm income of -\$12,144 was found in the base in 1970. Treatment 3 had the next lowest of -\$1,917 also occurring in 1970 followed by that of treatment 4 with \$2,300 in 1970.

Treatments 1 and 2 attained the highest minimum of \$8,177, the net farm income in 1965. The lowest maximum of \$307,952, was found in the Base. Treatment 2 was next with \$389,204, followed by treatment 1 with \$396,331. The highest value of \$433,517 was found in treatment 3 and the second highest of \$426,332 was found in treatment 4. All maxima were obtained at the end of the simulation in 1984.

TABLE 17

SUMMARY NET FARM INCOME COMPARISONS FOR SCENARIO 1

		Treatment				Mean
	Base 1	1	2	3	4	
Minimum $	-12,144	8,177(65)	8,177(65)	-1,917(70)	2,300(70)	4,184
Maximum $	307,952	396,331(84)	389,204(84)	433,517(84)	426,332(84)	411,346
Means						
Five Years $						
1	836	17,551	17,415	17,383	17,329	17,419
2	66,633	103,532	100,505	154,406	151,123	127,391
3	228,750	296,238	289,960	335,756	329,298	312,813
4	273,852	356,363	349,355	393,921	386,824	371,616
Ten Years $						
1	33,735	60,541	58,960	85,895	84,226	72,405
2	251,301	312,800	319,657	364,838	358,061	338,839
Twenty Years $						
1	142,517	193,421	189,309	225,367	221,143	207,310
S.D. $	125,305	151,176	148,283	173,036	170,041	160,634
S.E. $	28,019	33,804	33,157	38,692	38,022	35,919
C.V.	0.88	0.78	0.78	0.77	0.77	0.76
Growth at $						
5 Years	-1,447	3,069	3,034	2,641	2,679	2,856
10 Years	13,274	18,574	17,940	37,525	36,864	27,726
15 Years	15,895	20,704	20,223	23,478	22,994	21,850
20 Years	16,163	20,429	20,054	22,412	22,040	21,234
Gross Ratio	0.57	0.54	0.56	0.54	0.56	0.55
Capital Turnover	0.42	0.42	0.42	0.42	0.42	0.42
Rate of Return on Capital	0.27	0.36	0.36	0.41	0.41	0.38

Examination of the five-year mean net farm income revealed that in all treatments the values of net farm income increased continuously. For each five-year mean, the base had the lowest mean. In the first five-years, all means were significantly greater than that of the base with treatment 1 having the highest value of \$17,551 followed by treatment 2 with \$17,415, treatment 3 with \$17,383 and treatment 4 with \$17,329. In the second five-year period, the highest value of the mean was given in treatment 3 with \$154,406. The second highest mean in the second five-year period, 1970-1974, was found to be \$151,123 in treatment 4. This was followed by treatment 1 at \$103,532 and treatment 2 at \$100,505. In the third five-year period, treatment 3 achieved the highest mean of \$335,756; treatment 4 was next with \$329,298, treatment 1 with \$296,238 and treatment 2 with \$286,960. The value of the mean net farm income in the base case was \$228,750. In the fourth period the order was the same as in the third. The highest mean value was shown to be obtained in the order: treatment 3 -- \$393,921; treatment 4 -- \$386,824; treatment 1 -- \$356,363; treatment 2 -- \$349,355 and the base had the lowest value of \$273,852. Generally, a similar trend is shown by the ten-year means.

Over the twenty-years of the run, treatment 3 reached the highest mean, \$225,367; treatment 4 reached the second highest of \$221,143. The base showed a value of \$142,518 which was lower than the value of \$189,309 in treatment 2 and \$193,421 in treatment 1.

The average growth in net farm income in the period 1965-1969 was greatest, \$3,069 in treatment 1, followed by treatment 2, \$3,034. The values were \$2,679 in treatment 4 and \$2,641 in treatment 3. The average growth in net farm income for the base in this period was -\$1,447.

For the ten-year period, 1965-1979, the average growth in net farm income was highest for treatment 3 with $37,525. Next was treatment 4 with $36,864 followed by treatments 1 with $18,574 and 2 with $17,940. As was expected the lowest value was found in the base at $13,274. Similar patterns of growth were displayed over the fifteen-year and twenty-year periods.

Thus, the average growth in net farm income at the end of the fifteen-year period, 1965-1979 was $23,478 for treatment 3, followed by treatment 4 with $22,994, then treatment 1 with $20,704 and finally treatment 2 with $20,223. The value for the base was $13,752.

For the twenty-year period, the mean growth in net farm income was still highest for treatment 3 with $22,412, followed by treatment 4 with $22,040, treatment 1 with $20,429 and treatment 2 with $20,054. The base exhibited the lowest average growth for this period of $14,584.

The discussion to this point has shown how the model has behaved to influence the values of the performance variables and, in particular, to produce results both for the validation scenario and for the Base treatment. It is pointed out again that the Base treatments involve the execution of the model using the INCASE input with no additional return generated by attaching a rate of return to productive assets, with no additional debt structure constraints and with outright purchase of land procurement method. The latter, in effect, means that when the Base Experiment is run for twenty years, the model goes through the land procurement decision subroutines and determines if the financial situation of the business can afford it. Built into the model is the preference order of choice ranking of land procurement. Preferential ranking is always given to outright purchase followed by rent-to-purchase, share rent and cash rent in that order.

While the internal functioning of the model will partly explain variable values and their variations for each treatment, differentness between treatments and magnitudes of values will be the result of specific treatment effects.

Net Farm Income Summary for Scenario 1

The purpose of analyzing this scenario was to compare the total effects of outright purchase of land with debt structure relationship and return percentage on productive assets on net farm income, net cash flow and net worth. This will be done by summarizing the magnitudes, stability, rate of growth and survival or failure tendency of net farm income, net cash flow and net worth. In this section, only net farm income is summarized for the scenario. All four treatments comprising this scenario attained higher net farm income than the base treatment. These higher values were reflected in higher means, greater maxima, greater incremental five-year mean, net farm income, greater growth rates at five-year intervals, and higher minima. All treatments performed more efficiently than the base in terms of gross ratio and rate of return on capital and were as efficient in investment of capital.

Treatment 3, Outright Purchase - Rate of Return on Productive Assets Equal to the Annual Inflation Rate - Short Term Debt/Long Term Debt Constrained Debt Relationship was superior to all treatments including the base. It attained the highest maximum of $443,517, had the highest overall mean of $225,367, attained the highest mean growth over the twenty-year period and maintained both the highest five-year periodic mean net farm income and incremental five-year mean growth.

Gross ratio averaged 0.54 implying that 54 cents of crop sales went to meeting expenses or that 46 cents of net farm income were generated from each dollar of sales. This was also superior to the others. The capital turnover ratio of 0.42 was the same for all treatments including the Base. However, the rate of return on capital amounting to 0.41 was the highest return and implied that 41 cents were returned per dollar invested in the farm.

The statistical indicators of standard deviation, standard error and coefficient of variation were the best of all experiments in the sense that they indicated the smallest degree of spread among the data and between the data and the mean.

Treatment 4, Outright Purchase - IR - MTD/LTD provided the second best performance in all categories of indicators. The maximum net farm income was 2 percent less than that of treatment 3 but 8 percent higher than that of treatment 1 and 10 percent higher than that of treatment 2. Its mean was 14 percent and 17 percent higher than those of treatments 1 and 2, respectively. However, its mean was 2 percent less than that of treatment 3. Treatment 1 was the third ranking and treatment 2 the worst ranking. Treatment 2, however, outperformed the Base significantly. Its maximum attained net farm income of $389,204 was 27 percent greater than that of the Base while its overall mean of $189,309 was 33 percent higher. The mean growth in net farm income over the twenty-year run of $20,054 was 38 percent higher than the $14,584 reached by the Base.

The conclusions to be drawn are that purchase land control arrangement in the presence of debt structure relationships and the additional return on productive assets significantly influences the level of net farm income attained, the rate of growth of net farm income, the rate of return on capital invested in the farm, the efficiency of production and capital investment and the survival of the farm.

Following through from the previous observation, one may conclude that since treatments 3 and 4 were superior in overall performance to treatments 1 and 2, that a rate of return on productive assets equal to the inflation rate had a more significant impact on net farm income than did a rate of return equal to that charged by the Farm Credit Corporation. A closer examination of the annual rate of inflation and the annual rates of interest charged by the Farm Credit Corporation reveals that inter-year variations in values of both the former and latter are such that in one year the one value may be greater or lesser. For example, the annual values of FCAF are greater than those of IR in 1965, and 1968-1971 but that IR was greater in all other years. However, the average interest rate charged farmers by the Farm Credit Corporation over the twenty-year period was 0.08 and the average rate of inflation over the same period was 0.14. These variations provide an explanation of changes among the treatments and treatment means. These differences between years and treatments will be used to discuss treatment differences later.

One may also deduce that part of the differentness in behaviour among treatments relates to the debt structure ratio used in each treatment. For example, the only real differences between treatments

1 and 2, and, 3 and 4 are the debt structure ratios used, STD/LTD in treatments 1 and 3 and MTD/LTD in treatments 2 and 4. Drawing further on this it can be tempting to conclude that because the value of MTD/LTD is greater than than of STD/LTD, treatment 2 should outperform treatment 3.

Similarly, treatments 1 and 3, and, 2 and 4 can be compared since each pair only differs by the rate of return type used. In treatments 1 and 3, the former uses FCAF, the latter IR; the same applies to 2 and 4 for IR. Purchase and STD/LTD are common to the former pair of treatments and P and MTD/LTD are common to the latter pair. It should be expected that the combination of IR (higher than FCAF) and MTD/LTD (higher than STD/LTD) in the presence of Purchase land control arrangement would yield higher values than FCAF and STD/LTD in the presence of purchase land control.

Treatment 3 outperforms treatment 1 and treatment 4 outperforms treatment 2 for the reasons put forward above. The effect of differences in the rate of return on productive assets work through the net farm income statement. The return on capital investment, calculated as the rate of return specified (FCAF, IR) multiplied by the total capital invested annually in capital assets, is added into nonfarm income which is one of the variables in the net farm income statement.

It would be expected that outright purchase of land, because it involves the largest capital investment, will generate the highest levels of return on capital invested which will augment the quantity of nonfarm income and ultimately the net farm income. Each treatment in this scenario will be expected to behave similarly but to different levels of magnitudes.

Net Cash Flow

Table 18 presents the farm cash flow statement for the base. In general, the net cash flow situation for the base shows an increasing tendency with time, ranging between a minimum of -$21,811 in 1970 to a maximum of $307,584 in 1984. The mean was $130,920. Despite this increasing tendency, interyear behaviour varies from declining to increasing. This has been explained on more than one occasion and it follows from the experience in the agriculture industry and as displayed by the behaviour of the model. However, at this point, it is reiterated that net cash flow varies as the total inflow and total outflow vary. Variations in total inflow are mainly due to changes in crop sales, capital borrowing and off-farm income; variations in outflow vary with crop expenses, value of capital purchases, total principal paid on loans, share rent and cash withdrawn for household consumption.

Whenever the combined effects of the changes in all variables influencing net cash flow cause total outflow to exceed total inflow, a deficit situation prevails necessitating borrowing to meet the deficit. A decrease in net cash flow does not necessarily mean a negative deficit. The ups and downs in net cash flow are all explainable by changes in values of relevant variables, these changes being dictated by the model.

The behaviour of net cash flow can be seen in the table. Some of these were explained in detail earlier and as the pattern of behaviour is the same in all cases, it would not be re-explained here.

Table D.5 shows the farm cash flow statement for treatment 1. In treatment 1, net cash flow, in general is an increasing function of time,

TABLE 18

NET CASH FLOW STATEMENT SUMMARY
FOR THE PURCHASE BASE SIMULATION RUN

Year	Total Inflow	Total Outflow	Net Cash Flow
1965	50415.02	34661.09	15753.93
1966	27618.97	32231.82	-4612.85
1967	37307.64	42019.53	-4711.89
1968	57343.55	56903.24	440.31
1969	70774.50	72758.00	-1983.50
5. YR AVG	48691.91	47714.71	977.20
1970	64780.54	86591.81	-21811.28
1971	86757.12	98052.00	-11294.87
1972	134714.87	106532.87	28182.00
1973	280943.75	115565.06	165378.69
1974	237306.06	127264.31	110041.75
5. YR AVG	160900.44	106801.19	54099.25
10 YR AVG	104796.19	77257.94	27538.22
1975	279952.19	130836.31	149115.87
1976	321492.56	137831.06	183661.50
1977	403215.87	144082.44	259133.44
1978	405666.50	146243.75	259422.75
1979	371912.50	148009.56	223902.94
5. YR AVG	356447.75	141400.62	215047.19
15 YR AVG	188680.00	98638.75	90041.19
1980	368348.94	169181.19	199167.75
1981	395880.44	173001.31	222879.12
1982	432042.44	178120.12	253922.31
1983	467793.69	183561.69	284232.00
1984	497855.44	190271.37	307584.06
5. YR AVG	432383.75	178827.12	253557.00
20 YR AVG	249605.94	118685.81	130920.12
STD DEV	166226.75	50871.15	118791.06
STD ERR	37169.43	11375.13	26562.49
C. V.	0.67	0.43	0.91
MINIMUM	27618.97	32231.82	-21811.28
MAXIMUM	497855.44	190271.37	307584.06

ranging from a low of -$47,703 in 1970 to a maximum of $321,046 in 1984. The mean net cash flow over the 20 year simulation run was $126,888. The information in the table reveals that net cash flow averaged only a negative value of $11,062 in the first five-years as the farm uses capital for machinery and land purchases for increasing production causing rising value of outflow at a faster rate than inflow in the early years. Table D.5 to D.8 show cash flow values for treatments 2, 3 and 4.

Gradually, net cash flow rises as the earlier expenditures borrowed to purchase land, machinery and operating inputs generate increasing crop sales. Increasing efficiencies of scale cause a drop in expenses, and as depreciation slows and interest and principal paid are reduced, the cash flow situation improved. In the second five-year period, 1970-1974, average net cash flow increased to $35,382. As the business continues to develop and efficiencies are gained, total inflows continue to outpace total outflow resulting in an increasing average net cash flow of $128,442 in the third five-year period and $264,788 in the fourth five-year period. The increasing strength of the business is also shown by the ten-year means.

The average growth in net cash flow over five years was negative but this growth increased to $9,688 over ten years. As the farm solidifies itself and becomes a fully mature business the rate of growth grows as seen by the fifteen year average growth of net cash flow of $15,573 and that for the twenty year period of $16,075. All treatments behaved in essentially the same way.

All treatments outperformed the base in terms of their maximum net cash flow which was achieved in the final year of the run. Treatment 1 had the highest maximum of $321,046 followed by treatment 3 with $321,044, treatment 2 with $314,246 and treatment 4 had $314,017. The maximum achieved in the Base was $307,584. All treatments had their lowest value in 1970 when outflow increased over inflow due to purchases of machinery and equipment to replace obsolescent ones and the purchase of land. Principle paid, interest paid on debts, and capital purchases were the primary reasons for the deficit situation shown in the Base and treatments 1 and 4.

The five year average net cash flow shows how the means changed over the twenty year period. The lowest value was obtained in the first five years for each treatment, reflecting the need of the business to incur indebtedness more rapidly than cash inflows as the model replaces obsolete machines, purchases land and meet the operating costs of the farm in the early years of the buiness. The Base had the best mean in the first five-years followed by treatments 4, 2, 3 and 1. In the second-five year period, treatment 2 had the best mean of $54,947 followed by treatments 4, the Base, 1 and 3. In the third five-year period, treatment 1 had the best mean of $128,442 followed by treatment 3 with $127,966, treatment 2 with $216,524, treatment 4 with $215,527 and the Base with $215,047. The same order prevailed in the final five-year period. Through the twenty year period the five year averages vary among the treatments.

Over the first ten-years, treatment 2 showed the highest mean net cash flow of $27,572, followed by the Base $27,538, and treatment 4 with $27,252. The averages over the ten year period for treatments 1 and 3 were much lower at $12,160 and $12,146. Over the second ten-year period, treatment 1 with $241,615 and treatment 3 with a mean of $241,174 were better than treatment 2 with $237,747, treatment 4 with $236,858 and the Base with $234,302.

Over the twenty year run, treatment 2 had the largest mean of $132,659 followed by treatment 4 with $132,055. The overall mean net cash flow was $130,920, $126,888 and $126,660, for the Base, treatment 1 and 3, respectively.

The average growth in net cash flow at progressive five year intervals show that in general, treatment 2 grew the fastest, and reached its maximum at twenty years. The average growth in net cash flow at the tenth year was highest in treatment 2 with a value of $10,497 followed by the Base with $10,476, treatment 4 with $10,113, treatment 1 with $9,688 and treatment 3 with $9,354. Over the twenty year period, the average growth was highest for treatment 2 followed by treatments 1, 3, 4 and the Base, respectively.

Summary of Net Cash Flow Analysis For Scenario 1

The four treatments all produced higher total net cash flow than did the control. They showed higher overall rates and amounts of growth in net cash flow than the Base. Treatment 1, Outright Purchase - FCAF - STD/LTD, and treatment 3, Outright Purchase - IR - STD/LTD reached the same level of maximum. This level was higher than the level reached in treatment 2, Outright Purchase - FCAF - MTD/LTD by 2 percent and that reached by treatment 4, Outright Purchase - IR - MTD/LTD by the same amount. Thus, treatments 1 and 3 achieved the same maximum which was higher than those for treatments 2 and 4 which were the same. The former were 4 percent higher than the base while the latter values were 2 percent higher than the base (see Table 19).

The highest average growth over the twenty year period was given by treatment 2 which was 10 percent higher than those of treatments 1 and 3, and 12 percent more than the twenty year average growth in net cash flow of treatment 4. Treatment 2 achieved an average twenty year growth in net cash flow that was 15 percent higher than the base.

The overall mean net cash flow among treatments was highest for treatment 2, Outright Purchase - FCAF - MTD/LTD. This value was only \$604 larger than the value for treatment 4, Outright Purchase - IR - MTD/LTD. The mean of the base was second and was 3 percent higher than the means for treatment 1, Outright Purchase - FCAF - STD/LTD and treatment 3, Outright Purchase - IR - STD/LTD. Treatment 1 mean net cash flow was only \$228 more than that of treatment 3.

The statistical indicators of standard deviation, standard error and coefficient of variation indicate that treatments 2 and 4 displayed much less variation among the observations and between the mean and the observations than did treatments 1 and 3.

The results illustrate that outright purchase land control arrangement in the presence of debt structure relationships and an added return for productive assets affect the level of net cash flow, the rate of growth and the general health and survival of the bases. Treatments 2 and 4 having the overall best performance suggest that the debt structure ratio influences the net cash flow and that the ratio MTD/LTD was more important in this regard than was STD/LTD.

Treatments 1 and 3 produced almost identical maxima both in terms of net cash flow and the twenty year average growth in net cash flow. The twenty year mean net cash flow was almost the same. This

TABLE 19

SUMMARY NET CASH FLOW COMPARISONS FOR SCENARIO 1

	Treatment					Mean
	Base 1	1	2	3	4	
Minimum $	-21,811(70)	-47,703(70)	20,340(70)	46,231(70)	-19,568(70)	-0.25
Maximum $	307,584(84)	321,046(84)	314,246(84)	321,044(84)	314,017(84	317,588
Means						
Five Years $						
1	977	-11,062	197	-10,846	585	-5,281
2	54,099	35,382	54,947	35,137	53,918	44,846
3	215,047	218,442	216,525	217,966	215,527	217,115
4	253,557	264,788	258,969	264,382	258,189	261,582
Ten Years $						
1	27,538	12,160	27,572	12,146	27,252	19,782
2	234,302	241,615	237,747	241,174	236,858	239,348
Twenty Years $	130,920	126,888	132,659	126,660	132,055	129,565
S.D.	118,791	130,859	120,795	130,435	120,251	125,585
S.E.	26,562	29,261	27,011	29,166	26,889	28,082
C.V.	0.91	1.03	0.91	1.03	0.91	0.97
Growth at $						
5 Years	-4,434	-9,996	-4,407	-9,626	-4,128	-7,039
10 Years	10,476	9,688	10,497	9,354	10,113	9,913
15 Years	14,868	15,573	17,669	15,531	15,012	15,946
20 Years	15,359	16,075	17,619	16,074	15,710	16,369

suggests that the rate of return had no significant effect on net cash flow. Similar deductions come from treatments 2 and 4.

The impact of debt structure relates to the interrelationships between net income, net cash flow and net worth. The more one borrows the greater the indebtedness, the greater the payments on principal and interest and the greater the expenses. Total outflow will increase, and, as was shown earlier, it increases more rapidly than inflow causing declines in net cash flow. Besides, medium term liabilities occur much more frequently and comprise a very significant part of debt. To the extent it is reduced, to that extent will it positively influence net cash flow. While short term debt influences net cash flow because the latter occurs less frequently and in smaller amounts, together with the fact that it is retired during the crop year, it is less subject to inflationary cost-rises as would MTD/LTD which are retired over a much longer period of time.

It is interesting to note that in the early years of the business, treatments 1 and 3 with constrained short term debt reacted with deficit net cash flow whereas treatments 2 and 4 with constrained medium term debt showed a less pronounced effect. The effect on the base was the least.

The farm business needs short term capital to cover operating expenses and avoid deficits and early bankruptcy in the first eight-years more than it would medium term capital. However, as the farm business expands, proper structuring of both types of indebtedness but more especially medium term debt becomes more important.

Net Farm Worth

Table 20 shows the farm worth situation for the base. Net farm worth increased in general terms for the base and all treatments throughout the twenty year run. Except for declines in 1969, 1970 and 1972, all other years showed increases in net farm worth. Changes in interyear values were partly explained earlier as due to changes in the quantities and structure of the balance sheet. For example, the decline in 1969 was partly due to a rise in medium term and long term liabilities generated by the borrowing of funds to purchase 320 acres of land. The drop in net worth amounted to 21 percent mainly due to increases of 31 percent in long term liabilities and 26 percent in medium term liabilities incurred to purchase land and machinery.

Although total assets increased by 8 percent, this increase was insufficient to maintain the rate of increase in net worth to generate a positive increase. Similar circumstances account for declines in 1970 and 1972. The latter was the last year in which land purchase was made during this treatment. Thereafter, net farm worth accelerated rapidly to a maximum of $545,027 in 1984. This changed trend partly reflects the decreasing liabilities resulting from the retirement of debt, especially long term debt, with time. Concurrently with the above, land appreciated in value with the result that over time net farm worth was accreting in value.

The general pattern of behaviour displayed by the base, and repeatedly referred to in earlier sections, is again shown. This increasing tendency applies to the other performance variables also. It was mentioned earlier that differences between treatments will be

TABLE 20

NET FARM WORTH AND BALANCE SHEET INDICATORS FOR THE BASE TREATMENT 1

Simulation Year	Short Term Assets	Annual Change In Short Term Assets	Medium Term Assets	Annual Change In Medium Term Assets	Long Term Assets	Annual Change In Long Term Assets
1965	14430.80	0.0	30727.39	0.0	63279.35	0.0
1966	18982.47	4551.66	29803.29	-924.11	107326.19	44046.84
1967	17459.31	-1523.16	28897.14	-906.14	164128.19	56802.00
1968	13577.06	-3882.25	33861.84	4964.70	222610.87	58482.69
1969	7504.43	-6072.64	40599.98	6738.15	243525.31	20914.44
5 YR AVG	14390.81	-1731.59	32777.91	2468.15	160173.94	45061.48
1970	8416.68	912.25	42576.21	1976.23	254911.87	11386.56
1971	9845.75	1429.07	42164.97	-411.24	285586.12	30674.25
1972	7641.95	-2203.80	44142.12	1977.14	288543.25	2957.12
1973	8251.96	610.01	44163.95	21.83	382102.69	93559.44
1974	7973.61	-278.36	46048.00	1884.05	503659.44	121556.75
5 YR AVG	8425.99	93.84	43819.01	1089.60	342960.37	52026.82
10 YR AVG	11408.40	-717.47	38298.46	1702.29	251567.06	48931.12
1975	8212.48	238.87	47166.28	1118.29	518254.25	14594.81
1976	7756.09	-456.39	53089.50	5923.21	532890.00	14635.75
1977	7026.17	-729.92	53000.41	-89.08	547560.37	14670.37
1978	7016.20	-9.97	52582.06	-418.35	562260.44	14700.06
1979	7016.20	0.0	59101.15	6519.09	576985.81	14725.37
5 YR AVG	7405.43	-191.48	52987.86	2610.63	547589.75	14665.27
15 YR AVG	10074.07	-529.61	43194.93	2026.70	350241.31	36693.32
1980	7016.20	0.0	57066.44	-2034.71	591732.87	14747.06
1981	7016.20	0.0	57018.33	-48.11	606498.75	14765.87
1982	7016.20	0.0	60405.42	3387.09	621280.75	14782.00
1983	7016.20	0.0	67039.50	6634.08	636076.87	14796.12
1984	7016.20	0.0	71209.50	4170.00	650885.19	14808.31
5 YR AVG	7016.20	0.0	62547.82	2421.67	621294.37	14779.87
20 YR AVG	9309.60	-390.24	48033.15	2130.64	418004.56	30926.62
STD DEV	3699.91		12053.22		194650.12	
STD ERR	827.32		2695.18		43525.09	
C. V.	0.40		0.25		0.47	
MINIMUM	7016.20		28897.14		63279.35	
MAXIMUM	18982.47		71209.50		650885.19	

TABLE 20 (continued)

Simulation Year	Total Assets	Annual Change In Total Assets	Short Term Liabilities	Annual Change In Short Term Liabilities	Medium Term Liabilities	Annual Change In Medium Term Liabilities
1965	108437.50	0.0	2658.88	0.0	21433.05	0.0
1966	156111.94	47674.44	1794.63	-864.25	19316.54	-2116.51
1967	210484.62	54372.69	1854.90	60.27	17078.33	-2238.21
1968	270049.75	59565.12	1959.58	104.68	20567.00	3488.67
1969	291629.69	21579.94	2017.36	57.78	25947.58	5380.58
5 YR AVG	207342.69	45798.05	2057.07	-160.38	20868.48	1128.63
1970	305904.75	14275.06	2019.77	2.41	25890.39	-57.19
1971	337596.81	31692.06	2020.57	0.79	23899.02	-1991.37
1972	340327.31	2730.50	2017.19	-3.37	27594.54	3695.52
1973	434518.56	94191.25	515.46	-1501.73	24112.98	-3481.55
1974	557681.00	123162.44	0.0	-515.46	27072.30	2959.32
5 YR AVG	395205.56	53210.26	1314.60	-403.47	25713.82	224.94
10 YR AVG	301274.06	49915.94	1685.83	-295.43	23291.16	626.58
1975	573633.00	15952.00	0.0	0.0	29552.32	2480.02
1976	593735.56	20102.56	0.0	0.0	41545.40	11993.09
1977	607586.94	13851.37	0.0	0.0	39958.91	-1586.49
1978	621858.69	14271.75	0.0	0.0	36275.83	-3683.09
1979	643103.12	21244.44	0.0	0.0	52493.01	16217.18
5 YR AVG	607983.00	17084.42	0.0	0.0	39965.07	5084.14
15 YR AVG	403510.37	38190.40	1123.89	-189.92	28849.13	2218.57
1980	655815.50	12712.37	0.0	0.0	45281.29	-7211.73
1981	670533.25	14717.75	0.0	0.0	39600.76	-5680.52
1982	688702.31	18169.06	0.0	0.0	43008.43	3407.66
1983	710132.56	21430.25	0.0	0.0	52530.33	9521.91
1984	729110.87	18978.31	0.0	0.0	62469.21	9938.88
5 YR AVG	690858.37	17201.55	0.0	0.0	48577.97	1995.24
20 YR AVG	475347.37	32667.02	842.92	-139.94	33781.34	2159.80
STD DEV	203058.81		1024.11		12797.67	
STD ERR	45405.33		229.00		2861.65	
C. V.	0.43		1.21		0.38	
MINIMUM	108437.50		0.0		17078.33	
MAXIMUM	729110.87		2658.88		62469.21	

TABLE 20 (continued)

Simulation Year	Long Term Liabilities	Annual Change In Long Term Liabilities	Total Liabilities	Annual Change In Total Liabilities	Net Worth	Annual Change In Net Worth
1965	18200.42	0.0	42292.34	0.0	66145.12	0.0
1966	51062.92	32862.50	72174.06	29881.72	83937.87	17792.75
1967	87381.75	36318.83	106314.94	34140.87	104169.69	20231.81
1968	127098.19	39716.44	149624.75	43309.81	120425.00	16255.31
1969	168527.12	41428.94	196492.00	46867.25	95137.69	-25287.31
5 YR AVG	90454.06	37581.67	113379.56	38549.91	93963.06	7248.14
1970	203648.62	35121.50	231558.62	35066.62	74346.12	-20791.56
1971	232618.19	28969.56	258537.56	26978.94	79059.25	4713.12
1972	238718.50	6100.31	268330.00	9792.44	71997.31	-7061.94
1973	228590.87	-10127.62	253218.94	-15111.06	181299.62	109302.31
1974	218375.69	-10215.19	245447.62	-7771.31	312233.37	130933.75
5 YR AVG	224390.19	9969.71	251418.37	9791.12	143787.12	43419.14
10 YR AVG	157422.06	22241.69	182399.00	22572.80	118875.06	27343.14
1975	208067.00	-10308.69	237618.94	-7828.69	336014.06	23780.69
1976	197658.37	-10408.62	239203.12	1584.19	354532.44	18518.37
1977	187143.25	-10515.12	227101.44	-12101.69	380485.50	25953.06
1978	176514.37	-10628.87	212789.69	-14311.75	409069.00	28583.50
1979	165764.50	-10749.87	218256.87	5467.19	424846.25	15777.25
5 YR AVG	187029.50	-10522.23	226994.00	-5438.15	380989.37	22522.57
15 YR AVG	167291.19	10540.29	197264.00	12568.89	206246.50	25621.51
1980	156934.56	-8829.94	202215.19	-16041.69	453600.31	28754.06
1981	148104.69	-8829.87	187704.87	-14510.31	482828.37	29228.06
1982	139274.81	-8829.87	182282.56	-5422.31	506419.75	23591.37
1983	130445.00	-8829.81	182974.75	692.19	527157.81	20738.06
1984	121615.06	-8829.94	184083.69	1108.94	545027.19	17869.37
5 YR AVG	139274.81	-8829.89	187852.19	-6834.64	503006.37	24036.19
20 YR AVG	160287.06	5442.87	194911.00	7462.70	280436.50	25204.32
STD DEV	59642.63		61218.18		180895.25	
STD ERR	13336.50		13688.80		40449.41	
C. V.	0.37		0.31		0.65	
MINIMUM	18200.42		42292.34		66145.12	
MAXIMUM	238718.50		268330.00		545027.19	

TABLE 20 (continued)

Simulation Year	Current Ratio	Annual Change In Current Ratio	Leverage Ratio	Annual Change In Leverage Ratio	Change In Net Worth	Annual Change In Net Worth
1965	5.43	0.0	0.64	0.0	0.0	0.0
1966	10.58	5.15	0.86	0.22	17792.75	17792.75
1967	9.41	-1.16	1.02	0.16	20231.81	2439.06
1968	6.93	-2.48	1.24	0.22	16255.31	-3976.50
1969	3.72	-3.21	2.07	0.82	-25287.31	-41542.62
5 YR AVG	7.21	-0.43	1.17	0.36	5798.51	-6321.83
1970	4.17	0.45	3.11	1.05	-20791.56	4495.75
1971	4.87	0.71	3.27	0.16	4713.12	25504.69
1972	3.79	-1.08	3.73	0.46	-7061.94	-11775.06
1973	16.01	12.22	1.40	-2.33	109302.31	116364.25
1974	7973.61	7957.60	0.79	-0.61	130933.75	21631.44
5 YR AVG	1600.49	1593.98	2.46	-0.26	43419.14	31244.21
10 YR AVG	803.85	885.35	1.81	0.02	24608.82	14548.19
1975	8212.48	238.87	0.71	-0.08	23780.69	-107153.06
1976	7756.09	-456.39	0.67	-0.03	18518.37	-5262.31
1977	7026.17	-729.92	0.60	-0.08	25953.06	7434.69
1978	7016.20	-9.97	0.52	-0.08	28583.50	2630.44
1979	7016.20	0.0	0.51	-0.01	15777.25	-12806.25
5 YR AVG	7405.43	-191.48	0.60	-0.05	22522.57	-23031.30
15 YR AVG	3004.38	500.77	1.41	-0.01	23913.41	1126.95
1980	7016.20	0.0	0.45	-0.07	28754.06	12976.81
1981	7016.20	0.0	0.39	-0.06	29228.06	474.00
1982	7016.20	0.0	0.36	-0.03	23591.37	-5636.69
1983	7016.20	0.0	0.35	-0.01	20738.06	-2853.31
1984	7016.20	0.0	0.34	-0.01	17869.37	-2868.69
5 YR AVG	7016.20	0.0	0.38	-0.04	24036.19	418.42
20 YR AVG	4007.33	368.99	1.15	-0.02	23944.10	940.49
STD DEV	3727.30		1.05		36557.90	
STD ERR	833.45		0.23		8174.59	
C. V.	0.93		0.91		1.53	
MINIMUM	3.72		0.34		-25287.31	
MAXIMUM	8212.48		3.73		130933.75	

due to the specific treatment values of variables used. However, inter-year variations will also depend on the value of the level of factor. For example, for a given treatment, a value of rate of return equal to the inflation rate (IR) may be smaller or larger in one year or the other. If the treatment contains the exact level of another or the other two factors, then the values of the criteria variable will vary and the change reflects an interyear change in the value of the factor. Variations among treatments will reflect the latter as well as the effect of the other factors by themselves and in combination with each other.

Tables D.9-D.12 show the farm worth for treatments 1-4. Treatment 1, Outright Purchase - FCAF - STD/LTD reached the highest maximum of $658,407, the same value $658,418 as that reached by treatment 3, Outright Purchase - IR - STD/LTD. The maximum reached in treatment 2, Outright Purchase - FCAF - MTD/LTD was 14 percent less than that of treatments 1 and 3, was 6 percent higher than the base and was the same as that of treatment 4.

The tables reveal some idea of how the model functions in terms of net farm worth. Treatment 1 and 3 were the best of the treatments in overall performance. Apart from the highest maximum, the mean five year net worth for all four five-year periods was greatest for treatment 4 which was only very slightly superior to treatment 1. In general, the behaviour of treatments 2 and 4 were almost identical. Similar performance ranking apply for the five-yearly growth of net farm worth for the four treatments. The base performed inferiorly compared to the 4 treatments.

The twenty year mean net worth was $378,355 for treatment 3 and was almost exactly that recorded for treatment 1. Treatment 3 was 19 percent higher than those of treatments 2 and 4 which were the same. The mean growth at twenty years was the same, $31,172, for treatments 1 and 3, which was 16 percent higher than treatments 2 and 4. Treatment 3 had the fastest rate of growth of all.

The current ratio, representing the ability of the business to cover short term liabilities using short term assets, is a measure of the financial health of the farm. The value for the base was very large followed by treatments 2 and 4 followed by treatments 1 and 3. Another measure of the financial status is the debt/equity ratio measuring the solvency position of the farm. Treatment 3, Outright Purchase - IR - STD/LTD had the best ratio of 0.44 implying that for each dollar of equity, 44 cents are owed. Next was treatment 1, with 0.45, followed by treatments 4, 2 and the base in that order.

Changes in net worth are measures of the financial growth attained by the farm business and represents the business stability and survival capability. Again, treatments 1 and 3 averaging $29,614 were superior to treatments 2 and 4 by 16 percent and to the base by 24 percent.

It is concluded that variations exist as outright land control combines with FCAF (and the rate of inflation) and debt structure STD/LTD (MTD/LTD). The effects of return on productive assets are slight in the presence of STD/LTD. The reasons for this lack of difference are that FCAF and IR are almost similar or that their effects are confounded in the presence of debt structure and are not being revealed.

Summary of Net Farm Worth Analysis For Scenario 1

Table 21 summarizes the net worth for the scenario. A look at the values of treatment 1, Outright Purchase - FCAF - STD/LTD and treatment 2, Outright Purchase - FCAF - MTD/LTD and treatment 3, Outright Purchase - IR - STD/LTD and treatment 4, Outright Purchase - IR - MTD/LTD provides some interesting information. Treatment 1 outperforms treatment 2 and treatment 3 surpasses treatment 4 in performance. The debt structure affects the level of net farm worth achieved. The short term debt/long term debt in the presence of the outright purchase of land and FCAF causes an increase in net worth; more net worth is attained than from the ratio of medium term debt to long term debt.

Constraining short term debt frees up more capital for medium and long term projects. More asset value is added in terms of machinery and land as land accretes in value and the downpayment used to purchase the item ensures equity in the item. Constraining medium term debt tends to restrict the rate of expansion and slows down the growth of assets.

The standard deviation, standard error and coefficient of variation indicate that whereas all treatments including the base have reasonably low dispersion within treatments and closeness of the mean to the observations, that treatments 1 and 3 were the most stable followed by treatments 4, 5 and the base in that order.

Summary of Scenario Analysis

Figure 16 illustrates in graphic form the behaviour of net farm income, net worth and net cash flow for all treatments in this scenario while tables 22-25 display summaries of net farm income, net cash flow and net farm worth for treatments 1, 2, 3 and 4.

TABLE 21

SUMMARY NET FARM WORTH COMPARISONS FOR SCENARIO 1

	Base 1	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Mean
Minimum $	66,145(65)	66,145(65)	66,145(65)	66,145(66)	66,145(66)	66,145
Maximum $	545,027(84)	658,407(84)	577,040(84)	658,418(84)	576,418(84)	617,571
Means						
Five Years $						
1	93,963	114,365	102,065	116,171	104,670	109,318
2	143,787	246,794	186,673	249,125	186,362	217,238
3	380,989	519,343	434,973	520,308	434,249	477,218
4	503,007	627,532	544,306	627,819	543,738	585,849
Ten Years $						
1	118,875	180,579	144,369	182,648	145,516	163,278
2	441,998	573,437	489,640	574,064	488,993	531,533
Twenty Years $	280,436	377,009	317,004	378,355	317,254	347,405
S.D.	180,895	220,192	192,426	219,495	191,448	205,890
S.E.	40,449	49,236	43,028	49,081	42,809	46,038
C.V.	0.65	0.58	0.61	0.58	0.60	0.59
Current Ratio	4,007	1.16	58,96	1.18	58.45	30.06
Debt/Equity Ratio	1.15	0.45	0.77	0.44	0.76	0.60
Change in Net Worth $	23,944	29,613	25,545	29,614	25,514	27,571
Growth at $						
5 Years	7,248	19,417	13,138	20,261	14,937	16,938
10 Years	27,343	41,733	32,814	41,912	32,704	37,290
15 Years	18,479	35,332	29,393	35,378	29,358	32,365
20 Years	19,941	31,172	26,889	31,172	26,856	29,022

FIGURE 16

NET FARM CASH FLOW, NET FARM INCOME AND NET FARM WORTH FOR SCENARIO 1 (TREATMENTS 1-4)

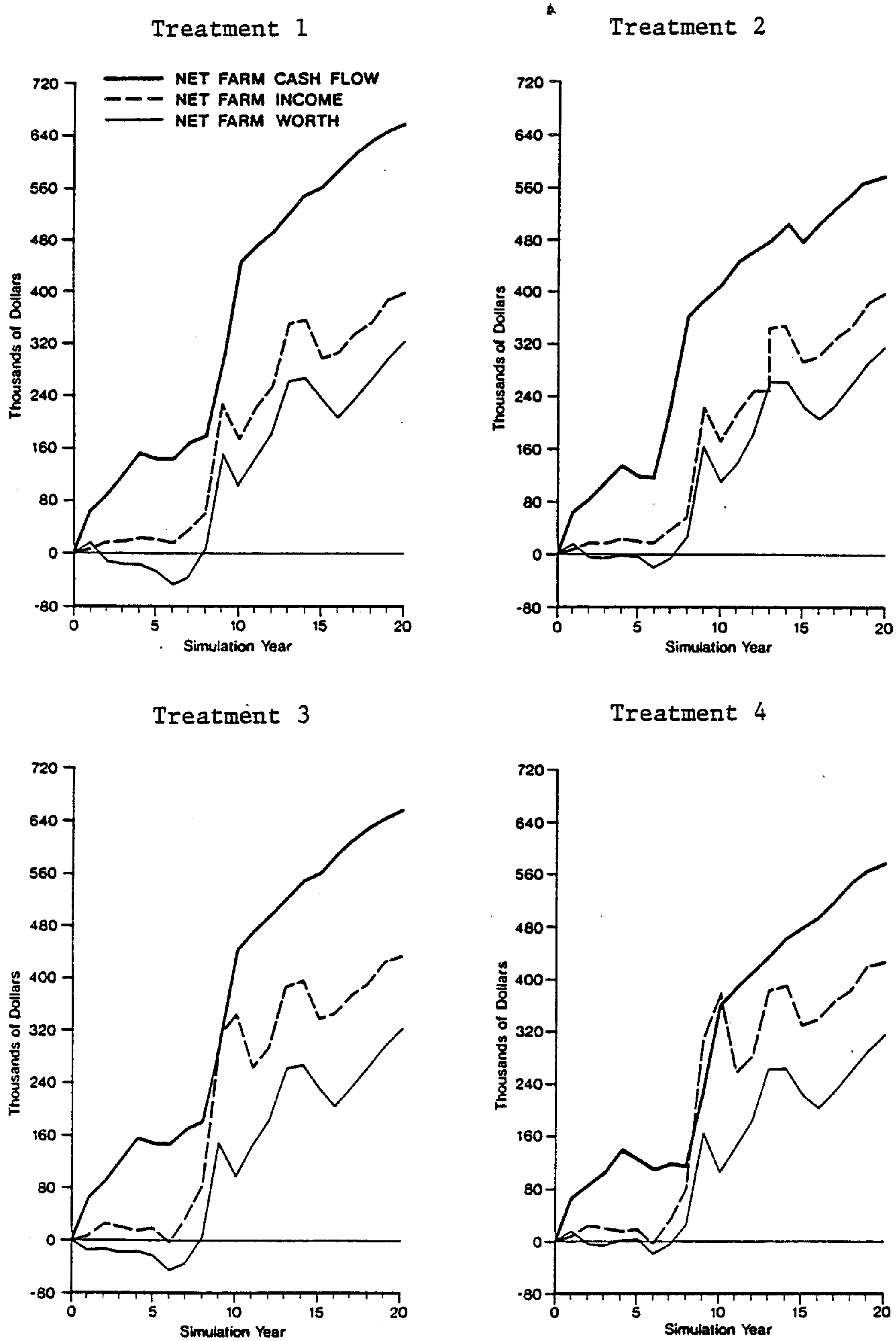


TABLE 22

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 1

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	8177.30	0.0	15622.18	0.0	66145.12	0.0
1966	18668.95	10491.65	-10897.61	-26519.79	90085.75	23940.62
1967	18581.30	-87.65	-17657.13	-6759.52	120449.31	30363.56
1968	21875.13	3293.84	-18017.26	-360.13	151335.06	30885.75
1969	20450.85	-1424.28	-24360.44	-6343.18	143812.75	-7522.31
5 YR AVG	17550.69	3068.39	-11062.05	-9995.65	114365.56	19416.91
1970	17538.59	-2912.26	-47703.09	-23342.65	142920.87	-891.87
1971	36074.87	18536.28	-36912.44	10790.65	168459.56	25538.69
1972	61011.39	24936.52	7329.75	44242.19	179012.00	10552.44
1973	227694.19	166682.75	151384.69	144054.94	301836.31	122824.31
1974	175341.75	-52352.44	102811.75	-48572.94	441741.56	139905.25
5 YR AVG	103532.12	30978.16	35382.14	25434.44	246794.00	59585.76
10 YR AVG	60541.42	18573.81	12160.04	9687.73	180579.75	41732.94
1975	223037.31	47695.56	145287.06	42475.31	471854.75	30113.19
1976	253422.87	30385.56	183565.44	38278.37	494133.19	22278.44
1977	350717.81	97294.94	262534.31	78968.87	521598.25	27465.06
1978	355970.06	5252.25	267185.94	4651.62	548335.44	26737.19
1979	298040.44	-57929.62	233639.81	-33546.12	560793.81	12458.37
5 YR AVG	296237.56	24539.73	218442.37	26165.61	519342.75	23810.45
15 YR AVG	139106.75	20704.50	80920.75	15572.69	293500.75	35332.05
1980	307702.19	9661.75	208337.00	-25302.81	587042.44	26248.62
1981	336330.00	28627.81	233247.81	24910.81	612811.62	25769.19
1982	353180.75	16850.75	265178.87	31931.06	632138.50	19326.87
1983	388270.25	35089.50	296132.81	30953.94	647265.06	15126.56
1984	396331.25	8061.00	321046.25	24913.44	658407.50	11142.44
5 YR AVG	356362.75	19658.16	264788.37	17481.29	627532.75	19522.73
20 YR AVG	193420.75	20429.14	126887.69	16074.95	377008.75	31171.70
STD DEV	151175.56		130859.50		220192.25	
STD ERR	33803.88		29261.07		49236.49	
C. V.	0.78		1.03		0.58	
MINIMUM	8177.30		-47703.09		66145.12	
MAXIMUM	396331.25		321046.25		658407.50	

TABLE 23

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 2

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	8177.30	0.0	15622.18	0.0	66145.12	0.0
1966	18618.18	10440.88	-5288.97	-20911.14	84427.44	18282.31
1967	18213.42	-404.75	-6702.91	-1413.95	106465.75	22038.31
1968	21752.29	3538.86	-636.98	6065.94	134593.06	28127.31
1969	20315.71	-1436.58	-2007.75	-1370.77	118697.81	-15895.25
5 YR AVG	17415.36	3034.60	197.11	-4407.48	102065.81	13138.17
1970	17280.34	-3035.37	-20339.90	-18332.15	107859.00	-10838.81
1971	34931.31	17650.97	-9265.06	11074.84	119660.87	11801.87
1972	57732.83	22801.52	27965.62	37230.69	116598.62	-3062.25
1973	222940.69	165207.81	166274.25	138308.62	227778.50	111179.87
1974	169640.81	-53299.87	110098.37	-56175.87	361468.25	133689.75
5 YR AVG	100505.19	29865.01	54946.65	22421.22	186673.00	48554.09
10 YR AVG	58960.27	17940.38	27571.88	10497.35	144369.37	32813.68
1975	217299.06	47658.25	147271.12	37172.75	388969.44	27501.19
1976	247476.00	30176.94	183175.56	35904.44	410444.62	21475.19
1977	344411.00	96935.00	262356.81	79181.25	435191.06	24746.44
1978	349311.19	4900.19	262985.31	628.50	462612.44	27421.37
1979	291301.75	-58009.44	226838.25	-36147.06	477646.37	15033.94
5 YR AVG	289959.56	24332.19	216525.37	23347.97	434972.56	23235.62
15 YR AVG	135960.00	20223.17	90556.31	15086.86	241237.12	29392.95
1980	300940.12	9638.37	205250.69	-21587.56	502305.44	24659.06
1981	329334.19	28394.06	228212.81	22962.12	527804.87	25499.44
1982	346087.94	16753.75	257584.69	29371.87	548997.37	21192.50
1983	381209.94	35122.00	289551.94	31967.25	565385.06	16387.69
1984	389204.06	7994.12	314246.19	24694.25	577040.19	11655.12
5 YR AVG	349355.19	19580.46	258969.19	17481.59	544306.37	19878.76
20 YR AVG	189308.75	20054.04	132659.50	15717.05	317004.44	26889.21
STD DEV	148282.56		120795.50		192425.75	
STD ERR	33156.99		27010.70		43027.71	
C. V.	0.78		0.91		0.61	
MINIMUM	8177.30		-20339.90		66145.12	
MAXIMUM	389204.06		314246.19		577040.19	

TABLE 24

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 3

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	7580.89	0.0	15632.91	0.0	66145.12	0.0
1966	24835.36	17254.46	-11026.31	-26659.22	90085.75	23940.62
1967	20054.68	-4780.67	-19187.88	-8161.57	121949.31	31863.56
1968	16299.54	-3755.14	-16776.51	2411.37	155485.94	33536.62
1969	18146.64	1847.09	-22871.81	-6095.30	147190.00	-8295.94
5 YR AVG	17383.41	2641.44	-10845.92	-9626.18	116171.19	20261.22
1970	-1916.60	-20063.23	-46231.15	-23359.34	146164.75	-1025.25
1971	33231.30	35147.90	-35810.62	10420.53	171105.50	24940.75
1972	83682.12	50450.82	7640.44	43451.06	181254.50	10149.00
1973	311729.25	228047.12	150271.37	142630.94	303741.19	122486.69
1974	345304.50	33575.25	99815.56	-50455.81	443358.69	139617.50
5 YR AVG	154406.06	65431.56	35137.12	24537.47	249124.75	59233.73
10 YR AVG	85894.75	37524.83	12145.60	9353.62	182648.00	41912.62
1975	263729.25	-81575.25	144913.19	45097.62	473229.31	29870.62
1976	292549.62	28820.37	183159.94	38246.75	495301.00	22071.69
1977	389218.81	96669.19	262079.94	78920.00	522487.31	27186.31
1978	396909.12	7690.31	266611.87	4531.94	549088.87	26601.56
1979	336375.75	-60533.37	233067.75	-33544.12	561434.81	12345.94
5 YR AVG	335756.19	-1785.75	217966.37	26650.44	520307.75	23615.22
15 YR AVG	169181.81	23485.34	80752.50	15531.05	295201.25	35377.83
1980	345668.75	9293.00	207742.31	-25325.44	587587.00	26152.19
1981	373998.44	28329.69	232628.75	24886.44	613274.56	25687.56
1982	390690.19	16691.75	264538.75	31910.00	632531.94	19257.37
1983	425731.75	35041.56	295955.06	31416.31	647284.75	14752.81
1984	433517.25	7785.50	321044.00	25088.94	658417.62	11132.87
5 YR AVG	393921.00	19428.30	264381.56	17595.25	627818.56	19396.56
20 YR AVG	225366.62	22417.70	126659.75	16074.27	378355.56	31172.23
STD DEV	173036.06		130435.44		219494.69	
STD ERR	38692.04		29166.25		49080.51	
C. V.	0.77		1.03		0.58	
MINIMUM	-1916.60		-46231.15		66145.12	
MAXIMUM	433517.25		321044.00		658417.62	

TABLE 25

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 4

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	7580.89	0.0	15632.91	0.0	66145.12	0.0
1966	24784.58	17203.69	-5417.67	-21050.58	84427.44	18282.31
1967	19686.81	-5097.77	-6733.67	-1316.00	106465.75	22038.31
1968	16295.77	-3391.04	322.16	7055.83	140416.19	33950.44
1969	18295.57	1999.79	-879.81	-1201.97	125896.19	-14520.00
5 YR AVG	17328.71	2678.67	584.78	-4128.18	104670.12	14937.77
1970	-2300.25	-20595.82	-19567.53	-18687.71	109813.37	-16082.81
1971	31801.55	34101.80	-8467.37	11100.15	119023.62	9210.25
1972	80059.62	48258.07	27028.50	35495.87	115605.87	-3417.75
1973	306695.19	226635.56	164050.44	137021.94	226883.87	111278.00
1974	339357.37	32662.19	106548.31	-57502.12	360484.31	133600.44
5 YR AVG	151122.69	64212.35	53918.46	21485.62	186362.19	46917.62
10 YR AVG	84225.69	36864.04	27251.62	10101.71	145516.06	32704.35
1975	257758.81	-81598.56	146424.69	39876.37	388331.06	27846.75
1976	286415.94	28657.12	182404.31	35979.62	409697.44	21366.37
1977	382736.31	96320.37	261306.06	78901.75	434191.12	24493.69
1978	390082.12	7345.81	261804.75	498.69	461857.50	27666.37
1979	329496.69	-60585.44	225696.19	-36108.56	477166.81	15309.31
5 YR AVG	329297.75	-1972.14	215527.19	23829.57	434248.37	23336.50
15 YR AVG	165916.37	22993.98	90010.12	15004.52	241760.19	29358.69
1980	338801.62	9304.94	203791.87	-21904.31	501832.44	24665.62
1981	366906.19	28104.56	227446.19	23654.31	527269.81	25437.37
1982	383502.50	16596.31	256820.31	29374.12	548395.31	21125.50
1983	418579.06	35076.56	288870.75	32050.44	564773.19	16377.87
1984	426332.06	7753.00	314016.62	25145.87	576418.50	11645.31
5 YR AVG	386824.19	19367.07	258189.00	17664.09	543737.56	19850.34
20 YR AVG	221143.31	22039.53	132054.81	15704.40	317254.50	26856.49
STD DEV	170040.75		120250.81		191448.37	
STD ERR	38022.27		26888.90		42809.16	
C. V.	0.77		0.91		0.60	
MINIMUM	-2300.25		-19567.53		66145.12	
MAXIMUM	426332.06		314016.62		576418.50	

CHAPTER VIII

ANALYSIS OF EXPERIMENTAL RESULTS - PART III

SCENARIO II - RESULTS AND DISCUSSIONS

This scenario comprising treatments 5-8, compares the total effect of land resource control by rental-purchase agreement (RTP) with debt structure relationship and return on productive assets. The four treatments are:

Treatment 5. Land control through rental-purchase arrangement (RTP) with return on productive assets equivalent to the rate of interest farmers are charged by the Farm Credit Corporation (FCAF) with debt structure relationship of short term liabilities to long term liabilities equal to 0.1427 (STD/LTD).

Treatment 6. Land control through rental-purchase arrangement (RTP) with return on productive assets equivalent to the rate of interest farmers are charged by the Farm Credit Corporation of Canada (FCAF) with a debt structure relationship of medium term indebtedness to long term indebtedness of 0.2857 (MTD/LTD).

Treatment 7. Land control through rental-purchase arrangement (RTP) with return on productive assets equivalent to the rate of inflation as reflected by the Consumer Price Index (IR) with a debt structure relationship of short term debts/long term debts (STD/LTD).

Treatment 8. Land control through rental-purchase arrangement (RTP); a return on productive assets equivalent to the rate of inflation as reflected by the Consumer Price Index (IR) with a debt structure relationship of medium term debt/long term debts equal 0.2857 (MTD/LTD).

Net Farm Income

The performance of the model as it relates to net farm income has been detailed both in the validation scenario and in the detailed description of the Base Simulation behaviour. As well, patterns of net farm income behaviour have been illustrated in Scenario 1. In this scenario, the performance variables are compared among the treatments and the base in terms of their levels and attainment, growth and variations of growth. More definitive statements of comparisons will be identified in the summary portion of each scenario analysis after each treatment results is presented descriptively.

Table D.13-D.17 show the farm income statements for the base and four experiments in this scenario while Table 26 shows a summary of the net farm income situation. Both tables are used concurrently to relate the analysis. Also Tables 27-30 present summaries of net income, net cash flow and net worth information. These three tables are referred to synonimously.

In treatment 5 net farm income generally increased continuously. It rose to a value of $20,394 in 1966 but declined to $19,918 in 1967. The value rose in 1968 to $22,388 but declined to a value of $21,539 in 1969. It fell again in 1970 to $20,676 before rising in 1971, 1972 and 1973. It declined in 1974 before continuing its increase to $333,270 in 1978 before falling to $271,797 in 1979. It began rising again reaching its maximum of $366,440 in 1984.

As the farm increases its operation through land and machinery acquisition, total farm receipts and non-farm income increase. If these increase faster than depreciation and total expenses, and if the

TABLE 26

SUMMARY NET FARM INCOME COMPARISONS FOR SCENARIO 2

	Treatment					Mean
	Base 2	5	6	7	8	
Minimum $	858	8,177(65)	8,177(65)	7,581(65)	7,581(65)	7,879
Maximum $	309,981	366,440(84)	360,520(84)	390,753(84)	385,268(84)	375,745
Means						
Five Years $						
1	9,521	18,483	18,211	18,864	18,412	18,435
2	77,046	94,761	94,666	125,587	124,589	109,901
3	234,096	271,744	268,953	294,796	293,372	282,216
4	274,599	326,110	320,872	350,419	345,748	335,787
Ten Years $						
1	43,283	56,622	56,439	72,136	71,500	64,174
2	254,348	298,927	294,912	322,607	319,560	309,001
Twenty Years $	148,815	177,774	175,75[illegible]	197,371	195,530	186,587
S.D. $	120,618	137,611	135,656	149,884	148,525	142,919
S.E. $	26,971	30,771	30,334	33,515	33,211	31,958
C.V.	0.81	0.77	0.77	0.76	0.76	0.76
Growth at $						
5 Years	2,698	3,340	3,178	3,223	3,060	3,200
10 Years	14,354	16,991	16,896	28,327	28,189	22,601
15 Years	16,140	18,830	18,554	20,618	20,411	19,603
20 Years	16,270	18,855	18,544	20,167	19,878	19,609
Gross Ratio	0.49	0.49	0.49	0.49	0.50	0.49
Capital Turnover	0.71	0.71	0.71	0.71	0.71	0.71
Rate of Return on Capital	0.43	0.52	0.52	0.57	0.57	0.55

TABLE 27

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 5

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	8177.30	0.0	15622.18	0.0	66145.12	0.0
1966	20393.77	12216.47	-50.32	-15672.49	79255.87	13110.75
1967	19918.20	-475.57	3215.85	3266.16	89666.69	10410.81
1968	22388.24	2470.04	16526.71	13310.87	93297.06	3630.37
1969	21539.39	-848.84	17127.33	600.62	85353.87	-7943.19
5 YR AVG	18483.37	3340.52	10488.35	376.29	82743.69	4802.19
1970	20675.75	-863.64	7034.06	-10093.27	81942.69	-3411.19
1971	33947.07	13271.32	58523.25	51489.19	50035.75	-31906.94
1972	58466.27	24519.20	30603.87	-27919.37	67268.69	17232.94
1973	199614.12	141147.81	142005.56	111401.69	153990.31	86721.62
1974	161100.44	-38513.69	110183.81	-31821.75	237308.06	83317.75
5 YR AVG	94760.69	27912.19	69670.06	18611.29	118109.06	30390.84
10 YR AVG	56622.05	16991.44	40079.23	10506.84	100426.37	19018.10
1975	203682.12	42581.69	143651.62	33467.81	262539.62	25231.56
1976	226529.62	22847.50	192485.25	48833.62	270516.25	7976.62
1977	323441.37	96911.75	259307.94	66822.69	290422.94	19906.69
1978	333269.62	9828.25	265140.94	5833.00	310038.50	19615.56
1979	271797.50	-61472.12	223413.62	-41727.31	329387.25	19348.75
5 YR AVG	271743.75	22139.41	216799.75	22645.96	292580.75	18415.84
15 YR AVG	128329.25	18830.00	98986.06	14842.24	164477.81	18803.01
1980	279678.37	7880.87	199806.50	-23607.12	352763.81	23376.56
1981	300271.31	20592.94	227853.94	28047.44	372155.81	19392.00
1982	332760.62	32489.31	250676.56	22822.62	391905.19	19749.37
1983	351402.31	18641.69	293760.87	43084.31	400037.31	8132.12
1984	366440.00	15037.69	310767.25	17006.37	408257.19	8219.87
5 YR AVG	326110.37	18928.50	256573.00	17470.72	385023.56	15773.98
20 YR AVG	177774.50	18855.92	138382.75	15533.95	219614.25	18005.89
STD DEV	137610.81		111740.31		133407.69	
STD ERR	30770.71		24985.89		29830.87	
C. V.	0.77		0.81		0.61	
MINIMUM	8177.30		-50.32		50035.75	
MAXIMUM	366440.00		310767.25		408257.19	

change in value of crop inventory is positive, net farm income will continue to increase. For example, in 1973, total farm receipts were $258,126, 124 percent greater than its value in 1972. Total farm expenses increased by only 20 percent resulting in an increase in net cash income of 254 percent. Non farm income is directly dependent on investment income, other income, off farm income, etc. In 1973, non farm income of $23,884 was 44 percent higher than in 1972. The change in value of crop inventory was only $600 in 1973. But the difference between the value of change in inventory in 1973 and 1972 was $3,427. This difference is reflected in the net farm income between the years, but is insufficient to create the change. This point will be pursued later.

In 1974, by comparison, net farm income declined by 18 percent from 1973. During this time, total farm receipts declined by 13 percent due to a drop in crop sales resulting from price and yield declines and redistribution of crop acreage based on the relative contribution of each crop to the profitability of the farm business in 1973. Total expenses increased 11 percent due to increases in crops, machinery and building operating expenses, interest paid on loans and fertilizer expenses. This decrease was enough to offset the decline in farm receipts with the result that net cash income dropped to $137,231 in 1974 from $180,792 in 1973, a decline of 80 percent. Although non farm income increased by 52 percent, depreciation was increasing by 91 percent. The difference between the change in value of inventory (-391) in 1974 and (600) in 1973 was $991. The changes in expenses and depreciation far outweighed the positive changes

TABLE 28

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 6

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	8177.30	0.0	15622.18	0.0	66145.12	0.0
1966	20294.66	12117.36	1569.12	-14053.06	77539.44	11394.31
1967	19707.11	-587.55	6589.29	5020.18	84903.25	7363.81
1968	21986.55	2279.44	20016.42	13427.12	85534.56	631.31
1969	20889.73	-1096.82	20210.11	193.69	74484.50	-11050.06
5 YR AVG	18211.05	3178.11	12801.42	1146.98	77721.37	2084.84
1970	19720.83	-1168.90	10174.52	-10035.59	67472.19	-7012.31
1971	32828.62	13107.79	13941.31	3766.79	79364.25	11892.06
1972	60427.47	27598.85	47563.69	33622.37	81557.56	2193.31
1973	200109.94	139682.44	168702.12	121138.44	149420.87	67863.31
1974	160244.44	-39865.50	129479.62	-39222.50	218141.37	68720.50
5 YR AVG	94666.25	27870.92	73972.25	21853.90	119191.25	28731.37
10 YR AVG	56438.65	16896.33	43386.83	12650.82	98456.31	16888.47
1975	202157.44	41913.00	156672.87	27193.25	233565.25	15423.87
1976	224353.25	22195.81	200886.81	44213.94	234828.87	1263.62
1977	320561.12	96207.87	266769.87	65883.06	247010.37	12181.50
1978	329766.06	9204.94	270473.62	3703.75	260490.94	13480.56
1979	267929.44	-61836.62	228121.69	-42351.94	274439.00	13948.06
5 YR AVG	268953.19	21537.00	224584.75	19728.41	250066.75	11259.52
15 YR AVG	127276.75	18553.71	103786.12	15178.53	148993.12	14878.13
1980	275237.44	7308.00	205139.06	-22982.62	291646.56	17207.56
1981	295328.00	20090.56	229431.37	24292.31	306640.56	14994.00
1982	327451.37	32123.37	250114.50	20683.12	323459.37	16818.81
1983	345824.00	18372.62	290879.75	40765.25	330601.94	7142.56
1984	360519.69	14695.69	307906.25	17026.50	337166.94	6565.00
5 YR AVG	320871.75	18518.05	256694.00	15956.91	317902.75	12545.59
20 YR AVG	175675.50	18544.33	142013.06	15383.37	191220.50	14264.30
STD DEV	135655.94		113204.00		104413.94	
STD ERR	30333.59		25313.18		23347.67	
C. V.	0.77		0.80		0.55	
MINIMUM	8177.30		1569.12		66145.12	
MAXIMUM	360519.69		307906.25		337166.94	

in cash receipts, nonfarm income and inventory change resulting in the decline in net farm income. All changes in net farm income are explained in a similar manner as the above.

In treatment 6, net farm income behaved similarly to that of treatment 5 in that its value increased continuously from the low of $8,177 in 1965 to the maximum value of $360,519 in 1984 except that decreases were obtained in 1967, 1969, 1970, 1974 and 1979. The explanation for these are partly given above by interyear changes.

In treatment 7, net farm income again behave similarly to treatments 5 and 6, by generally increasing throughout the simulation. However, its low value in 1965 was lower than that of the other two being $7,581 compared to $8,177 in treatments 5 and 6. Additionally, net farm income declined in 1967, 1968, 1970, 1975 and 1979 by 6, 12, 56, 25 and 18 percent, respectively relevant to the year before. In 1967, total farm receipts increased over 1966 by 21 percent as a result of increased yield prices and quantity marketed. At the same time total farm expenses increased 21 percent. This resulted in net cash income of $12,594, 28 percent higher than in 1966. While non farm income was decreasing by 15 percent and depreciation was decreasing by 5 percent, change in value of inventory in 1967 was declining from $3,491 in 1966 to -$1,330. These combined changes produced the negative drop in net farm income in 1967.

The decline in net farm income in 1970 is again explained by the behaviour of the model and the values it generates. Total farm receipts increased by 2 percent while total expenses went up by 13 percent resulting in net cash income of 29 percent less than in 1969.

TABLE 29

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 7

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	7580.89	0.0	15632.91	0.0	66145.12	0.0
1966	24942.16	17361.27	-145.25	-15778.16	79255.87	13110.75
1967	20756.16	-4186.00	3198.36	3343.61	89666.69	10410.81
1968	19671.14	-1085.02	16583.43	13385.07	93297.06	3630.37
1969	20472.08	800.93	17149.61	566.18	85353.87	-7943.19
5 YR AVG	18684.47	3222.80	10483.81	379.17	82743.69	4802.19
1970	13360.39	-7111.68	7186.69	-9962.92	81942.69	-3411.19
1971	32553.62	19193.23	58552.31	51365.62	50035.75	-31906.94
1972	70411.87	37858.25	68072.06	9519.75	29551.25	-20484.50
1973	249081.19	178669.31	142518.44	74446.37	119267.62	89716.37
1974	262527.62	13446.44	92631.50	-49886.94	210227.37	90959.75
5 YR AVG	125586.94	48411.10	73792.19	15096.37	98204.94	24974.70
10 YR AVG	72135.69	28327.41	42138.00	8555.39	90474.31	16009.14
1975	226440.62	-36087.00	136090.50	43459.00	239689.94	29462.56
1976	248723.94	22283.31	183443.81	47353.31	252638.25	12948.31
1977	345531.12	96807.19	253177.94	69734.12	275706.12	23067.87
1978	357050.00	11518.87	259815.69	6637.75	298030.12	22324.00
1979	296233.19	-60816.81	219853.56	-39962.12	319671.87	21641.75
5 YR AVG	294795.56	6741.11	210476.19	25444.41	277147.00	21888.90
15 YR AVG	146355.62	20618.02	98250.69	14587.19	152698.50	18109.05
1980	303995.37	7762.19	195935.25	-23918.31	345000.00	25328.12
1981	324588.44	20593.06	224553.00	28617.75	366049.56	21049.56
1982	356936.31	32347.87	248756.56	24203.56	386311.75	20262.19
1983	375820.37	18884.06	291130.37	42373.81	395756.69	9444.94
1984	390753.06	14932.69	308859.25	17728.87	404632.31	8875.62
5 YR AVG	350418.56	18903.97	253846.75	17801.14	379549.75	16992.09
20 YR AVG	197371.37	20166.95	137149.75	15432.96	209411.31	17815.11
STD DEV	149883.56		108720.87		133188.06	
STD ERR	33514.98		24310.73		29781.76	
C. V.	0.76		0.79		0.64	
MINIMUM	7580.89		-145.25		29551.25	
MAXIMUM	390753.06		308859.25		404632.31	

With an increase of 15 percent in depreciation charges, a 35 percent drop in nonfarm income and a change in value of inventory of $371 in 1970, a difference of $4,326 from 1969, net farm income dropped by 56 percent.

Treatment 8 behaved more similar to treatment 7 than to treatments 5 and 6 in that although generally increasing values of net farm income are obtained there were declines in 1967, 1968, 1970, 1975 and 1979. In 1979, net farm income declined by 17 percent below 1978. Again, a combination of influences is at work. Total farm receipts, due to changes in prices, yields, quantity marketed and crop acreage allocation based on the relative contribution of the crop to profitability, declined to 86 percent of the 1978 value. At the same time, however, total farm expenses increased 3 percent, resulting in a net cash income value 21 percent lower than in 1978. With nonfarm income increasing by 12 percent and value of inventory change of zero, and with depreciation of machines and building soaring by 296 percent, net farm income has decreased by 17 percent.

Table 31 summarizes the net cash flow for Scenario 2. All treatments reached higher minima and maxima than the base. While the minima in treatments 5 and 6 were $8,177 those in treatments 7 and 8 were $7,581. The highest maximum was reached in treatment 7 with $390,753 followed by treatment 8 with $385,268, treatment 5 with $366,440, and treatment 6 with $360,520.

The changes in values of net farm income over the twenty year period are also revealed in the table. After five years (1965-1969), treatment 7 showed the highest mean, followed by treatments 5, 8, 6 and the base with the least. After the second five-year period

TABLE 30

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 8

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	7580.89	0.0	15632.91	0.0	66145.12	0.0
1966	24843.05	17262.16	1474.19	-14158.72	77539.44	11394.31
1967	20545.07	-4297.98	6571.80	5097.62	84903.25	7363.81
1968	19269.45	-1275.62	20073.12	13501.32	85534.56	631.31
1969	19822.41	552.96	20232.39	159.26	74484.50	-11050.06
5 YR AVG	18412.16	3060.38	12796.88	1149.87	77721.37	2084.84
1970	12405.48	-7416.94	10327.20	-9905.19	67472.19	-7012.31
1971	31435.18	19029.70	61470.37	51143.18	31864.25	-35607.94
1972	69010.19	37575.01	51039.37	-10431.00	27039.75	-4824.50
1973	248808.25	179798.06	134925.06	83885.69	107134.50	80094.75
1974	261284.81	12476.56	78654.06	-56271.00	208066.19	100931.69
5 YR AVG	124588.75	48292.47	67283.19	11684.32	88315.37	26716.34
10 YR AVG	71500.44	28189.32	40040.04	7002.34	83018.37	15769.00
1975	226342.87	-34941.94	134906.94	56252.87	233565.25	25499.06
1976	248393.00	22050.12	200385.06	65478.12	234828.87	1263.62
1977	344082.69	95689.69	266279.00	65893.94	247010.37	12181.50
1978	354716.25	10633.56	269952.87	3673.87	260490.94	13480.56
1979	293328.37	-61387.87	227591.62	-42361.25	274439.00	13948.06
5 YR AVG	293372.37	6408.71	219823.00	29787.51	250066.75	13274.56
15 YR AVG	145457.69	20410.53	99967.62	15139.90	138701.12	14878.13
1980	300338.50	7010.12	204615.19	-22976.44	291646.56	17207.56
1981	320275.62	19937.12	228910.75	24295.56	306640.56	14994.00
1982	352125.94	31850.31	249599.50	20688.75	323459.37	16818.81
1983	370733.81	18607.87	290359.87	40760.37	330601.94	7142.56
1984	385268.19	14534.37	307389.69	17029.81	337166.94	6565.00
5 YR AVG	345748.19	18387.96	256175.00	15959.61	317902.75	12545.59
20 YR AVG	195530.31	19878.27	139019.50	15355.61	183501.50	14264.30
STD DEV	148524.75		111154.25		112072.69	
STD ERR	33211.14		24854.85		25060.21	
C. V.	0.76		0.80		0.61	
MINIMUM	7580.89		1474.19		27039.75	
MAXIMUM	385268.19		307389.69		337166.94	

(1970-1974), treatment 7 again had the highest mean followed by treatments 8, 5 and 6. During the period 1975-1979, and 1980-1984, the same order prevailed. The greatest change in means occurred between the third and second five-year periods and the smallest between the third and fourth periods. Over the twenty year run, treatment means were all greater than the base with treatment 7 the highest with a value of $197,371. It was followed by treatment 8 ($195,530), treatment 5 ($177,774) and treatment 6 (($175,675) in that order.

The growth of net farm income during the twenty years is shown by the mean growth at five yearly intervals. At the end of five years all treatments generated average growth in net farm income that exceeded that of the base. At the end of ten years all treatments continued to show greater average growth than the base and also faster growth rates than the base. After ten years the rates of growth slowed dramatically. Treatment 8 slowed the most followed by treatments 7, 6, the base and treatment 5 in that order. In other words, although the rate of growth declined in all treatments, they were less for the base and treatments 6 and 5.

In the general discussions about net farm income emphasis has been put on inter-year variations in treatments and among treatments. Some of the inter-year variations were caused by variations in the values of variables making up the net farm income value. For example, it has been pointed out that nonfarm income plays a role in the changes of net farm income. How important has deliberately not been discussed to this point. Nonfarm income comprises investment income such as total dividends, interest received on stocks and bonds and the return on capital investment. Return on capital investment depends on the treatment since it is a control or treatment variable.

If an experiment does not utilize an additional inflationary return on productive assets as in the base treatment, then the return on investment will be less than for an experiment where such is the case. The higher the return on investment, the higher will be the value of nonfarm income and net farm income and vice versa. But, the effects of return on investment, and thus non farm income on net farm income cause differences among treatment also.

The analysis of net farm income suggests that rent-to-purchase as a land control arrangement tends to increase net farm income above the levels obtained in its absence. The effects are more definitively defined in combination with debt structure and rate of return on productive assets. The analysis also suggests that rental purchase and rate of return on productive assets equal to that charged by the Farm Credit Corporation of Canada the STD/LTD ratio caused net farm income to reach a maximum 2 percent higher than that reached with MTD/LTD.

With the rental purchase option and rate of return on productive assets fixed at the consumer price index, a debt structure ratio of STD/LTD gives a maximum almost 2 percent higher than that produced with MTD/LTD.

Given the rental purchase option and a debt structure ratio of STD/LTD, a rate of return equal to the consumer price index (IR) yields a higher net farm income than one with FCAF. With rental purchase option and MTD/LTD, rate of return equal to the consumer price index gives a higher maximum than STD/LTD.

The influences are almost those described in Scenario 1. Under a rental purchase option, the farmer is able to save, if not all, some of the money required to acquire the land when it becomes due. The model dictates that under the rental purchase plan the farmer saves an amount equal to the total price divided by the number of years before the rent-to-purchase plan becomes due. This prevents too much pressure on the farmer to look for funds at the time or to suffer the loss of the land due to failure to arrange credit.

The amount set aside is placed in the array SURPLUS where it earns interest. Surplus is an indicator of the financial status of the farm. Thus, the effects of rental purchase plan on net farm income is worked through the normal income statement augmented by the added income generated through the investment cycle.

Net Cash Flow

The cash flow statements are presented in Tables D.18-D.22. The value of net cash flow, in general, follows the pattern of behaviour showed throughout this discussion. It also follows, in a general way, the movements of net farm income and where it vacillates it reflects the combined influences of elements from the income statement and balance sheet which together determine the net cash flow. While the general tendency of the net cash flow in the base was to increase over the duration of the run, declining tendencies were displayed in 1966, 1969, 1970, 1972, 1974, and 1979. The reasons were explained in the detailed discussion of the base but will be repeated here for continuity of discussion of the other treatments. The reasons for changes will not be restated in looking at the treatments.

Total inflow decreased from $50,415 in 1965 to $38,926 in 1966, a decrease of 23 percent primarily because the amount of money borrowed decreased from $21,294 in 1965 to zero in 1966. In addition, machinery sales declined from $6,012 in 1965 to zero in 1966. Although crop sales increased by 73 percent and off-farm income increased by 32 percent, respectively in 1966, they were not large enough to balance off the combined decreases in borrowings and machinery sales. At the same time, total outflow was rising in 1966 by 9 percent, the result of an 18 percent increase in share rent, and, a decline of capital purchases to zero from $5,671 in 1965. Interest paid on farm debts decreased by 11 percent over 1965, total principle paid on loans increased by 14 percent, cash withdrawn for consumption by the household increased by 36 percent and all other relevant farm expenses increased by 45 percent. The combination of all changes generated the decline in net cash flow.

In 1980, net cash flow declined by 10 percent below the 1979 value of $229,430. This change is explained by the same events that occur repeatedly throughout the model discussion and elsewhere, in the base, for example, total inflow was reduced from $369,373 in 1979 to $368,376 in 1980, due to changes in the activities comprising it. The value of crop sales increased by 6 percent due to changes in price and yields and allocation of new land. The amount of money borrowed dropped from $20,567 in 1979 to $41, in 1980. Total outflow, contrarily, increased from $136,375 in 1979 to $139,944 in 1980, an increase of 3 percent. This increase arose principally because of a decrease in machinery operating expenses together with normal increases in other activities.

Net cash flow in treatments 5, 6, 7 and 8 behaves like that of the base in an essential way. Although a continuously increasing tendency pervades the net cash flow in all treatments, the magnitudes and inter-year variations show some deviations from the general trend.

Table 31 summarizes the essentials of the net cash flow for the treatments and the base. All treatments reached their minimum in 1966, with treatment 7 showing the lowest minimum. The highest minimum was obtained in treatment 6, next was treatment 8 with $1,474 followed by the base, 5 and 7 in that order. All maxima were reached in 1984, that of treatment 5 at $310,767 was the highest followed by the base, and treatments 7, 6 and 8 in that order.

In the first five-year period, 1965-1969, treatment 6 had the highest mean with treatment 8 ($12,797), the base ($12,511), treatment 5 ($10,488) and treatment 7 ($10,484) following in that order. In the second five-year period, treatment 6 with a value of $73,972 was the best followed by treatments 7, 5, 8 and the base in that order. Treatment 6 displayed the highest change of $61,171 between the period means, while treatment 8 showed the least change. In the third five-year period, treatment 6 had the highest mean with the base, treatments 8, 5 and 7 in that order. But in the fourth five-year period, the base had the highest mean net cash flow. It was followed by treatments 6, 5, 8 and 7 in that order.

The rate of growth of net cash flow at five-yearly intervals was greatest for treatment 6 for the first 15-years. After twenty years, treatment 5 generated the highest mean growth of $15,534. The

TABLE 31

SUMMARY NET CASH FLOW COMPARISONS FOR SCENARIO 2

	Treatment					Mean
	Base 2	5	6	7	8	
Minimum $	1,194	50(66)	1,569(66)	-145(66)	1,474(66)	737
Maximum $	309,634	310,767(84)	307,906(84)	308,859(84	307,390(84)	308,730
Means						
Five Years $						
1	12,511	10,488	12,801	10,484	12,797	11,642
2	67,331	69,670	73,972	73,792	67,283	71,179
3	221,197	216,800	224,585	210,476	219,823	217,921
4	259,096	256,573	256,694	253,847	256,175	255,822
Ten Years $						
1	39,921	40,079	43,387	42,138	40,040	41,411
2	240,147	236,686	240,639	231,996	237,999	236,830
Twenty Years $	140,034	138,383	142,013	137,150	139,019	139,141
S.D.	112,267	111,740	113,204	108,721	111,154	111,204
S.E.	25,104	24,986	25,313	24,311	24,855	24,866
C.V.	0.80	0.81	0.80	0.79	0.80	0.80
Growth at $						
5 Years	947	376	1,147	379	1,150	763
10 Years	7,179	10,507	12,651	8,555	7,002	9,679
15 Years	15,263	14,842	15,393	14,587	15,140	14,990
20 Years	15,467	15,534	14,262	15,433	15,356	15,146

base was the next best followed by treatments 7, 8 and 6 in that order. The overall mean net cash flow was highest in treatment 6 with the base next with a value of $140,034. Treatment 8 was next followed by 8, 7 and 6.

The treatments generally showed very little differences in terms of cash flow. Apart from treatment 5 having the best maximum and twenty year mean growth and treatment 6 the highest mean, the base gave a better performance than the treatments implying insignificant effects of treatments on net cash flow.

Net Farm Worth

Net farm worth values are shown for scenario 2 in Tables D.23-D.27. The behaviour of net worth in terms of the model has been described and explained many times before. However, because of the nature of the study and the extensiveness of the data available, patterns of behaviour for the performance variables have been described and discussed where necessary to provide fluidity in reading the thesis. In discussing net farm worth in this scenario, specific situations in the base case will be used to reiterate the pattern of behaviour of the net worth. Net worth is defined as the residual between total assets and total indebtedness. It measures the financial growth of the business and indicates the prospects for survival and failure.

For the first eight-years of the run, net farm worth as indicated for the base case, tends to show upwards and downwards changes. Thus, declines occurred in 1969 and 1970-1972 while increases occurred in 1966-1968. As explained elsewhere throughout this thesis, changes in net worth reflect changes in composition and amounts of assets and liabilities as the farm business undertakes decisions for production.

The decline in net worth from $87,348 in 1968 to $77,409 in 1969 are explained by the changes in values and structure of the farm assets and liabilities. As the figures in the table indicate, short term assets dropped from $11,297 in 1968 to $7,343 in 1969. This decline of 35 percent in short term assets was due exclusively to a drop in the value of crops in inventory from $4,281 in 1968 to $326 in 1969. At the same time, medium term assets was improving by 21 percent resulting from the acquisition of machinery. Concurrently, long term assets decreased to $70,725 from $78,611 due to a 10 percent drop in value of lands and buildings.

While these changes were taking place, changes were ramifying themselves on the liabilities side of the ledger. Both medium term and long term liabilities were changing in 1969 to reflect the indebtedness incurred from purchasing machinery and depreciation in long term values. Medium term liabilities were up by 29 percent and long term dropped by 6 percent culminating in an increase of 31 percent in total liabilities. The decrease of 4 percent in total assets was overrun by the 31 percent increase in total liabilities resulting in the fall of net farm worth.

It is interesting to observe that net worth reached its lowest value of $34,340 for the base in 1972 after which it rose continuously and rapidly to a maximum of $357,718 in the last year of the run.

In order to restate the behaviour of the model when the net worth shows an increase, the increase in net worth between 1973 and 1974 is examined. Net farm worth is shown to have increased from

\$116,351 in 1973 to \$219,277 in 1974, an increase of 88 percent. The tabulations indicate that the major cause of the accretion arose in the increase of long term assets from \$218,501 in 1973 to \$287,353 in 1974. Moreover, this was mainly due to an increased value of land from \$214,858 in 1973 to \$284,074 in 1974. This increased value was due to the increased improvement and value of land. Consequently, total assets increased by 26 percent. In the meantime, total liabilities were decreasing by 21 percent; medium term liabilities were decreasing by 4 percent. The increase in medium term liabilities was caused by debt incurred to purchase machinery and implement while the drop in long term assets reflect repayment of debts.

SCENARIO SUMMARY ANALYSIS

All treatments portrayed the general behaviour of the base, that is, over the first eight-years, upward interspersed with downward movements after which net worth increases.

Table 32 presents a summary of net farm worth indicators for scenario 2. While Figure 17 presents a graphic representation of net farm income, net worth and net cash flow for scenario 2. The results show that the treatments 5 and 7 outperformed the base in that they registered higher maxima net farm worth than the base. The base minimum net farm worth, valued at \$34,340 was obtained in 1972. So too were those of treatments 7 and 8. However, treatments 5 and 6 generated their minima of \$66,145 in 1965. The best results of net worth in this scenario originated with treatment 5; a maximum of \$408,257, followed by treatment 7 with a maximum of \$404,632. Both treatments 6 and 8 had the same maximum of \$337,167. The base had a maximum of \$357,718. All maxima were obtained in 1984,

TABLE 32

SUMMARY NET FARM WORTH COMPARISONS FOR SCENARIO 2

	Treatment					Mean
	Base 2	5	6	7	8	
Minimum $	34,340(72)	66,145(65)	66,145(65)	29,551(72)	27,040(72)	47,220
Maximum $	357,718(84)	408,257(84)	337,167(84)	404,632(84)	337,167(84)	371,805
Means						
Five Years $						
1	79,038	82,744	77,721	82,744	77,721	80,232
2	95,922	118,109	119,191	98,205	88,315	105,955
3	263,996	292,581	250,067	277,147	250,067	267,465
4	337,072	385,024	317,903	379,550	317,903	350,095
Ten Years $						
1	87,480	100,427	98,456	90,474	83,018	93,094
2	300,534	338,802	283,985	328,349	283,985	308,780
Twenty Years $	194,007	219,614	191,220	209,411	183,501	200,936
S.D.	118,739	133,408	104,414	133,188	112,073	120,771
S.E.	26,551	29,831	23,348	29,782	25,060	27,005
C.V.	0.61	0.61	0.55	0.64	0.61	0.60
Current Ratio	5,858	2.04	7,565	1.92	5,858	1,907
Debt/Equity Ratio	0.81	0.49	0.58	0.72	0.98	0.69
Change in Net Worth $	14,579	17,100	13,551	16,924	13,551	15,281
Growth at $						
5 Years	2,816	4,802	2,085	4,802	2,085	3,443
10 Years	17,015	19,018	16,888	16,009	15,769	16,921
15 Years	16,129	18,803	14,878	18,109	14,878	16,667
20 Years	15,346	18,006	14,264	17,815	14,264	16,112

confirming the general increasing tendencies of the performance criteria.

The table also indicates the behaviour of the variables throughout the run both in terms of the five-yearly means of net farm worth and the growth behaviour at five-year intervals. The average net farm worth during the first five-year period show that treatments 5 and 7 were superior to the base. In fact, the values for treatments 5 and 7 were the same at $82,744 and higher than those for treatments 6 and 8 which were equal at $77,721. The mean for the base was $79,038. In the second five-year period, 1970-1975, except for treatment 8, the treatments all outperformed the base, but they varied in value from each other. The highest mean during this time frame was from treatment 6, with 5, 7, base and 8, in that order, following.

In the third period, treatment 5 with an average of $292,581 was best, with 7, base, 8 and 6 following in that order. The behaviour was the same in the fourth period with differing values for the mean. The overall mean during the twenty years of run revealed that treatment 5 with a value of $219,614 was the highest followed by treatment 7 with $209,411, the base, treatment 6 with a value of $191,220, and treatment 8 with a value of $183,501. The overall twenty years mean value of the base was $194,007.

Tables 33, 34 and Figure 18 indicate that all treatments including the base developed an increasing rate of growth of net worth up to the tenth year. After peaking, the rate of growth, though still positive, shows down reflecting the behaviour of the farm business in its later growth cycle.

Comparing the treatments for differences it is concluded that treatment 5, Rent-to-Purchase - FCAF - STD/LTD was the best performer

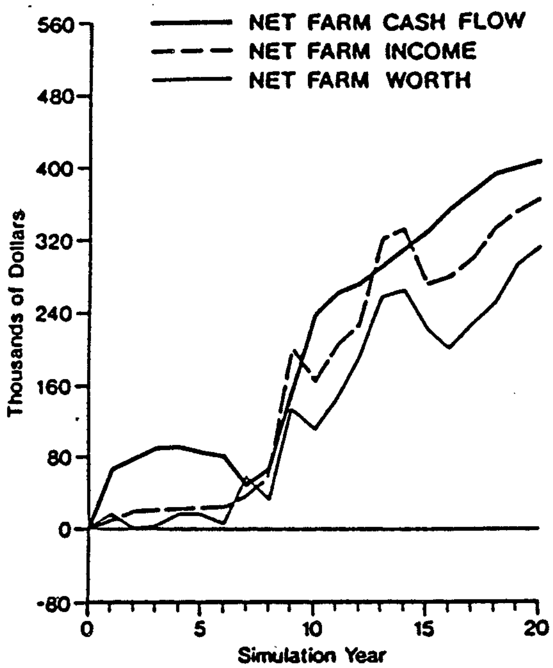
TABLE 33

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR BASE

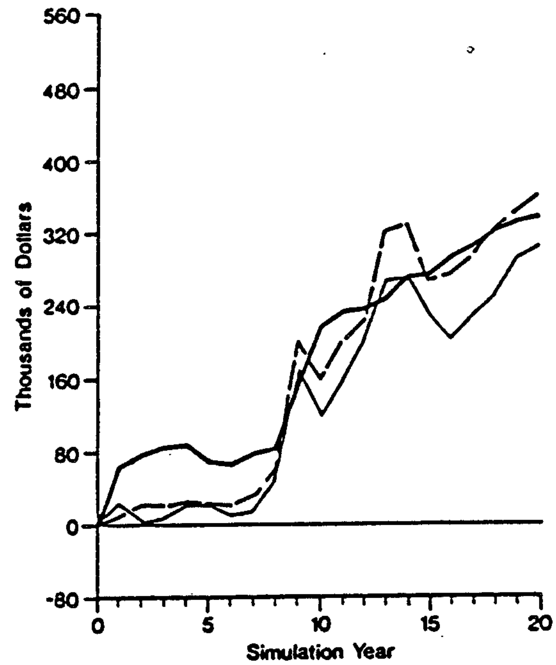
Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	857.78	0.0	15753.93	0.0	66145.12	0.0
1966	12606.06	11748.28	1193.71	-14560.22	78159.25	12014.12
1967	10243.41	-2362.64	6293.17	5099.46	86129.87	7970.62
1968	12247.62	2004.21	19774.03	13480.86	87348.25	1218.37
1969	11650.67	-596.95	19540.84	-233.19	77408.56	-9939.69
5 YR AVG	9521.11	2698.22	12511.13	946.73	79038.19	2815.86
1970	10229.71	-1420.96	8854.11	-10686.73	72347.50	-5061.06
1971	21365.68	11135.97	61660.56	52806.46	37292.25	-35055.25
1972	45136.64	23770.96	50407.12	-11253.44	34340.25	-2952.00
1973	178456.37	133319.69	135366.56	84959.44	116351.19	82010.94
1974	130040.69	-48415.69	80369.25	-54997.31	219276.94	102925.75
5 YR AVG	77045.81	23677.98	67331.50	12165.67	95921.62	28373.67
10 YR AVG	43283.45	14353.64	39921.32	7179.47	87479.87	17014.64
1975	171209.31	41168.62	137323.06	56953.81	244619.19	25342.25
1976	191093.56	19884.25	202837.94	65514.87	245802.62	1183.44
1977	285886.87	94793.31	266550.69	63712.75	260723.56	14920.94
1978	295478.37	9591.50	269844.25	3293.56	276883.00	16159.44
1979	226812.25	-68666.12	229429.81	-40414.44	291951.12	15068.12
5 YR AVG	234096.00	19354.31	221197.00	29812.11	263995.75	14534.84
15 YR AVG	106887.56	16139.60	100346.50	15262.55	146318.50	16129.00
1980	232854.44	6042.19	207027.50	-22402.31	309937.94	17986.81
1981	251203.69	18349.25	231909.12	24881.62	325510.62	15572.69
1982	281693.75	30490.06	253184.50	21275.37	342481.62	16971.00
1983	297261.87	15568.12	293724.12	40539.62	349712.94	7231.31
1984	309980.75	12718.87	309633.75	15909.62	357717.94	8005.00
5 YR AVG	274598.56	16633.70	259095.75	16040.79	337072.00	13153.36
20 YR AVG	148815.31	16269.62	140033.81	15467.35	194006.87	15345.94
STD DEV	120617.94		112266.56		118739.19	
STD ERR	26970.99		25103.57		26550.89	
C. V.	0.81		0.80		0.61	
MINIMUM	857.78		1193.71		34340.25	
MAXIMUM	309980.75		309633.75		357717.94	

FIGURE 17

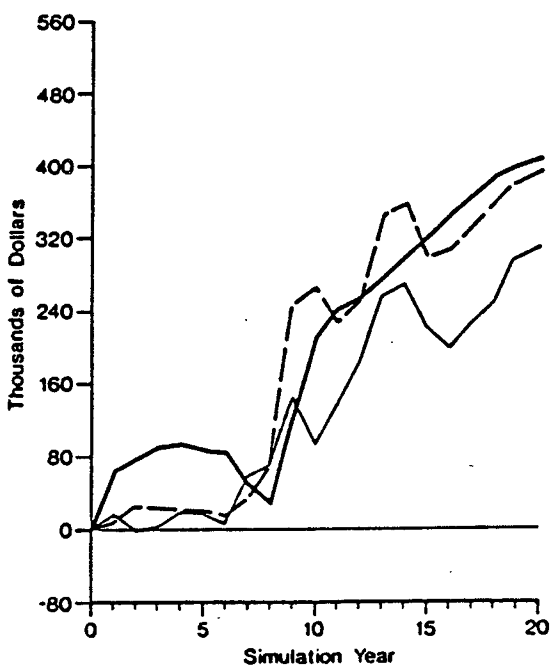
NET FARM CASH FLOW, NET FARM INCOME AND NET FARM WORTH FOR SCENARIO 2 (TREATMENTS 5-8)



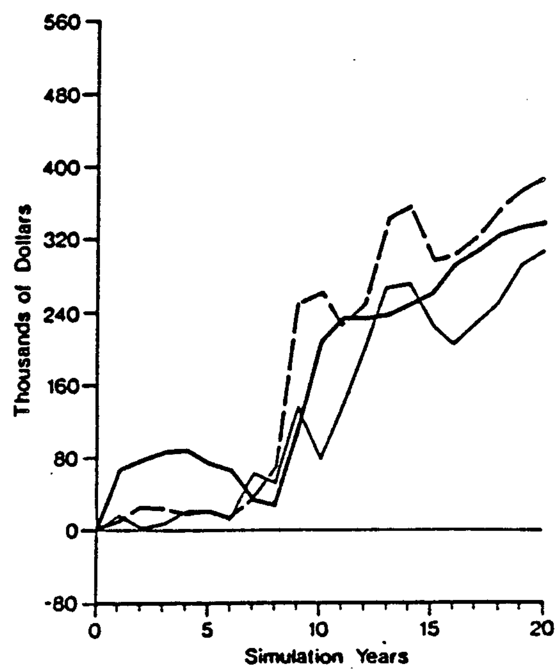
Treatment 5



Treatment 6



Treatment 7



Treatment 8

followed by treatment 7, Rent-to-Purchase - IR - STD/LTD. The base was ranked third being better than treatment 6, Rent-to-Purchase - FCAF - MTD/LTD. Treatment 8, Rent-to-Purchase - IR - MTD/LTD performed exactly like treatment 6.

The analysis and examination suggest that in the presence of RTP and FCAF, STD/LTD produced better results than MTD/LTD; that in the presence of IR and RTP, STD/LTD outperformed MTD/LTD; that in the presence of RTP and STD/LTD, FCAF outperformed IR; that in the presence of RTP and MTD/LTD, no differences show up in growth and maximum but the mean of 6 is greater than that of 8; and that rent-to-purchase as a land control measure is beneficial.

The effect of rent-to-purchase is translated to net worth through increases in land ownership and through increases in long term assets.

SCENARIO III - RESULTS AND DISCUSSIONS

In this scenario comprising treatments 9-12, the total effects of cash rental as a method of land control, debt structure relationship and return on productive assets, on net farm income, net cash flow and net worth are evaluated. The treatments are as follows:

Treatment 9. Cash rental land control arrangement (CR) by return on productive assets equal to the interest charged farmers by the Farm Credit Corporation under the Farm Credit Act (FCAF with a debt structure relationship equal to short term debt/long term debt (STD/LTD).

Treatment 10. Cash rental land control arrangement (CR) with return on productive assets equal to the interest charged farmers by the Farm Credit Corporation of Canada under the Farm Credit Act (FCAF) by debt structure equal to medium term assets/long term assets (MTD/LTD).

Treatment 11. Cash rental land control arrangement (CR) with return on productive assets equal to the inflation rate in Canada as reflected by the annual consumer price index (IR) with short term debt/long term debt (STD/LTD), debt relationship.

Treatment 12. Cash rental land control arrangement (CR) with return on productive assets equal to the annual rate of inflation as reflected by the consumer price index (IR) by the debt structure ratio (MTD/LTD).

Net Farm Income

Table D.28 shows the farm income statement for the base. The net farm income for the base tends to show similar amounts of alternative upward and downward variations as did previous bases. Like the latter, most of these were in the first ten-years of simulation. Declining values were obtained in 1967 (a drop of 19 percent), 1969 (5 percent), 1970 (12 percent), 1974 (30 percent), 1979 (21 percent). The values of net farm income for the base ranged from a low of \$858 to a high of \$322,435.

The mean net farm income over the twenty-year run amounted to \$157,225 with a standard deviation of \$125,133, a standard error of \$27,981 and a coefficient of variation of 0.80. These statistics imply a high degree of variability among the annual data and between the mean and data. The gross ratio was 0.46, implying that on average, over the twenty years expenses comprised 46 cents per dollar of cash receipts or that net farm income amounted to 53 cents per dollar of cash sales. The capital turnover ratio indicates that over the twenty year, on average, for each dollar of capital invested, $1.44 of income was generated while the rate of return on capital suggests that the return on investment was 0.96 percent.

Thus, from an efficiency standpoint the base farm was very efficient. In the following discussion treatments 9-12 are discussed. Treatment 9 (Table D.29) showed the same upward and downward patterns as did the base except that the declines were less. Like the base, net farm income increased continuously, to a maximum of $344,349 in 1984.

The variation in net farm income between years were due to changes in major variables such as cash sales, expenses, nonfarm income and change in value of inventory. These have been discussed repeatedly and in much detail in the past.

Treatment 10 (Table D.30) performed in exactly the same way as did the base and treatment 9 in terms of movements. It had a minimum of $8,177 and a maximum of $341,049 with a twenty year mean of $169,532, a standard deviation of $128,597, a standard error of $28,755 and a coefficient of variation of 0.76. The gross ratio of 0.47, capital turnover ratio of 1.44 and rate of return on capital of 1.05 are almost similar to that of treatment 9.

Both treatments 11 and 12 (Tables D.31 and D.32) complied with the behaviour shown by the base. Both had a minimum net farm income of $7,581 but treatment 11 maximum of $354,651 was higher than that of treatment 12 by $3,300. The mean net farm income was $179,819 for treatment 11 and $178,338 for treatment 12.

Interyear variations within treatments have been explained throughout partly on the basis of how the model operates to generate annual values of relevant explanatory variables. For example, a decline in net farm income between two years is rationalized on the basis of changes in crop sales due to yield, prices or quantity marketed and acreage changes; or due to changes in expenses, change in value of inventory or non farm income.

In the earlier scenario, when comparing differences between treatments, it was shown that while the above explanations are partly true, the actual treatment differences result from the levels of factors each treatment involves and how these augment such variables as average, nonfarm income and expenses to vary the value of net farm income.

Table 34 summarizes the farm income situation for treatments 9-12. Comparisons among the four treatments by reference to the Cash Rent - Base will be treated as in earlier scenarios by looking at the maximum, means, growth and five-year means.

All treatments attained a higher level net farm income than the base. Treatment 11 was the best overall performer, reaching a maximum of \$354,651 and a twenty year mean net farm income of \$179,819. This treatment showed an average overall growth of \$18,267. Treatment 12 was the next with a maximum of \$351,351 and a mean of \$178,338. Its twenty year mean growth was \$18,093. Treatment 9 had a maximum of \$344,349, a twenty year mean of \$171,012 and an average twenty year growth in net farm income of \$12,430. Treatment 10 was the next with a maximum of \$341,049, a mean of \$169,533 and a twenty year average growth in net farm income of \$17,519.

In the presence of cash rented land control arrangement and a rate of return on productive assets equivalent to the inflation rate, the debt structure ratio of short term debt/long term debt generated

TABLE 34

SUMMARY NET FARM INCOME COMPARISONS FOR SCENARIO 3

	Base 3	Treatment 9	10	11	12	Mean
Minimum $	857(65)	8,177(65)	8,177(65)	7,581(65)	7,581(65)	7,879
Maximum $	322,435(84)	344,349(84)	341,049	354,651	351,351(84)	347,850
Means						
Five Years $						
1	9,497	18,429	18,208	18,630	18,400	18,417
2	88,633	98,859	97,574	112,835	111,550	105,204
3	244,556	260,690	259,000	271,497	269,808	265,249
4	286,215	306,069	303,349	316,315	313,594	309,832
Ten Years $						
1	49,065	58,644	57,891	65,732	64,975	61,810
2	265,386	283,379	281,174	293,906	291,701	287,540
Twenty Years $	157,225	171,012	169,533	179,819	178,338	174,675
S.D.	125,133	129,458	128,597	134,913	134,059	132,007
S.E.	27,981	28,948	28,755	30,168	29,977	29,462
C.V.	0.80	0.76	0.76	0.75	0.75	0.75
Growth at $						
5 Years	2,698	3,319	3,178	3,202	3,060	3,190
10 Years	15,814	16,470	16,302	21,691	21,523	18,996
15 Years	17,043	10,647	17,654	18,582	18,446	16,332
20 Years	16,925	12,430	17,519	18,267	18,093	16,577
Gross Ratio	0.46	0.46	0.47	0.46	0.47	0.46
Capital Turnover	1.44	1.44	1.44	1.44	1.44	1.44
Rate of Return on Capital	0.96	1.05	1.05	1.10	1.10	1.07

a net farm income that averaged $1,481 more than that of a ratio of medium term debts to long term debts. Cash rental land control with a rate of return on productive assets equal to the interest charged by the Farm Credit Corporation and with a debt structure ratio of short term debt/long term debt generated a mean net farm income of $171,012, $1,479 more than that generated by a debt structure ratio of medium term debt/long term debt.

Cash rent land control in combination with a rate of return on productive assets equivalent to the interest charged by the Farm Credit Corporation of Canada and a limiting debt structure ratio of short term debt/long term debt produced a mean net farm income that was 5 percent less than that produced by cash rent in combination with a rate of return on productive assets equivalent to the inflation rate and a debt structure limitation of short term debts/long term debts.

Cash rent land control in combination with a rate of return on productive assets equal to the interest charged by the Farm Credit Corporation of Canada and a constrained debt structure ratio of short term debt to long term debt generated a mean value of net farm income that was 4 percent less than that generated in the presence of a debt structure ratio of medium term debt to long term debt.

Net Cash Flow

Tables D.33-D.77 present the farm cash flow statements for the treatments comprising this scenario. The net cash flow for the base with cash rental displayed similar patterns of upward and downward movements as did other bases. It reached a minimum of $2,364 in

1966, and a maximum of $299,651 in 1983. In general, cash flow growth was continuous with the five year mean net cash flow increasing most rapidly during the third five-year period after which its growth slowed. Initially, net cash flow grew quickly, slowed down and then continued its upward movement before again turning downwards. The twenty year mean net cash flow for the base was $144,479, with a standard error of $25,276 and a coefficient of variation of 0.78.

Table D.34 gives the farm cash flow statement for treatment 9. The net cash flow for treatment 9, showed a general increasing tendency from a minimum of $1,120 in 1966 to a maximum of $299,209 in 1984. Declining tendencies were found in 1966, 1970, 1974, 1979 and 1980, the same years in which similar tendencies for the net farm income. For example, in 1974, while total inflow was declining by 15 percent below 1973, total outflow was increasing by 9 percent as crop sales declined in the former while expenses increased in the latter.

In 1974, the amount of money borrowed increased seven-fold over that of 1973, highlighting the need to borrow to replace obsolete machines. As a consequence of the increased capital purchases, interest paid on farm debts and principle paid on loans increased. The five year means revealed that the maximum expansion incurred in the middle period, 1970-1974, with declines in the third and fourth periods. The decline in the fourth perior shows the consequence of a slower but positive rate of increase. The overall mean was $144,317.

The pattern of behaviour of net cash flow in treatment 10 (Table D.35) was the same discussed for treatment, same minimum and the maximum in treatment 10 was only $607 more than that for treatment 9. However, the expansion in the second five-year period was greater in treatment 9 than that of treatment 10. In treatment 11 (Table D.36), the net cash flow ranged from a minimum of $1,025 to a maximum of $298,994 in 1983, with a mean of $144,133.

The range of values for treatment 12 (Table D.37), net cash flow was $1,905 to $298,757 with a mean of $144,727, a standard deviation of $112,843, standard error of $25,233 and a coefficient of variation of 0.78. The twenty year mean growth was $9,549 with the most rapid growth occurring in the second five-year period. The rate of growth slowed but continued to increase up to the fifteenth year after which it declined.

Summary Net Cash Flow Analysis

Table 35 shows the summary cash flow situation for treatments 9-12. A comparison of the performances of all treatments reveals that the base attained the highest maximum of $299,651, followed by treatments 9, 11, 10 and 12 in that order. The difference between the highest maximum of the base and the lowest of treatment 11 was only $894. The highest mean net cash flow was obtained in treatment 10. This was followed by treatment 12, the base, treatments 9 and 11 in that order. The difference between the highest mean value of $144,924 and the lowest was $791. The highest mean growth net cash flow was $9,561 in treatment 10, the same value as that of the base. It was followed by treatments 12, 9 and 11 in that order. The difference between the highest and lowest mean growth in net cash flow was $29.

There were no significant differences among treatments in the attainment of net cash flow.

TABLE 35

SUMMARY NET CASH FLOW COMPARISONS FOR SCENARIO 3

	Treatment					Mean
	Base 3	9	10	11	12	
Minimum $	2,364(66)	1,120(66)	1,414(66)	1,025(66)	1,905(66)	1,366
Maximum $	299,651 (83)	299,209(83)	298,973(84)	298,994(84)	298,757(84)	298,983
Means						
Five Years $						
1	11,720	9,964	12,125	9,960	12,609	11,029
2	82,548	82,369	83,384	82,078	83,093	82,731
3	236,446	238,153	237,195	237,928	236,969	237,561
4	247,202	246,782	246,993	246,568	246,779	246,780
Ten Years $						
1	47,134	46,167	47,755	46,019	47,581	46,880
2	242,094	242,467	242,094	242,248	241,874	243,171
Twenty Years $	144,479	144,317	144,924	144,133	144,727	144,525
S.D.	113,039	114,128	112,941	114,017	112,843	113,482
S.E.	25,276	25,520	25,254	25,495	25,233	25,375
C.V.	0.78	0.79	0.78	0.79	0.78	0.78
Growth at $						
5 Years	611	-25	811	-22	814	394
10 Years	13,768	13,979	13,889	13,870	13,780	13,879
15 Years	16,256	16,385	16,392	16,369	16,376	16,380
20 Years	9,561	9,543	9,561	9,532	0,549	9,545

Net Farm Worth

The net farm worth for treatment base is shown in Table D.38. Examination of net farm worth for the cash rent base reveals that net farm worth though generally portraying an increasing trend is subject to declining interyear values. Such are the situations in 1969 and 1970, 1972, 1976, 1979 and 1984. The minimum was $66.145, the maximum was $143,968 and the twenty year overall mean net farm worth was $106,850. The standard deviation was $28,319, the standard error was $6,332 and the coefficient of variation was 0.27. The last three indicators reflect the smallness of the spread among the annual net farm worth and between the annual net worth values and the mean. It also reveals the relative stability of net farm worth.

The growth of net worth was fastest during the 1975-1979 period. While growth continued in the 1980-1984 period, the rate slowed.

In treatment 9 (Table D.39), net farm worth reflected an increasing tendency throughout the run although declining interyear changes were shown. Declining, but positive, changes occurred in 1969, 1970, 1972, 1976, 1979 and 1984. In 1979, for example, net farm worth was 4 percent less than in 1978. Total assets were 5 percent higher in 1979 but total liabilities were 37 percent higher. The combined changes accounted for the drop, though net worth remained positive, in net farm worth between 1979 and 1978. The rise in total assets were due to new acquisition of machinery and implement and inflation in long term assets.

Correspondingly, medium term liabilities increased by 37 percent as a result of an increase in borrowing of 756 percent in 1979 over

TABLE 36

SUMMARY NET FARM WORTH COMPARISONS FOR SCENARIO 3

	Treatment					Mean
	Base 3	9	10	11	12	
Minimum $	66,145(65)	66,145(65)	62,491(72)	66,145(65)	66,145(65)	65,231
Maximum $	143,968(83)	143,923(83	110,594(82)	143,923(83)	110,594(82)	127,258
Means						
Five Years $						
1	78,635	81,694	77,674	81,694	77,517	79,645
2	85,260	94,821	76,996	94,821	76,996	85,908
3	123,009	126,555	104,940	126,555	104,940	115,747
4	140,496	140,449	107,816	140,449	107,816	124,132
Ten Years $						
1	81,948	88,257	77,335	77,335	77,256	80,046
2	131,753	133,502	106,378	106,378	106,378	113,159
Twenty Years $	106,850	110,879	91,856	110,879	91,817	101,358
S.D.	28,319	26,258	17,347	26,258	17,378	21,810
S.E.	6,332	5,871	3,879	5,871	3,886	4,877
C.V.	0.27	0.24	0.19	0.24	0.19	0.21
Current Ratio	6,674	4,524	6,688	4,524	6,676	5,603
Debt/Equity Ratio	0.42	0.35	0.62	0.35	0.62	0.48
Change in Net Worth $	3,796	3,794	1,851	3,794	1,851	2,822
Growth at $						
5 Years	2,816	4,521	2,084	4,521	2,084	3,302
10 Years	5,490	6,424	4,145	6,424	4,145	5,284
15 Years	4,302	4,298	2,569	4,298	2,569	3,433
20 Years	3,996	3,994	1,948	3,994	1,948	2,971

1978. Net farm worth ranged from a minimum of \$66,145 in 1965 to a maximum of \$143,923 in 1983 with an overall mean of \$110,880.

A similar pattern of behaviour and rationale for interyear changes were found in treatments 10, 11 and 12 (Tables D.40-D.42). As was expected individual values varied. In treatment 10, the range of values were from \$62,491 in 1972 to \$110,594 in 1982 and a mean value of \$91,856. The comparative values for treatments 11 and 12 were \$66.145 in 1965 to \$143,923 in 1983 and a mean of \$110,879. Treatment 12 had a range from \$62,491 to a maximum of \$110,594 in 1982 and a mean of \$91,817.

The cash rental land control together with a rate of return on productive inputs equal to the interest charged by the Farm Credit Corporation of Canada and with a constrained debt structure of short term debt to long term debt produced a higher maximum and greater mean net worth than when the debt structure constraint is medium term debt/long term debt. The differences were a 38 percent higher maximum and 21 percent higher mean. The attained financial growth averaged 105 percent higher with the STD/LTD constraint.

Cash rental land control with a rate of return on productive assets equal to the inflation rate in combination with a short term debt/long term debt constraint debt structure attains a higher level of net worth, \$143,923 and greater mean, \$110,879 than when the debt structure constraint is medium term debt/long term debt. The corresponding values were \$110,594 and \$91,817.

Cash rental land control with either a debt structure constraint and in combination with either rate of return on productive assets have no effects on net farm worth attainment.

Tables 37-41 presents summaries of net farm income, net cash flow and net worth for Base 3 and treatments 9-12. Table 42 provides the summary of net wroth results for Scenario 3, treatments 9-12 and Figure 19 shows the data graphically.

TABLE 37

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR BASE

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	857.78	0.0	15753.93	0.0	66145.12	0.0
1966	12606.06	11748.28	2364.11	-13389.82	78159.25	12014.12
1967	10153.41	-2452.64	4573.27	2209.16	86129.87	7970.62
1968	12216.75	2063.33	17710.50	13137.23	87348.25	1218.37
1969	11650.67	-566.07	18196.84	486.34	77408.56	-9939.69
5 YR AVG	9496.93	2698.22	11719.73	610.73	79038.19	2815.86
1970	10229.71	-1420.96	7142.12	-11054.71	72347.50	-5061.06
1971	26372.80	16143.09	19185.81	12043.69	37292.25	-35055.25
1972	58429.90	32057.10	56511.50	37325.69	34340.25	-2952.00
1973	204950.25	146520.31	190234.37	133722.87	116351.19	82010.94
1974	143182.00	-61768.25	139666.19	-50568.19	219276.94	102925.75
5 YR AVG	88632.87	26306.25	82548.00	24293.86	95921.62	28373.67
10 YR AVG	49064.92	15813.79	47133.86	13768.02	87479.87	17014.64
1975	182339.31	39157.31	169650.81	29984.62	244619.19	25342.25
1976	201501.44	19162.12	213695.75	44044.94	245802.62	1183.44
1977	294930.75	93429.31	276124.69	62428.94	260723.56	14920.94
1978	304547.87	9617.12	279420.44	3295.75	276883.00	16159.44
1979	239461.44	-65086.44	243340.87	-36079.56	291951.12	15068.12
5 YR AVG	244556.00	19255.89	236446.37	20734.94	263995.75	14534.84
15 YR AVG	114228.56	17043.11	110238.00	16256.20	146318.50	16129.00
1980	245344.44	5883.00	222252.56	-21088.31	309937.94	17986.81
1981	263792.00	18447.56	244111.19	21858.62	325510.62	15572.69
1982	288264.31	24472.31	272586.12	28474.94	342481.62	16971.00
1983	311241.06	22976.75	299651.06	27064.94	349712.94	7231.31
1984	322434.69	11193.62	197410.12	-102240.94	357717.94	8005.00
5 YR AVG	286215.00	16594.65	247202.19	-9186.15	337072.00	13153.36
20 YR AVG	157225.19	16925.09	144479.00	9560.85	194006.87	15345.94
STD DEV	125133.25		113038.62		118739.19	
STD ERR	27980.64		25276.21		26550.89	
C. V.	0.80		0.78		0.61	
MINIMUM	857.78		2364.11		34340.25	
MAXIMUM	322434.69		299651.06		357717.94	

TABLE 38

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 9

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	8177.30	0.0	15622.18	0.0	66145.12	0.0
1966	20393.77	12216.47	1120.09	-14502.09	77755.87	11610.75
1967	19819.20	-574.57	2356.44	1236.35	88282.75	10526.87
1968	22297.11	2477.91	15200.28	12843.84	92055.56	3772.81
1969	21455.36	-841.75	15523.52	323.25	84228.56	-7827.00
5 YR AVG	18428.52	3319.52	9964.50	-24.66	81693.56	4520.86
1970	20597.24	-858.12	5068.94	-10454.59	80926.25	-3302.31
1971	35889.99	15292.75	17768.75	12699.81	84220.94	3294.69
1972	66778.62	30888.64	55687.44	37918.69	81688.81	-2532.12
1973	214620.19	147841.56	191889.50	136202.06	103311.50	21622.69
1974	156410.75	-58209.44	141433.00	-50456.50	123955.75	20644.25
5 YR AVG	98859.31	26991.07	82369.50	25181.89	94820.62	7945.44
10 YR AVG	58643.94	16470.38	46167.01	13978.97	88257.06	6423.40
1975	196903.06	40492.31	171389.87	29956.87	129254.19	5298.44
1976	217482.56	20579.50	215405.37	44015.50	120544.56	-8709.62
1977	311280.94	93798.37	277826.87	62421.50	125361.87	4817.31
1978	320552.50	9271.56	281130.06	3303.19	131300.00	5938.12
1979	257229.94	-63322.56	245013.69	-36116.37	126315.87	-4984.12
5 YR AVG	260689.75	20163.84	238153.00	20716.14	126555.25	472.02
15 YR AVG	125992.50	17789.47	110162.31	16385.10	101023.12	4297.91
1980	263442.75	6212.81	221868.75	-23144.94	133483.62	7167.75
1981	282526.50	19083.75	243714.25	21845.50	139791.19	6307.56
1982	307882.19	25355.69	272170.94	28456.69	143024.81	3233.62
1983	332145.81	24263.62	299209.19	27038.25	143922.94	898.12
1984	344348.75	12202.94	196947.25	-102261.94	142023.31	-1899.62
5 YR AVG	306069.00	17423.76	246782.00	-9613.29	140449.12	3141.49
20 YR AVG	171011.62	17693.23	144317.25	9543.42	110879.56	3993.59
STD DEV	129458.00		114128.50		26257.61	
STD ERR	28947.69		25519.91		5871.38	
C. V.	0.76		0.79		0.24	
MINIMUM	8177.30		1120.09		66145.12	
MAXIMUM	344348.75		299209.19		143922.94	

TABLE 39

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 10

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	8177.30	0.0	15622.18	0.0	66145.12	0.0
1966	20294.66	12117.36	1414.30	-14207.87	77364.62	11219.50
1967	19696.62	-598.04	5817.81	4403.51	84843.31	7478.69
1968	21982.95	2286.33	18902.39	13084.57	85534.56	691.25
1969	20889.73	-1093.22	18866.11	-36.28	74484.50	-11050.06
5 YR AVG	18208.23	3178.11	12124.55	810.98	77674.37	2084.84
1970	19720.83	-1168.90	8462.56	-10403.55	67472.19	-7012.31
1971	34720.58	14999.75	19681.00	11218.44	68079.37	607.19
1972	65424.06	30703.48	56947.44	37266.44	62491.06	-5588.31
1973	213110.12	147686.06	191209.56	134262.12	83482.06	20991.00
1974	154895.94	-58214.19	140622.00	-50587.56	103454.12	19972.06
5 YR AVG	97574.25	26801.23	83384.50	24351.17	76995.75	5793.92
10 YR AVG	57891.27	16302.06	47754.53	13888.86	77335.06	4145.44
1975	195352.75	40456.81	169614.06	28992.06	108988.94	5534.81
1976	215938.25	20585.50	213703.44	44089.37	100469.19	-8519.75
1977	309606.44	93668.19	277252.62	63549.19	104089.50	3620.31
1978	318768.25	9161.81	280294.31	3041.69	109044.31	4954.81
1979	255334.81	-63433.44	245109.25	-35185.06	102109.31	-6935.00
5 YR AVG	259000.00	20087.77	237194.56	20897.45	104940.25	-268.96
15 YR AVG	124927.44	17654.10	110901.19	16391.93	86536.75	2568.87
1980	261248.69	5913.87	222534.69	-22574.56	106462.81	4353.50
1981	280088.81	18840.12	244055.37	21520.69	110042.62	3579.81
1982	305188.94	25100.12	272119.81	28064.44	110594.44	551.81
1983	329169.12	23980.19	298972.56	26852.75	108814.62	-1779.81
1984	341048.56	11879.44	197281.25	-101691.31	103165.31	-5649.31
5 YR AVG	303348.56	17142.75	246992.56	-9565.60	107815.94	211.20
20 YR AVG	169532.75	17519.54	144924.00	9561.00	91856.50	1948.43
STD DEV	128596.81		112941.25		17347.01	
STD ERR	28755.12		25254.43		3878.91	
C. V.	0.76		0.78		0.19	
MINIMUM	8177.30		1414.30		62491.06	
MAXIMUM	341048.56		298972.56		110594.44	

Table 40

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 11

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm worth
1965	7580.89	0.0	15632.91	0.0	66145.12	0.0
1966	24942.16	17361.27	1025.16	-14607.75	77755.87	11610.75
1967	20657.16	-4285.00	2338.95	1313.79	88282.75	10526.87
1968	19580.01	-1077.15	15256.99	12918.04	92055.56	3772.81
1969	20388.04	808.03	15545.80	288.81	84228.56	-7827.00
5 YR AVG	18629.64	3201.79	9959.96	-21.78	81693.56	4520.86
1970	13281.89	-7106.16	5221.62	-10324.18	80926.25	-3302.31
1971	34849.84	21567.95	17790.44	12568.81	84220.94	3294.69
1972	74018.94	39169.10	55536.31	37745.87	81688.81	-2532.12
1973	239224.62	165205.69	191376.00	135839.69	103311.50	21622.69
1974	202800.94	-36423.69	140464.81	-50911.19	123955.75	20644.25
5 YR AVG	112835.19	36482.57	82077.81	24983.80	94820.62	7945.44
10 YR AVG	65732.44	21691.11	46018.89	13870.21	88257.06	6423.40
1975	208047.25	5246.31	171157.31	30692.50	129254.19	5298.44
1976	228348.94	20301.69	215178.56	44021.25	120544.56	-8709.62
1977	321774.62	93425.69	277607.87	62429.31	125361.87	4817.31
1978	331589.50	9814.87	280899.69	3291.81	131300.00	5938.12
1979	267727.37	-63862.12	244794.62	-36105.06	126315.87	-4984.12
5 YR AVG	271497.37	12985.29	237927.56	20865.96	126555.25	472.02
15 YR AVG	134320.69	18581.89	109988.37	16368.69	101023.12	4297.91
1980	273730.81	6003.44	221654.00	-23140.62	133483.62	7167.75
1981	292692.81	18962.00	243502.06	21848.06	139791.19	6307.56
1982	318038.06	25345.25	271959.00	28456.94	143024.81	3233.62
1983	342462.75	24424.69	298993.87	27034.87	143922.94	898.12
1984	354650.81	12188.06	196732.25	-102261.62	142023.31	-1899.62
5 YR AVG	316314.75	17384.69	246568.19	-9612.47	140449.12	3141.49
20 YR AVG	179819.25	18266.83	144133.31	9531.54	110879.56	3993.59
STD DEV	134913.19		114016.87		26257.61	
STD ERR	30167.51		25494.95		5871.38	
C. V.	0.75		0.79		0.24	
MINIMUM	7580.89		1025.16		66145.12	
MAXIMUM	354650.81		298993.87		143922.94	

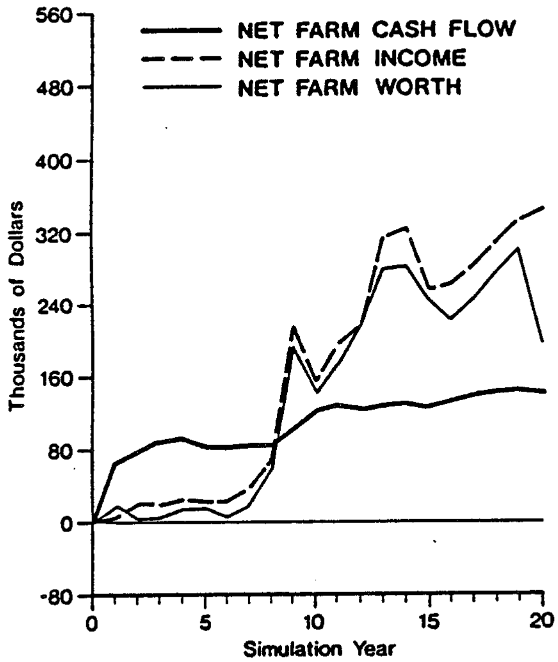
TABLE 41

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 12

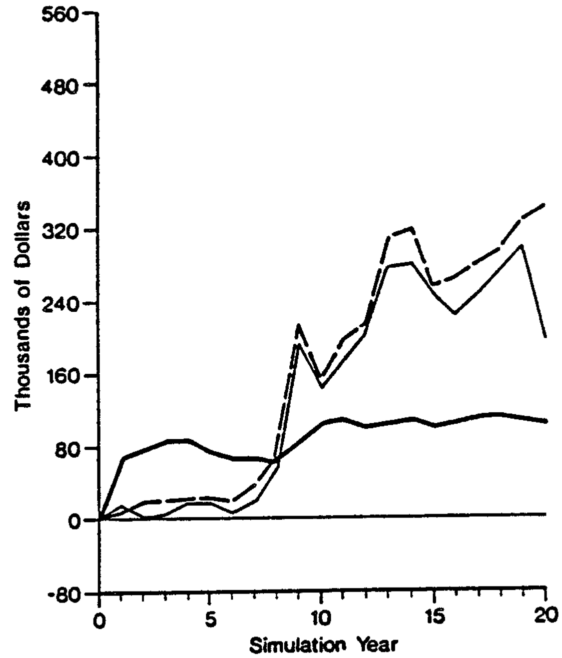
Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	7580.89	0.0	15632.91	0.0	66145.12	0.0
1966	24843.05	17262.16	1905.05	-13727.86	76779.00	10633.87
1967	20499.45	-4343.60	5381.18	3476.13	84642.37	7863.37
1968	19253.80	-1245.65	18539.47	13158.29	85534.56	892.19
1969	19822.41	568.62	18888.39	348.92	74484.50	-11050.06
5 YR AVG	18399.91	3060.38	12069.39	813.87	77517.06	2084.84
1970	12405.48	-7416.94	8615.20	-10273.18	67472.19	-7012.31
1971	33680.43	21274.95	19702.75	11087.55	68079.37	607.19
1972	72664.37	38983.95	56796.31	37093.56	62491.06	-5588.31
1973	237714.56	165050.19	190696.00	133899.69	83482.06	20991.00
1974	201286.12	-36428.44	139653.81	-51042.19	103454.12	19972.06
5 YR AVG	111550.19	36292.73	83092.81	24153.07	76995.75	5793.92
10 YR AVG	64975.05	21522.80	47581.10	13780.09	77256.44	4145.44
1975	206496.94	5210.81	169381.50	29727.69	108988.94	5534.81
1976	226804.62	20307.69	213476.62	44095.12	100469.19	-8519.75
1977	320100.12	93295.50	277033.56	63556.94	104089.50	3620.31
1978	329805.25	9705.12	280063.94	3030.37	109044.31	4954.81
1979	265832.25	-63973.00	244890.19	-35173.75	102109.31	-6935.00
5 YR AVG	269807.56	12909.22	236969.00	21047.27	104940.25	-268.96
15 YR AVG	133252.50	18446.52	110710.37	16375.51	86484.31	2568.87
1980	271536.75	5704.50	222319.94	-22570.25	106462.81	4353.50
1981	290255.12	18718.37	243843.25	21523.31	110042.62	3579.81
1982	315344.81	25089.69	271907.81	28064.56	110594.44	551.81
1983	339486.06	24141.25	298757.25	26849.44	108814.62	-1779.81
1984	351350.62	11864.56	197066.25	-101691.00	103165.31	-5649.31
5 YR AVG	313594.37	17103.67	246778.75	-9564.79	107815.94	211.20
20 YR AVG	178338.00	18093.14	144727.50	9549.12	91817.19	1948.43
STD DEV	134059.12		112843.50		17377.55	
STD ERR	29976.53		25232.57		3885.74	
C. V.	0.75		0.78		0.19	
MINIMUM	7580.89		1905.05		62491.06	
MAXIMUM	351350.62		298757.25		110594.44	

FIGURE 18

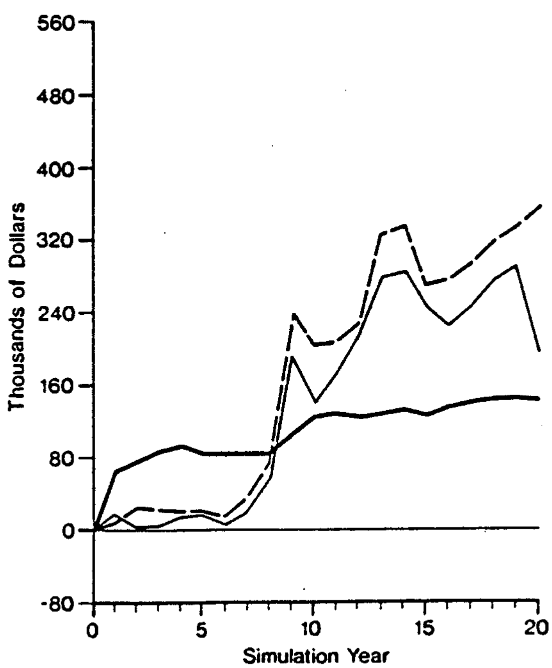
NET FARM CASH FLOW, NET FARM INCOME AND NET FARM WORTH FOR SCENARIO 3 (TREATMENTS 9-12)



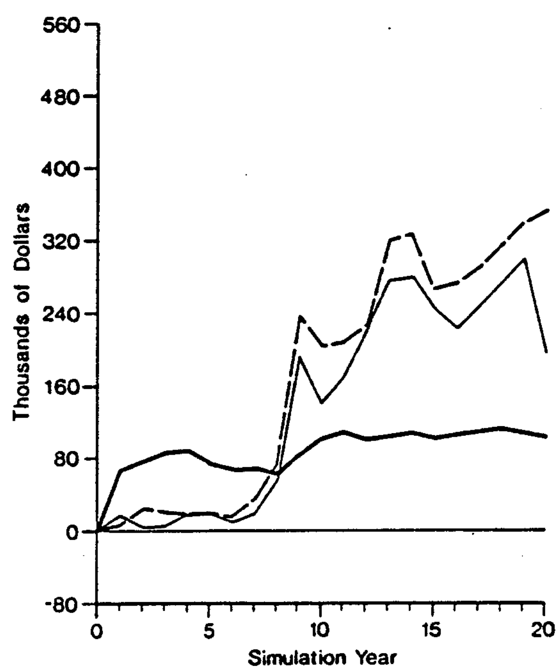
Treatment 9



Treatment 10



Treatment 11



Treatment 12

CHAPTER IX

ANALYSIS OF EXPERIMENTAL RESULTS - PART IV

SCENARIO IV - RESULTS AND DISCUSSIONS

Scenario 4 compares the total effects of share rental as a method of land control arrangement in combination with debt structure relationship and rate of return on productive assets on net farm income, net farm cash flow and net farm worth. The treatments in the scenario are as follows:

Treatment 13. Share rental land control arrangement by rate of return on productive assets equal to the interest charged farmers by the Farm Credit Corporation of Canada under the Farm Credit Act (FCAF) with a debt structure relationship equal to the ratio of short term debts to long term debts (STD/LTD).

Treatment 14. Share rental land control arrangement by rate of return on productive assets equal to the interest charged farmers by the Farm Credit Corporation of Canada under the Farm Credit Act (FCAF) with a debt structure relationship equal to the ratio of medium term debt to long term debt (MTD/LTD).

Treatment 15. Share rental land control arrangement (SR) by rate of return on productive assets equal to the annual rate of inflation as reflected by the Consumer Price Index (IR) and a debt structure relationship equal to short term debts/long term debts (STD/LTD).

Treatment 16. Share rental land control arrangement (SR) by rate of return on productive assets equal to the annual rate of inflation as reflected by the consumer price index (IR) and a debt structure relationship of medium term debt to long term debt (MTD/LTD).

Net Farm Income

The farm cash income statement for the base is shown in Table D.43. Showing the same behavioural trend over the twenty year simulation run, net farm income for the share rental base had a range in values from \$858 in 1965 to \$237,616 in 1984. The mean value was \$115,651 with a standard deviation of \$93,919, a standard error of \$21,001 and a coefficient of variation of 0.81. The spread and precision of the annual values and the mean are shown to be wide in the former and good in the latter. The variability of net farm income is in agreement with the pattern of net farm income behaviour in Manitoba and the Prairies. One example of change will be examined here to refresh the reasons for upward and downward movements in net farm income.

Net farm income increased from \$40,370 in 1972 to \$150,813 in 1973 then fell to \$103,916 in 1974. The increase of 274 percent followed by the decrease of 31 percent is reflective of the real world behaviour of net farm income due to the uncertainties of prices, yields, marketings and weather conditions. Farm receipts comprising crop sales amounted to \$121,016 in 1972 but increased to \$274,289 in 1973, an increase of 127 percent. The increase in farm receipts was due to the combination of increased share rental land increased prices and increased yields of crops.

The way the model allocates additional control land, that is, by how much each crop contributes to the profitability of the farm in the previous year, contributes to the crop receipts. Thus, the more wheat or flax seed contributes the more area will each be allocated and the more will be its contribution, especially if prices, yields and quantities marketed increase as the model trends indicate.

At the same time farm expenses increased by 62 percent. This increase was due to a 202 percent increase in cost of share renting but machinery, building and current operating expenses also increased by 7, 13, and 13 percent, respectively. The amount of expenses paid for interest declined by 12 percent simply because of the declining borrowing for land purchases. The declines in expenses stems partly from the fact that the model dictates a 33 percent contribution to variable expenses by the landlord of share rented area.

The combined effects of the increased receipts and increased but smaller farm expenses was an increase in net cash income of 235 percent. With depreciation declining by 9 percent and nonfarm income only increasing by $979 or 25 percent, net farm income increased. The financial strength and operational efficiency are revealed by the value of the quantity of funds in surplus for investment purposes. This averaged $103,269 over the twenty year run. The gross ratio averaged 0.61, implying that for every dollar of crop receipts, 61 cents went to pay for expenses and 39 cents were received as net farm income. The capital turnover ratio averaged 1.44 suggesting that for each dollar invested, $1.44 of crop receipts were generated. The rate of return on capital averaged 0.71, that is, the return on investment was 71 cents. The average growth in net farm income over the twenty year run was $12,461.

In treatment 13 (Table D.44) net farm income increased from $8,177 in 1965 to $259,531 in 1984 and showed an overall mean net farm income over the twenty year run of $129,467. Despite this generally increasing tendency, however, declining but positive changes occurred inter yearly. Thus, in 1967, 1969, 1970, 1974 and 1979 declines in net farm income were observed; in other years increases were generated. As was done in previous discussions an example of an interyear decline and one of increase will be examined in order to illustrate the tabular values.

In 1974, net farm income declined by 27 percent from 1973, a net change of $43,375. As has been repeatedly illustrated this was due to changes in the component variables from which net farm income is derived.

Total farm receipts in 1974 was 19 percent less than its value in 1973 due to changes in prices, yields, marketing and mix of crops grown. At the same time, total farm expenses only declined 8 percent resulting in a net cash income that was 28 percent less than in 1973. Although, non farm income increased by 31 percent, change in inventory declined by $818, 148 percent, and depreciation increased by 81 percent. These changes culminated in the decline in net farm income.

In 1977, net farm income increased by 44 percent above 1976. The table reveals that farm receipts increased by 30 percent and farm expenses by 19 percent resulting in a net cash income that was 40 percent higher in 1973. Nonfarm income increased by 5 percent, change in value of inventory increased and total depreciation declined by 39 percent. At the same time the quantity borrowed declined 80 percent reflecting a substantial drop in interest costs.

Treatment 14 (Table D.45) showed that ~~net~~ farm income like the behaviour in treatment 13, typified the behaviour of the general model both in terms of increasing tendency punctuated by some years of declines satisfactorily explained. It ranged from a minimum of $8,117 to a maximum of $256,231 in 1962 and a mean over twenty year of $127,989.

The five yearly means show that net farm income, on average, have increased. The largest increase occurred between the first two five-year periods. The average mean growth values indicate that after ten years the average rate of growth was $12,107, significantly higher than the value after five years. The value after fifteen years was almost identical to that after twenty years.

For treatment 15 (Table D.46) net farm income ranged from a minimum of $7,581 to a maximum of $269,836 in 1984. The twenty year mean for the run was $138,251. The comparative figures for treatment 16 (Table D. 47) were $7,581 to a maximum of $266,533 and an overall mean of $136,791.

The mean net farm income values progressively increased from $15,031 in treatment 15 and $14,801 in treatment 16 to $87,152 and $85,909. After the first five-years $87,152 for treatment 15 and $85,909 for treatment 16 after the second five-year period to $207,713 (treatment 15) and $206,061 (treatment 16), after the third five-year period to $243,107 (treatment 15) and $240,392 (treatment 16).

An examination of the mean attained growth at five yearly intervals reveals that the average growth in income after five years was much less than those at the end of successive five-year periods. Thus, at the end of ten-years the average growth was $17,230 for treatment 15 and $17,159 for treatment 16. However, it was also revealed that the average growth after fifteen and twenty years remained essentially the same.

Net Farm Income Summary

Table 45 summarizes the situation for the scenario. All treatments were better than the base in terms of maximum net farm income attained, the highest mean achieved, the highest mean growth, and rate of return on capital. All treatments experienced the same capital turnover ratio as the base but the gross ratio for the base while equal to those treatments 14 and 16 was greater than those of treatments 13 and 15. Treatment 15 - share rental with IR and STD/LTD was the most superior. Treatment 16 - share rent with IR and MTD/LTD was next, followed by treatment 13 - share rent with FCAF and STD/LTD, treatment 14 - share rent with FCAF and MTD/LTD. The base performed the worst.

Share rent land control in combination with the inflation rate as the rate of return on productive assets and either debt structure ratio outperformed share rent in combination with the rate of return equal to the interest charged by the Farm Credit Corporation and either debt structure ratio. Share rent in combination with FCAF produced better net farm income in association with a debt structure of STD/LTD than with MTD/LTD. Share rent with rate of return equal to FCAF did better in combination with STD/LTD than with MTD/LTD.

TABLE 42

SUMMARY NET FARM INCOME COMPARISONS FOR SCENARIO 4

	Treatment					Mean
	Base 4	13	14	15	16	
Minimum $	858(65)	8,177(65)	8,177(65)	7,581(65)	7,581(65)	7,879
Maximum $	237,616(84)	25,953(84)	256,231(84	269,836(84)	266,533(84)	257,554
Means						
Five Years $						
1	5,881	14,830	14,610	15,031	14,801	14,818
2	62,912	73,235	71,950	87,152	85,909	79,561
3	180,800	196,939	195,249	207,713	206,061	201,490
4	213,012	232,866	230,146	243,107	240,392	236,627
Ten Years $						
1	34,396	44,032	43,280	51,092	50,355	47,190
2	196,906	214,902	212,697	225,410	223,226	219,059
Twenty Years $	115,651	129,467	127,989	138,251	136,791	133,124
S.D.	93,919	98,215	97,356	103,742	102,899	100,553
S.E.	21,001	21,962	21,769	23,197	23,009	22,484
C.V.	0.81	0.76	0.76	0.75	0.75	0.75
Growth at $						
5 Years	1,185	1,828	1,687	1,711	1,569	1,699
10 Years	11,451	12,107	11,939	17,320	17,159	14,631
15 Years	12,534	13,282	13,145	14,071	13,937	13,609
20 Years	12,461	13,231	13,055	13,803	13,629	13,429
Gross Ratio	0.61	0.60	0.61	0.60	0.61	0.60
Capital Turnover	1.44	1.44	1.44	1.44	1.44	1.44
Rate of Return on Capital	0.71	0.80	0.80	0.85	0.85	0.82

Net Cash Flow

Table D.48 shows the farm cash flow statement for the base. The net cash flow for this share rent base showed wide variability as did the other bases discussed previously and supports the observation that net cash flow is very variable and more so than both net farm income and net farm worth. The values ranged from $446 in 1966 to $241,891 in 1984. The twenty year mean was $111,690 with a standard deviation of $89,498, a standard error of $20,012 and a coefficient of variation of 0.81. The overall mean growth in net cash flow was $11,902.

Throughout the twenty years of run, patterns of behaviour reflect what has become the normal behaviour of upward and downward movements partly explainable by the conditions of production and marketing and their effects on the component variables of the net cash flow system of equations. Thus, changes in net cash flow are dependent on the cash inflow - cash outflow relationships. In addition, total inflow depends on the direction and magnitude of value of crop sales, amount of money borrowed, off farm income, and other income. Total outflow depends on the direction and magnitude of share rent, expenses, interest paid on farm debts, principle paid on loans and investment income.

In this base where share rent is the form of land control one would expect that share rent will be the most formidable variable on the expenses side and ultimately in the whole farm financial situation, interest paid on debts will be less than in the case of full ownership, and dependent on the efficiency of the farm, less than in the case of cash rental. For example, net cash flow was $138,183 in 1973 but was $38,839 in 1972. In 1974, it was $103,269. Total inflow in 1972 was

\$130,437 but rose by 114 percent in 1973. This increase was due to a 126 percent increase in value of crop sales but a 77 percent decrease in amount borrowed. Total outflow, on the other hand, increased but only by 55 percent. Of this share rent increase by 202 percent between 1972 and 1973. Interest paid on farm debts declined by 12 percent, principle paid on loan declined by 6 percent and expenses increased by 11 percent over 1972.

In 1974, net cash flow fell by 25 percent due to a 15 percent fall in inflow combined with a 5 percent decline in outflow. Share rent cost declined by 27 percent as the crop sales on which it is dependent falls. Similar behaviour and rationale apply to treatments 13-16.

The net cash flow for all experiments in this scenario are expected to replicate the general behaviour shown by the model as ramified in earlier discussions. The extent of the behaviour is expected to vary as different contributory factors impact differently on share rental as compared to other land procurement measures. The expected generally increasing tendency with interyear declining situations of both positive and negative dimensions are again shown. It should also be expected that net cash flow values being tied closely to net farm income, will exhibit essentially the same type of changes and at roughly the same time though of different magnitude to that of net farm income.

In treatment 13 (Table D.49), net cash flow ranges from -\$1,226 in 1967 to \$241,428 in 1984, with a twenty year mean of \$111,653. This wide range shows tremendous variation and emphasizes the volatile nature of the variables that contribute to the net cash flow. A similar situation was identified for the net farm income earlier and will be discussed in more detail a little later. The enhanced volalitily of net farm cash flow is reflected in the negative values especially in the early years. These imply an inability of the business to meet its costs and under normal circumstances means bankruptcy and failure to survive.

Although, net cash flow declined in 1966, 1967, 1970, 1974 and 1979, only in 1966 and 1967 were values of net cash flow negative. In the absence of savings (surplus) to tide over the business, the firm will not survive. However, having credit availability allowed the firm to survive the adverse years and turn the business into a successful long term operation.

Net cash flow fell from \$15,622 in 1965 to -\$798 in 1966 and even lower to \$1,226 in 1967. Thereafter, net cash flow increased and although it dropped significantly in 1970, it was still positive and continued to show strong cash flow performance for the rest of the run.

Total inflow declined by 20 percent while total outflow increased by 18 percent in 1966 below 1965. In 1967, total inflow was 9 percent below its 1965 value while total outflow was 36 percent greater over the two year period. A closer look at the components of total inflow and outflow serves to explain the changes. The major components of inflow are crop sales, machinery sales, nonfarm income and amount borrowed. The decrease in inflow was primarily due to the decline in borrowing from \$21,294 in 1965 to \$1,500 in 1966 to zero in 1967. At the same time, however, crop sales were not increasing that significantly nor was nonfarm come to compensate for the decline.

Meanwhile, as a result of the earlier borrowing to acquire machinery and implement, the interest paid on farm debts and principal paid continued. Additionally, as share rental procurement increased, the share rental cost increased as were all crops, buildings and machinery expenses. The net result of all the above was negatively recorded net cash flow. Bankruptcy was avoided by use of surplus.

The contrary behaviour in net cash flow is exemplified by the change between 1972 and 1973. Net cash flow increased by 250 percent in that period. Total inflow grew by 114 percent primarily due to increased crop sales while total outflow grew by 54 percent, relatively much less than the increase in total outflow.

The five year average net cash flow shown in Table 44 highlight the growing strength in the operation of the business. Whereas the first five-year average was only $7,066 again reflecting the early struggle to keep the farm operation going, the second shows a growing process culminating in a period of very rapid growth reflected by the third five-year mean and finally essentially one of consolidation and maturity. The mean growth at five year intervals shown in the table also reflected this pattern. Thus, at the end of five years, the average growth in net cash flow was still a negative value. As the farm operation expanded and management became efficient, the average growth was $9,935 at the end of ten years. The average growth for fifteen years was $12,130 and $11,885 at the end of twenty years, once again reflecting that fully operative business.

Essentially, the same patterns are exhibited by treatments 14, 15 and 16 (Tables D.50-D.52), though the magnitudes vary. The net cash flow

TABLE 43

SUMMARY NET CASH FLOW COMPARISONS FOR SCENARIO 4

	Treatment					Mean
	Base 4	13	14	15	16	
Minimum $	446(66)	-1,226(67)	504(66)	-1,244(67)	-13(66)	-495
Maximum $	241,891(84)	241,428(84)	241,762(84)	241,183(84)	241,547(84)	241,480
Means						
Five Years $						
1	9,129	7,066	9,226	7,062	9,171	8,131
2	58,582	59,211	60,226	58,666	59,872	59,494
3	176,168	177,875	176,917	177,475	176,691	177,239
4	202,879	202,459	202,670	202,188	202,456	202,443
Ten Years $						
1	33,856	33,138	34,726	32,864	34,521	33,812
2	189,524	190,167	189,753	189,831	189,573	189,831
Twenty Years $	111,690	111,653	112,259	111,347	112,047	111,826
S.D.	89,498	90,483	89,337	90,205	89,216	89,810
S.E.	20,012	20,233	19,976	20,170	19,949	20,082
C.V.	0.80	0.81	0.80	0.81	0.80	0.80
Growth at $						
5 Years	-424	-1,140	-305	-1,138	-302	-721
10 Years	9,724	9,935	9,845	9,802	9,736	9,829
15 Years	12,001	12,130	12,136	12,105	12,120	12,123
20 Years	11,902	11,885	11,902	11,871	11,890	11,887

for treatment 14 ranged from $504 in 1966 to $241,762 in 1984, with a twenty year mean of $112,259; the range for treatment 15 was $1,244 in 1967 to $241,183 in 1984 and a twenty year mean of $111,347. Treatment 16 values of net cash flow ranged from -$13 in 1966 to $241,547 in 1984 and a twenty year mean of $112,047, table 44 refers.

The five yearly average net cash flow for treatments 14, 15 and 16 convey the same pattern of behaviour and similar type of information and the average growth in net cash flow at five, ten, fifteen and twenty years likewise emphasizing the same. The comparisons of the treatments will be presented in the scenario summary later.

There were very slight but insignificant differences between all treatments and base implying that the factors do not augment net cash flow.

Net Farm Worth

Table D.53 presents the farm worth statement for the base. The share rent base run had a range of values from $66,145 to $143,970, a mean of $106,504, a standard deviation of $28,740, a standard error of $6,427 and a coefficient of variation of 0.27. Net farm worth showed an average annual attained financial growth of $3,996. Despite inter-year variations, net farm worth continued an increasing trend throughout the experimental run. Changes during the years are caused by changes in the behaviour of the model but also reflect specific impacts of treatments on the component variables. Changes among treatments are mainly due to treatment differences.

For example, in 1966, net farm worth appreciated over 1965 by 16 percent due to a 6 percent increase in total assets and a 9 percent decrease in total liabilities. The increase in assets was due to a 24 percent increase in short term assets. The latter was mainly due to a 47 percent increase in value of crop in inventory. A 4 percent decline in medium term assets due to depreciation and a 6 percent increase in long term assets accompanied the increase in short term assets. The increase in value of long term assets reflect price increase for land showing up as a capital gain.

The decline in total liabilities resulted from a 33 percent decline in short term liabilities, a 10 percent decline in medium term debt and a 5 percent drop in long term liabilities.

Net farm worth showed less variability and more precision than net farm income and net cash flow. The debt/equity ratio indicates that for each dollar of equity the business carries 42 cents of debt.

The annual net farm worth of the four treatments comprising this scenario will be expected to conform to the behaviour depicted by the model and earlier displayed, described and explained in the validation scenario and in the discussion of the base. The major behavioural pattern include a generally continuously increasing function of time with less variability and more stability than both net farm income and net cash flow.

Tables D.54-D.57 reveals the values for net farm worth for treatments 13-16. For treatment 13, net farm worth ranges from \$66,145 in 1965 to \$143,925 in 1983 and a twenty year mean net farm worth of \$110,898. Of the twenty years, declines in net farm worth were found in 1969, 1970, 1972, 1976, 1979 and 1974. The reasons for these declines and, indeed, for increases are inextricably tied up to the assets and liabilities of the balance sheet. To the extent that total assets show a change reflecting values greater than total liabilities, to that extent will net farm worth be positive and vice versa.

The declines in net farm worth between years much less than those declines for net cash flow and net farm worth. In 1969, net farm worth dropped by 9 percent below its value in 1968. Looking at the value for total assets in the table,it is seen to have decreased by 4 percent in 1969 compared to 1968; at the same time, total liabilities were increasing by 9 percent. The net result of latter increase and former decrease was a 9 percent drop in net farm worth.

The table shows, likewise, that short term assets declined by 36 percent from 1968. This decline was the result of a seven-fold depletion in value of crops in inventory. The value of medium term assets, machinery and implements, increased by 21 percent while long term assets declined by 10 percent, due to a combination of value change.

Correspondingly, on the liabilities side, short term liabilities declined, medium term liabilities increased due to borrowing to acquire medium term assets and long term liabilities declined as payments are made. Increases in net farm worth reflect the contrary circumstances of opposing trends.

Net farm worth for treatment 13, as revealed by the five year averages, display increases up to the fourth five-year period. The rate of increase of the five-year means vary, however, with the mean rate between the first and second five-years being greater (16 percent more) than that between the third and fourth (11 percent more) but less than that between the second and third periods (34 percent).

The growth in net farm worth at five yearly intervals depict a similar theme. At the end of five years, the average growth was $4,520, while that at the end of ten years was 42 percent higher. After fifteen years, the average growth was 33 percent lower than that at the end of ten years. The mean growth in net farm worth at the end of twenty years was 7 percent less than that at the end of fifteen years.

The behavioural tendencies of treatments 14, 15 and 16 as expected, parallel those of treatment 13 with only magnitudinal differences. The net farm worth for treatment 14 ranged from $62,478 in 1972 to $110,597 in 1982 with a twenty year mean of $91,875. Treatment 15 had values of net farm worth ranging from $66,145 in 1965 to $143,964 in 1983, and a twenty year mean of $110,598.

Summary Scenario Analysis

All treatments attained lower levels of net farm worth and higher means than the base (Table 44). Treatment 15, share rent - rate of return on productive assets equal to the inflation rate - short term debt/long term debt relationship was the best; second was treatment 13, share rent land control - rate of return on productive assets euqal to FCAF - short term debt/long term debt structure. Treatment 13 was better than treatment 15 which was better than the base in terms of the means. The base was better than treatments 14 and 16. In terms of debt/equity treatment 13 was better than treatment 15, which was better than the base. The base was better than treatments 14 and 16.

Share rent land control with a rate of return equal to FCAF gives a higher level of net worth and a larger maximum with a debt structure relationship of short term debt/long term debt than with medium term

TABLE 44

SUMMARY NET FARM WORTH COMPARISONS FOR SCENARIO 4

	Treatment					Mean
	Base 4	13	14	15	16	
Minimum $	66,145(65)	66,145(65)	62,478(72)	66,145(65)	62,239(72)	64,251
Maximum $	143,970(83)	143,925(83)	110,597(82)	143,964(83)	110,597(82)	127,271
Means						
Five Years $						
1	78,072	81,698	77,678	81,697	77,521	79,648
2	84,381	94,833	77,008	93,966	76,821	85,657
3	123,066	126,613	104,997	126,288	104,997	115,724
4	140,499	140,451	107,818	140,442	107,818	124,132
Ten Years $						
1	81,227	88,265	77,343	87,831	77,171	82,652
2	131,783	133,532	106,407	133,365	106,407	119,928
Twenty Years $	106,504	110,898	91,875	110,598	91,789	101,290
S.D.	28,740	26,263	17,356	26,368	17,458	21,861
S.E.	6,427	5,873	3,881	5,896	3,904	4,888
C.V.	0.27	0.24	0.19	0.24	0.19	0.21
Current Ratio	4,516	4,535	6,706	755	5,838	4,458
Debt/Equity Ratio	0.42	0.35	0.62	0.36	0.62	0.49
Change in Net Worth $	3,796	3,794	1,851	3,796	1,851	2,823
Growth at $						
5 Years	2,409	4,520	2,096	4,520	2,083	3,305
10 Years	5,488	6,421	4,142	6,346	4,143	5,263
15 Years	4,302	4,298	2,569	4,287	2,569	3,431
20 Years	3,996	3,994	1,950	3,996	1,949	2,972

debt/long term debt. Better financial position is also given by the former. Similarly, share rent with an inflation rate as rate of return on productive assets performs better with STD/LTD than with MTD/LTD. The range in value for treatment 16 was $48,358, from a minimum of $110,597 in 1982 with an overall mean of $91,789.

Tables 45, 46, 47, 48 and 49 illustrate the summary net farm income, net cash flow and net farm worth for Base 4 and Treatments 13-16, respectively. Figure 20 illustrates the Scenario 4 situation, treatments 13-16, graphically,

TABLE 45

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR BASE

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	857.78	0.0	15753.93	0.0	66145.12	0.0
1966	10431.43	9573.66	446.00	-15307.93	76659.25	10514.12
1967	5868.52	-4562.91	990.46	544.46	85606.25	8947.00
1968	6645.98	777.46	14396.21	13405.75	86168.94	562.69
1969	5599.62	-1046.36	14058.89	-337.31	75780.44	-10388.50
5 YR AVG	5880.66	1185.46	9129.10	-423.76	78072.00	2408.83
1970	3575.88	-2023.74	2179.44	-11879.46	70460.81	-5319.62
1971	15883.75	12307.86	10440.12	8260.69	72297.69	1836.87
1972	40370.00	24486.25	38839.06	28398.94	70102.19	-2195.50
1973	150813.12	110443.12	138183.06	99344.00	93509.81	23407.62
1974	103916.12	-46897.00	103269.06	-34914.00	115537.00	22027.19
5 YR AVG	62911.77	19663.30	58582.15	17842.02	84381.50	7951.31
10 YR AVG	34396.22	11450.92	33855.62	9723.89	81226.75	5487.98
1975	133909.87	29993.75	123985.31	20716.25	122647.87	7110.87
1976	147403.37	13493.50	163179.69	39194.37	115169.56	-7478.31
1977	218665.19	71261.81	203562.06	40382.37	121703.50	6533.94
1978	227694.69	9029.50	206352.62	2790.56	129438.50	7735.00
1979	176328.69	-51366.00	183762.94	-22589.69	126371.81	-3066.69
5 YR AVG	180800.31	14482.51	176168.50	16098.77	123066.25	2166.96
15 YR AVG	83197.56	12533.63	81293.19	12000.64	95173.19	4301.91
1980	183066.25	6737.56	163533.25	-20229.69	133537.69	7165.87
1981	196567.44	13501.19	180577.69	17044.44	139842.87	6305.19
1982	215239.87	18672.44	203414.12	22836.44	143074.00	3231.12
1983	232570.25	17330.37	224979.81	21565.69	143970.19	896.19
1984	237616.44	5046.19	241891.25	16911.44	142068.25	-1901.94
5 YR AVG	213012.00	12257.55	202879.19	11625.66	140498.56	3139.29
20 YR AVG	115651.19	12460.98	111689.69	11901.96	106504.50	3995.95
STD DEV	93918.87		89497.62		28740.27	
STD ERR	21000.90		20012.28		6426.52	
C. V.	0.81		0.80		0.27	
MINIMUM	857.78		446.00		66145.12	
MAXIMUM	237616.44		241891.25		143970.19	

TABLE 46

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 13

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	8177.30	0.0	15622.18	0.0	66145.12	0.0
1966	18219.14	10041.85	-798.02	-16420.20	77755.87	11610.75
1967	15533.58	-2685.56	-1226.36	-428.33	88273.75	10517.87
1968	16728.96	1195.38	10673.80	11900.16	92088.37	3814.62
1969	15490.58	-1238.38	11059.37	385.57	84223.69	-7864.69
5 YR AVG	14829.91	1828.32	7066.19	-1140.70	81697.31	4519.64
1970	14074.59	-1415.99	370.37	-10689.00	80957.12	-3266.56
1971	25569.82	11495.23	9512.94	9142.56	84308.44	3351.31
1972	48868.44	23298.62	40208.06	30695.12	81676.19	-2632.25
1973	160518.06	111649.56	140926.44	100718.37	103288.81	21612.62
1974	117143.00	-43375.06	105035.94	-35890.50	123933.06	20644.25
5 YR AVG	73234.75	20330.46	59210.75	18795.31	94832.69	7941.87
10 YR AVG	44032.34	12107.28	33138.47	9934.86	88265.00	6420.88
1975	148501.44	31358.44	125723.81	20687.87	129567.37	5634.31
1976	163381.50	14880.06	164889.37	39165.56	120512.69	-9054.69
1977	235015.56	71634.06	205264.25	40374.87	125363.69	4851.00
1978	243699.50	8683.94	208062.25	2798.00	131302.12	5938.44
1979	194097.37	-49602.12	185435.75	-22626.50	126317.69	-4984.44
5 YR AVG	196939.06	15390.87	177875.06	16079.96	126612.69	476.92
15 YR AVG	95001.19	13279.99	81384.00	12129.54	101047.56	4298.04
1980	201164.81	7067.44	163149.50	-22286.25	133485.87	7168.19
1981	215302.19	14137.37	180180.75	17031.25	139793.50	6307.62
1982	234857.94	19555.75	202998.94	22818.19	143026.94	3233.44
1983	253475.31	18617.37	224537.94	21539.00	143925.50	898.56
1984	259530.81	6055.50	241428.37	16890.44	142025.87	-1899.62
5 YR AVG	232866.19	13086.69	202459.06	11198.52	140451.50	3141.64
20 YR AVG	129467.44	13229.12	111652.75	11884.54	110898.50	3993.72
STD DEV	98215.50		90483.00		26262.91	
STD ERR	21961.65		20232.61		5872.57	
C. V.	0.76		0.81		0.24	
MINIMUM	8177.30		-1226.36		66145.12	
MAXIMUM	259530.81		241428.37		143925.50	

TABLE 47

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 14

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	8177.30	0.0	15622.18	0.0	66145.12	0.0
1966	18120.04	9942.74	-503.80	-16125.98	77364.62	11219.50
1967	15411.01	-2709.03	2235.02	2738.82	84834.31	7469.69
1968	16414.81	1003.80	14375.91	12140.89	85567.37	733.06
1969	14924.95	-1489.86	14401.96	26.05	74479.62	-11087.75
5 YR AVG	14609.61	1686.91	9226.25	-305.05	77678.19	2083.62
1970	13198.18	-1726.77	3763.94	-10638.02	67503.06	-6976.56
1971	24400.45	11202.27	11425.12	7661.19	68166.87	663.81
1972	47513.88	23113.43	41468.12	30043.00	62478.44	-5688.44
1973	159008.00	111494.06	140246.50	98778.37	83459.37	20980.94
1974	115628.19	-43379.81	104224.94	-36021.56	103431.44	19972.06
5 YR AVG	71949.69	20140.62	60225.72	17964.59	77007.81	5790.36
10 YR AVG	43279.67	11938.97	34725.98	9844.74	77343.00	4142.92
1975	146951.12	31322.94	123948.00	19723.06	109302.12	5870.69
1976	161837.19	14886.06	163187.44	39239.44	100437.31	-8864.81
1977	233341.06	71503.87	204689.94	41502.50	104091.31	3654.00
1978	241915.25	8574.19	207226.50	2536.56	109046.44	4955.12
1979	192202.25	-49713.00	185531.31	-21695.19	102111.12	-6935.31
5 YR AVG	195249.37	15314.81	176916.62	16261.27	104997.62	-264.06
15 YR AVG	93936.19	13144.63	82122.81	12136.36	86561.19	2569.00
1980	198970.75	6768.50	163815.37	-21715.94	106465.06	4353.94
1981	212864.50	13893.75	180521.87	16706.50	110044.94	3579.87
1982	232164.69	19300.19	202947.75	22425.87	110596.56	551.62
1983	250498.62	18333.94	224301.31	21353.56	108817.19	-1779.37
1984	256230.62	5732.00	241762.44	17461.12	103167.87	-5649.31
5 YR AVG	230145.75	12805.67	202669.75	11246.22	107818.31	211.35
20 YR AVG	127988.56	13055.43	112259.50	11902.11	91875.44	1948.57
STD DEV	97356.19		89337.37		17355.55	
STD ERR	21769.50		19976.45		3880.82	
C. V.	0.76		0.80		0.19	
MINIMUM	8177.30		-503.80		62478.44	
MAXIMUM	256230.62		241762.44		110596.56	

TABLE 48

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 15

Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	7580.89	0.0	15632.91	0.0	66145.12	0.0
1966	22767.54	15186.64	-892.95	-16525.86	77755.87	11610.75
1967	16371.49	-6396.05	-1243.84	-350.89	88273.75	10517.87
1968	14011.15	-2360.34	10730.52	11974.37	92088.37	3814.62
1969	14423.31	412.16	11081.69	351.16	84223.69	-7864.69
5 YR AVG	15030.86	1710.60	7061.66	-1137.81	81697.31	4519.64
1970	6757.24	-7666.07	523.06	-10558.62	80957.12	-3266.56
1971	24528.87	17771.63	11034.69	10511.62	82808.44	1851.31
1972	55997.80	31468.93	40040.94	29006.25	80337.31	-2471.12
1973	185016.56	129018.75	137879.12	97838.19	102469.56	22132.25
1974	163461.81	-21554.75	103850.62	-34028.50	123261.31	20791.75
5 YR AVG	87152.44	29807.69	58665.69	18553.79	93966.75	7807.52
10 YR AVG	51091.66	17320.09	32863.67	9801.96	87832.00	6346.24
1975	159611.37	-3850.44	125228.75	21378.12	129041.25	5779.94
1976	174199.44	14588.06	164468.06	39239.31	120103.06	-8938.19
1977	245472.81	71273.37	204876.37	40408.31	125055.00	4951.94
1978	254708.69	9235.87	207696.25	2819.87	131078.00	6023.00
1979	204574.31	-50134.37	185105.69	-22590.56	126165.37	-4912.62
5 YR AVG	207713.31	8222.50	177475.00	16251.01	126288.50	580.81
15 YR AVG	103298.81	14070.95	81067.37	12105.20	100650.81	4287.16
1980	211438.56	6864.25	162845.87	-22259.81	133394.12	7228.75
1981	225459.50	14020.94	179898.06	17052.19	139752.87	6358.75
1982	245009.44	19549.94	202732.31	22834.25	143029.44	3276.56
1983	263791.62	18782.19	224281.37	21549.06	143964.31	934.87
1984	269835.56	6043.94	241183.19	16901.81	142067.69	-1896.62
5 YR AVG	243106.75	13052.25	202188.12	11215.50	140441.69	3180.46
20 YR AVG	138250.81	13802.87	111347.50	11871.06	110598.50	3995.92
STD DEV	103742.00		90204.81		26368.42	
STD ERR	23197.42		20170.41		5896.16	
C. V.	0.75		0.81		0.24	
MINIMUM	6757.24		-1243.84		66145.12	
MAXIMUM	269835.56		241183.19		143964.31	

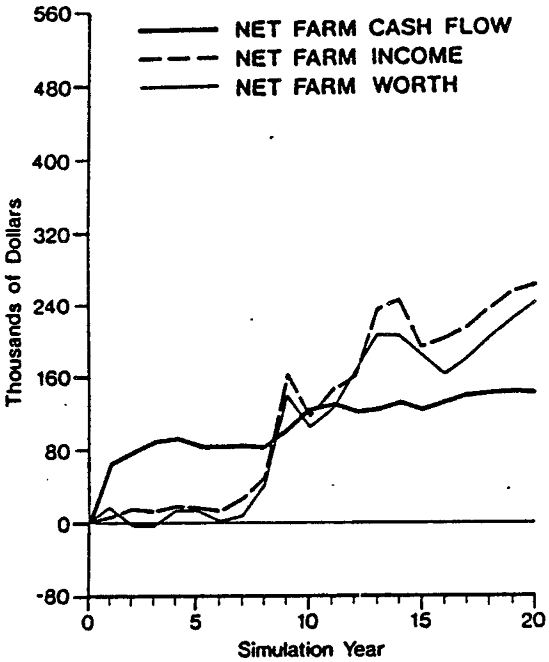
TABLE 49

SUMMARY NET FARM INCOME, NET CASH FLOW AND NET FARM WORTH FOR TREATMENT 16

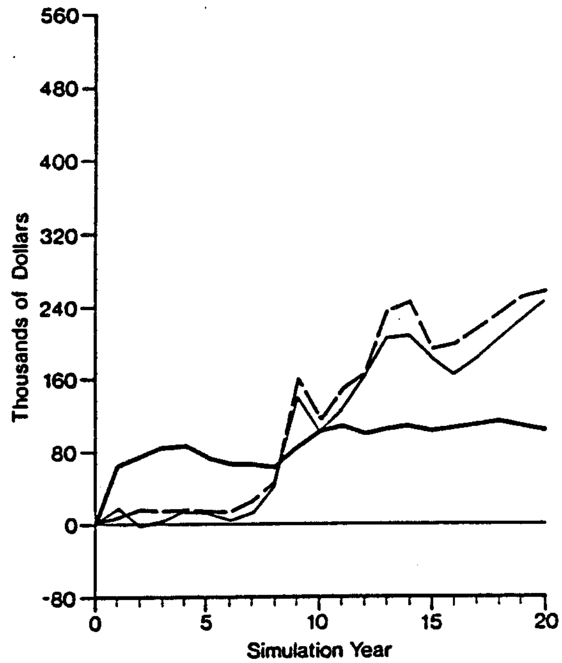
Simulation Year	Net Farm Income	Annual Change in Net Farm Income	Net Cash Flow	Annual Change in Net Cash Flow	Net Farm Worth	Annual Change in Net Farm Worth
1965	7580.89	0.0	15632.91	0.0	66145.12	0.0
1966	22668.43	15087.54	-13.06	-15645.97	76779.00	10633.87
1967	16213.77	-6454.65	1798.39	1811.45	84633.37	7854.37
1968	13684.93	-2528.84	14013.00	12214.61	85567.37	934.00
1969	13857.68	172.75	14424.23	411.23	74479.62	-11087.75
5 YR AVG	14801.14	1569.20	9171.09	-302.17	77520.87	2083.62
1970	5880.83	-7976.85	3916.69	-10507.54	67503.06	-6976.56
1971	23359.50	17478.67	12140.44	8223.75	67473.37	-29.69
1972	54704.24	31344.74	40814.56	28674.12	62239.31	-5234.07
1973	183591.19	128886.94	139229.94	98415.37	83459.37	21220.07
1974	162011.50	-21579.69	103256.87	-35973.06	103431.44	19972.06
5 YR AVG	85909.44	29630.75	59871.70	17766.52	76821.25	5790.36
10 YR AVG	50355.29	17158.94	34521.39	9735.99	77171.06	4142.92
1975	158117.44	-3894.06	123714.94	20458.06	109302.12	5870.69
1976	172701.44	14584.00	162960.69	39245.75	100437.31	-8864.81
1977	243834.81	71133.37	204470.94	41510.25	104091.31	3654.00
1978	252952.37	9117.56	206996.12	2525.19	109046.44	4955.12
1979	202699.81	-50252.56	185312.25	-21683.87	102111.12	-6935.31
5 YR AVG	206061.12	8137.66	176690.94	16411.07	104997.62	-264.06
15 YR AVG	102257.19	13937.05	81911.19	12119.95	86446.56	2569.00
1980	209258.87	6559.06	163600.69	-21711.56	106465.06	4353.94
1981	223030.94	13772.06	180309.69	16709.00	110044.94	3579.87
1982	242320.75	19289.81	202735.81	22426.12	110596.56	551.62
1983	260815.62	18494.87	224086.00	21350.19	108817.19	-1779.37
1984	266532.75	5717.12	241547.37	17461.37	103167.87	-5649.31
5 YR AVG	240391.56	12766.59	202455.87	11247.02	107818.31	211.35
20 YR AVG	136790.75	13629.04	112047.31	11890.23	91789.50	1948.57
STD DEV	102898.69		89216.12		17457.66	
STD ERR	23008.85		19949.33		3903.65	
C. V.	0.75		0.80		0.19	
MINIMUM	5880.83		-13.06		62239.31	
MAXIMUM	266532.75		241547.37		110596.56	

FIGURE 19

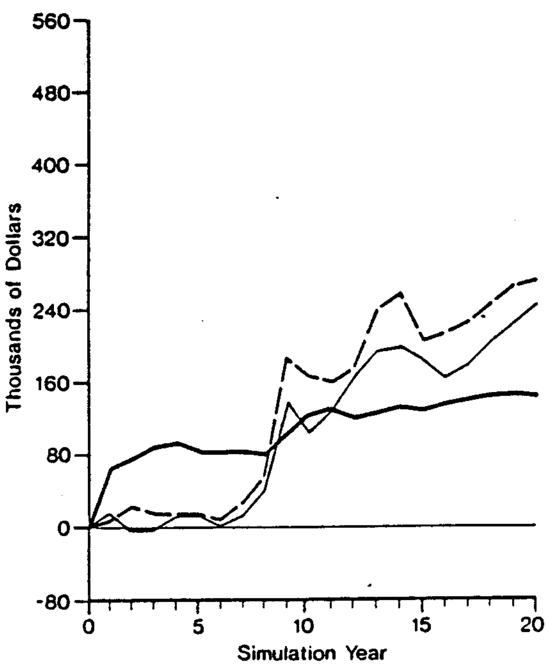
NET FARM CASH FLOW, NET FARM INCOME AND NET FARM WORTH FOR SCENÅRIO 4 (TREATMENTS 13-16)



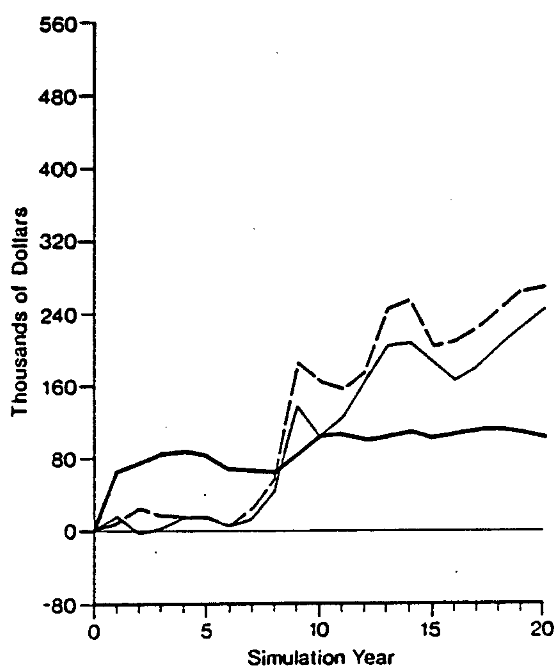
Treatment 13



Treatment 14



Treatment 15



Treatment 16

A COMPARISON OF NET FARM INCOME, NET WORTH AND NET CASH FLOW FOR THE TWENTY TREATMENTS

Net Farm Income

Tables 50-58 shows a summarized set of data for net farm income for all treatments and bases over twenty years. The individual treatments were discussed at length in an earlier section and would not be repeated here. Instead this section will merely rank the treatments and look at the four land procurement arrangements and four bases, one base run for each of the four land procurement methods.

Table 5C presents the aggregated means results. The mean net farm income of the four base runs was $141,052. Of the four bases, Base 03, the cash rental base generated the highest value of $157,225. This was 6 percent higher than that of the rent-to-purchase base, 10 percent higher than that of the outright base and 36 percent more than the amount of $115,651 generated by the share rental base. Table 51 shows net farm income comparisons by land control method.

Scenario 1, comprised of the outright land purchase method of land control generated the highest mean of $207,310. This was 11 percent higher than the amount generated by treatments 5-8 comprising the rent-to-purchase option of land control, 19 percent higher than the mean net farm income obtained from the cash rental option and 56 percent higher than the $133,125 generated by the share rental option.

Land purchase option, however, had the lowest value of capital turnover, 0.42. Both the cash rental and share rental options provided the highest turnover ratio of 1.44 while rent-to-purchase had a value of 0.71. The greater expenditures involved in the purchase of land with additional multiplier effects in expenditures on machinery and total

TABLE 50

SUMMARY NET FARM INCOME AND SELECTED INDICATORS
FOR ALL TREATMENTS OVER THE TWENTY-YEAR RUN

Treatment	Minimum	Maximum	Mean	Standard Deviation	Standard Error	Coefficient of Variation
		Dollars		Dollars		
Outright Purchase Base	-12,144	307,952	142,517	125,305	28,019	0.88
Rent to Purchase Base	858	309,981	148,815	120,618	26,971	0.81
Cash Rental Base	857	322,435	157,225	125,133	27,981	0.80
Share Rental Base	858	237,616	115,651	93,919	21,001	0.81
Mean of All Bases	-2,392	294,496	141,052	116,244	25,993	0.83
1. P x FCAF x STD/LTD	8,177	396,331	193,421	151,176	33,804	0.78
2. P x FCAF x MTD/LTD	8,177	389,204	189,309	148,283	33,157	0.78
3. P x IR x STD/LTD	-1,917	433,517	225,367	173,036	38,692	0.77
4. P x IR x MTD/LTD	2,300	426,332	221,143	170,041	38,022	0.77
5. RTP x FCAF x STD/LTD	8,177	366,440	177,774	137,611	30,771	0.77
6. RTP x FCAF x MTD/LTD	8,177	360,520	175,675	135,656	30,334	0.77
7. RTP x IR x STD/LTD	7,581	390,753	197,371	149,884	33,515	0.76
8. RTP x IR x MTD/LTD	7,581	385,268	195,530	148,525	33,211	0.76
9. CR x FCAF x STD/LTD	8,177	344,349	171,012	129,458	28,948	0.76
10. CR x FCAF x MTD/LTD	8,177	341,049	169,533	128,597	28,755	0.76
11. CR x IR x STD/LTD	7,581	354,651	179,819	134,913	30,168	0.75
12. CR x IR x MTD/LTD	7,581	351,351	178,338	134,059	29,977	0.75
13. SR x FCAF x STD/LTD	8,177	259,531	129,467	98,215	21,692	0.76
14. SR x FCAF x MTD/LTD	8,177	256,231	127,989	97,356	21,769	0.76
15. SR x IR x STD/LTD	7,581	269,836	138,251	103,742	23,197	0.75
16. SR x IR x MTD/LTD	7,581	266,533	136,791	102,899	23,009	0.75

TABLE 50 (continued)

Treatment	Capital Turnover	Surplus	Gross Ratio	Rate of Return on Capital	Mean Growth
		Dollars	Dollars		Dollars
Outright Purchase Base	0.42	124,701	0.57	0.27	16,163
Rent to Purchase Base	0.71	129,419	0.49	0.43	16,270
Cash Rental Base	1.44	143,300	0.46	0.96	16,925
Share Rental Base	1.44	103,269	0.61	0.71	12,461
Mean of All Bases	1.00	125,172	0.53	0.59	15,475
1. P x FCAF x STD/LTD	0.42	164,437	0.54	0.36	20,429
2. P x FCAF x MTD/LTD	0.42	164,452	0.56	0.36	20,054
3. P x IR x STD/LTD	0.42	197,879	0.54	0.41	22,412
4. P x IR x MTD/LTD	0.42	197,377	0.56	0.41	22,040
5. RTP x FCAF x STD/LTD	0.71	155,450	0.49	0.52	18,855
6. RTP x FCAF x MTD/LTD	0.71	162,132	0.49	0.52	18,544
7. RTP x IR x STD/LTD	0.71	173,000	0.50	0.57	20,167
8. RTP x IR x MTD/LTD	0.71	174,072	0.49	0.57	19,878
9. CR x FCAF x STD/LTD	1.44	156,289	0.46	1.05	12,430
10. CR x FCAF x MTD/LTD	1.44	157,131	0.47	1.05	17,519
11. CR x IR x STD/LTD	1.44	165,161	0.46	1.10	18,267
12. CR x IR x MTD/LTD	1.44	165,930	0.47	1.10	18,093
13. SR x FCAF x STD/LTD	1.44	116,315	0.60	0.80	13,231
14. SR x FCAF x MTD/LTD	1.44	117,156	0.61	0.80	13,055
15. SR x IR x STD/LTD	1.44	125,049	0.60	0.85	13,803
16. SR x IR x MTD/LTD	1.44	125,903	0.61	0.85	13,629

LEGEND:

P	- Outright Land Purchase Option.
RTP	- Rent To Purchase Option.
CR	- Cash Rent.
SR	- Share Rent.
FCAF	- Interest Rate Charged By Farm Credit Corporation.
IR	- Annual Rate Of Inflation.
STD/LTD	- Short Term Debt/Long Term Debt.
MTD/LTD	- Medium Term Debt/Long Term Debt.

1. P x FCAF x STD/LTD.
2. P x FCAF x MTD/LTD.
3. P x IR x STD/LTD.
4. P x IR x MTD/LTD.
5. RTP x FCAF x STD/LTD.
6. RTP x FCAF x MTD/LTD.
7. RTP x IR x STD/LTD.
8. RTP x IR x MTD/LTD.
9. CR x FCAF x STD/LTD.
10. CR x FCAF x MTD/LTD.
11. CR x IR x STD/LTD.
12. CR x IR x MTD/LTD.
13. SR x FCAF x STD/LTD.
14. SR x FCAF x MTD/LTD.
15. SR x IR x STD/LTD.
16. SR x IR x MTD/LTD.

TABLE 51

AGGREGATED TREATMENT MEANS FOR NET FARM INCOME BASED ON LAND CONTROL METHOD OF ARRANGEMENT FOR THE TWENTY YEAR SIMULATION

Treatment	Minimum	Maximum	Mean	Standard Deviation	Standard Error	Coefficient of Variation	Surplus	Growth	Rate of Return on Capital	Capital Turnover	Gross Ratio
	$	$	$	$	$		$	$			
All Bases	-2,392	294,496	141,052	116,244	25,993	0.83	125,172	15,475	0.59	1.00	0.53
Outright Land Purcahse (1-4)	4,184	411,346	207,310	160,634	35,919	0.77	181,036	21,234	0.38	0.42	0.55
Rent to Purchase (5-8)	7,879	375,745	186,588	142,919	31,958	0.76	166,163	19,361	0.54	0.71	0.49
Cash Rent (9-12)	7,879	347,850	174,676	131,757	29,462	0.75	161,128	16,577	1.07	1.44	0.46
Share Rent (13-16)	7,879	263,033	133,125	100,553	22,484	0.75	121,106	13,429	0.83	1.44	0.60

costs of production, even given economies of scale tend to generate only 42 cents of crop sales per dollar expended on assets.

Contrarily, less expenditures and capital are involved in cash-rental and share rental land control arrangements. Therefore, the value of assets is much less, and given the same expenses the latter options will tend to generate more dollars of crop sales per dollar of capital invested. It will be expected that rental purchase option would provide an intermediate value between outright land purchase.

Cash rental land control generated the lowest gross ratio, 0.46; rental purchase showed a value of 0.49; with share renting the worse at 0.60. The latter implies that over the twenty years, share renting only generated 40 cents of net farm income per dollar of crop sales; 60 cents were used to cover expenses. The reason why share renting is costly comes from the model behaviour earlier described.

Despite the high capital expenditure, only 38 cents per dollar of capital invested were returned compared with 54, 83 and 1.07 for rental purchase, share rental and cash rental in that order. Nevertheless, outright land purchase provided the highest average mean growth of $21,234, or 10 percent more than the rental purchase arrangement, 28 percent faster than cash rental and 58 percent more than the share rental option.

Since growth is measured in terms of wealth, it follows that ownership of resources and assets influence it. One would expect that outright purchase, and to a lesser extent rental purchase will display higher rates and levels of growth than share rental and cash rental.

TABLE 52

ANNUAL CHANGES IN NET FARM INCOME FOR ALL TREATMENTS

Simulation Year	Base	1	2	3	4	5	6	7
1965-1966	7,189	10,492	10,441	17,254	17,204	12,216	12,117	17,361
1966-1967	-6,842	-88	-405	-4,781	-5,098	-476	-588	-4,186
1967-1968	-2,201	3,294	3,539	-3,755	-3,391	2,470	2,279	-1,085
1968-1969	-3,933	-1,424	-1,437	1,847	2,000	-849	-1,097	801
1969-1970	-7,214	-2,912	-3,035	-20,063	-20,596	-864	-1,169	-7,112
1970-1971	17,101	18,536	17,651	35,148	34,102	13,271	13,108	19,193
1971-1972	25,842	24,937	22,802	50,451	48,258	24,519	27,599	37,858
1972-1973	158,434	166,683	165,208	228,047	226,636	141,148	139,682	178,669
1973-1974	-68,911	-52,352	-53,300	33,575	32,662	38,514	-39,865	13,446
1974-1975	42,556	47,696	47,658	-81,575	-81,599	42,582	41,913	-36,087
1975-1976	25,195	30,386	30,177	28,820	28,657	22,847	22,196	22,283
1976-1977	94,059	97,295	96,935	96,669	96,320	96,912	96,208	96,807
1977-1978	5,154	5,252	4,900	7,690	7,346	9,828	9,205	11,519
1978-1979	-63,903	-57,930	-58,009	-60,533	-60,585	-61,472	-61,837	-60,817
1979-1980	7,409	9,662	9,638	9,293	9,305	7,881	7,308	7,762
1980-1981	26,093	28,628	28,394	28,330	28,105	20,593	20,091	20,593
1981-1982	13,988	16,851	16,754	16,692	16,596	32,489	32,123	32,348
1982-1983	31,889	35,089	35,122	35,042	35,077	18,642	18,373	18,884
1983-1984	5,191	8,061	7,994	7,785	7,753	15,038	14,696	14,933

TABLE 52 (continued)

8	9	10	11	12	13	14	15	16
(Dollars)								
17,262	12,216	12,117	17,361	17,262	10,042	9,943	15,187	15,088
-4,298	-575	-598	-4,285	-4,344	-2,686	-2,709	-6,396	-6,455
-1,276	2,478	2,286	-1,077	-1,246	1,195	1,004	-2,360	-2,529
553	-842	-1,093	808	569	-1,238	-1,490	412	173
-7,417	-858	-1,169	-7,106	-7,417	-1,416	-1,727	-7,666	-7,977
19,030	15,293	15,000	21,568	21,275	11,495	11,202	17,772	17,479
37,575	30,889	30,703	39,169	38,984	23,299	23,113	31,649	31,345
179,798	147,842	147,686	165,206	165,020	111,650	111,494	129,019	128,887
12,477	-58,209	-58,214	-36,424	-36,428	-43,375	-43,380	-21,555	-21,580
-34,942	40,492	40,457	5,246	5,211	31,358	31,323	-3,850	-3,894
22,050	20,579	20,585	20,302	20,308	14,880	14,886	14,588	14,584
95,690	93,798	93,668	93,426	93,295	71,634	71,504	71,273	71,133
10,634	9,272	9,162	9,815	9,705	8,684	8,574	9,236	9,118
-61,388	-63,323	-63,433	-63,862	-63,973	-49,602	-49,713	-50,134	-50,253
7,010	6,213	5,914	6,003	5,704	7,067	6,768	6,864	6,559
19,937	19,084	18,840	18,962	98,718	14,137	13,894	14,021	13,772
31,850	25,356	25,100	25,345	25,090	19,556	19,300	19,550	19,290
18,608	24,264	23,980	24,425	24,141	18,617	18,334	18,782	18,495
14,534	2,203	11,879	12,188	11,865	6,055	5,732	6,044	5,717

TABLE 52 (continued)

LEGEND:

P	- Outright Land Purchase Option.
RTP	- Rent To Purchase Option.
CR	- Cash Rent.
SR	- Share Rent.
FCAF	- Interest Rate Charged By Farm Credit Corporation.
IR	- Annual Rate Of Inflation.
STD/LTD	- Short Term Debt/Long Term Debt.
MTD/LTD	- Medium Term Debt/Long Term Debt.

1. P x FCAF x STD/LTD.
2. P x FCAF x MTD/LTD.
3. P x IR x STD/LTD.
4. P x IR x MTD/LTD.
5. RTP x FCAF x STD/LTD.
6. RTP x FCAF x MTD/LTD.
7. RTP x IR x STD/LTD.
8. RTP x IR x MTD/LTD.
9. CR x FCAF x STD/LTD.
10. CR x FCAF x MTD/LTD.
11. CR x IR x STD/LTD.
12. CR x IR x MTD/LTD.
13. SR x FCAF x STD/LTD.
14. SR x FCAF x MTD/LTD.
15. SR x IR x STD/LTD.
16. SR x IR x MTD/LTD.

Variations in net farm income reflect changes in operating expenses, inventory adjustments, investment and supplementary payments.

Table 52 shows the behaviour of net farm incomes by annual changes.

If cash receipts remain the same between years, if cash expenses vary or if higher commodity prices prevail, variations in net income result. For example, a large value of net income in Year 8 could arise from rising commodity prices generating increases in inventory and consequent rise in net income. On the other hand, low incomes reflect depleted inventory, higher costs. A combination of lower commodity prices and substantial increases in expenses would account for the reduced incomes generated. Year 8 was actually 1972 in which incomes were very high. Year 7, 1971 had low incomes.

Net Cash Flow

Table 53 shows net cash flow by land control method. The mean net cash flow of all bases amounted to $131,781, with that of cash rent showing the highest value of $144,479. This was 4 percent higher than rent-to-purchase and 12 percent higher than outright land purchases.

Table 54 summarizes net cash flow values for all treatments.

Table 55 indicates the behaviour of net cash flow by annual changes.

Net Farm Worth

The net farm worth situation for all treatments and bases is shown in Tables 56 and 57. The mean net worth for the bases is $171,949. This value was higher than annual values of net worth for both share rent and cash rent options, but less than the purchase and rental-purchase options. It should be pointed out that both outright purchase and rent-to-purchase bases generated higher values of net farm worth than outright purchase and rent-to-purchase bases.

The fact that assets contribute to worth and to worth, and land and machinery usually dominate the structure of farm worth explains why share rental land use option and cash rental generate less net worth than either outright purchase or rent-to-purchase options.

TABLE 53

AGGREGATED TREATMENT MEANS FOR NET FARM CASH FLOW BASED ON LAND USE CONTROL METHOD OF ARRANGEMENT FOR THE TWENTY-YEAR SIMULATIONS

Treatment	Minimum	Maximum	Mean	Standard Deviation	Standard Error	Coefficient of Variation	Growth
	$	$	$	$	$		$
All Bases	-4,452	289,690	131,781	108,399	24,239	0.82	13,072
Outright Land Purchase (1-4)	-175	317,588	129,565	125,585	28,082	0.97	16,369
Rent to Purchase (5-8)	737	308,730	139,141	111,205	24,874	0.80	15,146
Cash Rent (9-12)	1,366	298,983	144,525	113,482	25,375	0.78	9,546
Share Rent (13-16)	-495	241,480	111,826	89,810	20,082	0.82	13,072

TABLE 54

SUMMARY NET CASH FLOW FOR ALL TREATMENTS OVER THE TWENTY-YEAR RUN

Treatment	Minimum	Maximum	Standard Deviation	Standard Error	Coefficient of Variation
			Dollars		
Outright Purchase Base	-21,811	307,584	118,791	26,562	0.91
Rent to Purchase Base	1,194	309,634	112,267	25,104	0.80
Cash Rental Base	2,364	299,651	113,039	25,276	0.78
Share Rental Base	446	241,891	89,498	20,012	0.80
Mean of All Bases	-4,452	289,690	108,399	24,239	0.82
1. P x FCAF x STD/LTD	-47,703	321,046	130,859	29,261	1.03
2. P x FCAF x MTD/LTD	20,340	314,246	120,795	27,011	0.91
3. P x IR x STD/LTD	46,231	321,044	130,435	29,166	1.03
4. P x IR x MTD/LTD	-19,568	314,017	120,251	26,889	0.91
5. RTP x FCAF x STD/LTD	50	310,767	111,740	24,986	0.81
6. RTP x FCAF x MTD/LTD	1,569	307,906	113,204	25,313	0.80
7. RTP x IR x STD/LTD	-145	308,859	108,721	24,311	0.79
8. RTP x IR x MTD/LTD	1,474	307,390	111,154	24,885	0.80
9. CR x FCAF x STD/LTD	1,120	299,209	114,128	25,520	0.79
10. CR x FCAF x MTD/LTD	1,414	298,973	112,941	25,254	0.78
11. CR x IR x STD/LTD	1,025	298,994	114,017	25,495	0.79
12. CR x IR x MTD/LTD	1,905	298,757	112,843	25,233	0.78
13. SR x FCAF x STD/LTD	-1,226	241,428	90,483	20,233	0.81
14. SR x FCAF x MTD/LTD	504	241,762	89,337	19,976	0.80
15. SR x IR x STD/LTD	-1,244	241,183	90,205	20,170	0.81
16. SR x IR x MTD/LTD	-13	241,547	89,216	19,949	0.80

TABLE 54 (continued)

Treatment	Net Cash Flow	Surplus	Growth	Current Ratio	Debt/ Equity Ratio	Change in Cash Flow
			Dollars			
Outright Purchase Base	130,920	--	15,359	--	--	--
Rent to Purchase Base	140,034	--	15,467	--	--	--
Cash Rental Base	144,470	--	9,561	--	--	--
Share Rental Base	111,690	--	11,902	--	--	--
Mean of All Bases	131,781	--	13,702	--	--	--
1. P x FCAF x STD/LTD	126,888	--	16,075	--	--	--
2. P x FCAF x MTD/LTD	132,659	--	17,619	--	--	--
3. P x IR x STD/LTD	126,660	--	16,074	--	--	--
4. P x IR x MTD/LTD	132,055	--	15,710	--	--	--
5. RTP x FCAF x STD/LTD	138,383	--	15,534	--	--	--
6. RTP x FCAF x MTD/LTD	142,013	--	14,262	--	--	--
7. RTP x IR x STD/LTD	137,150	--	15,433	--	--	--
8. RTP x IR x MTD/LTD	139,019	--	15,356	--	--	--
9. CR x FCAF x STD/MTD	144,317	--	9,543	--	--	--
10. CR x FCAF x MTD/LTD	144,924	--	9,561	--	--	--
11. CR x IR x STD/LTD	144,133	--	9,532	--	--	--
12. CR x IR x MTD/LTD	144,727	--	9,549	--	--	--
13. SR x FCAF x STD/LTD	111,653	--	11,885	--	--	--
14. SR x FCAF x MTD/LTD	112,259	--	11,902	--	--	--
15. SR x IR x STD/LTD	111,347	--	11,871	--	--	--
16. SR x IR x MTD/LTD	112,047	--	11,890	--	--	--

TABLE 54 (continued)

LEGEND:

P	- Outright Land Purchase Option.
RTP	- Rent To Purchase Option.
CR	- Cash Rent.
SR	- Share Rent.
FCAF	- Interest Rate Charged By Farm Credit Corporation.
IR	- Annual Rate Of Inflation.
STD/LTD	- Short Term Debt/Long Term Debt.
MTD/LTD	- Medium Term Debt/Long Term Debt.
--	- Not relevant.

1. P x FCAF x STD/LTD.
2. P x FCAF x MTD/LTD.
3. P x IR x STD/LTD.
4. P x IR x MTD/LTD.
5. RTP x FCAF x STD/LTD.
6. RTP x FCAF x MTD/LTD.
7. RTP x IR x STD/LTD.
8. RTP x IR x MTD/LTD.
9. CR x FCAF x STD/LTD.
10. CR x FCAF x MTD/LTD.
11. CR x IR x STD/LTD.
12. CR x IR x MTD/LTD.
13. SR x FCAF x STD/LTD.
14. SR x FCAF x MTD/LTD.
15. SR x IR x STD/LTD.
16. SR x IR x MTD/LTD.

The amount of surplus, the money left for investment after all indebtednesses are fulfilled, provides a vasis of the financial health. The greater the surplus the healthier the business. The average annual value of surplus for outright purchase was $181,036. This was 9 percent higher than rent-to-purchase, 12 percent more than cash rent and 49 percent more than the value given by the share rental option and 45 percent greater than that of the base.

The average growth of net worth over the twenty years amounted to $29,022 compared with $16,087 for rent-to-purchase, an 80 percent difference. Both cash rent and share rent displayed much slower growth than rental purchase and outright purchase; however, they attained the same amount of growth, $2,972.

The success of the operation and its ability to withstand bankruptcy and failure are also reflected in the current ratio values. As can be seen, these values are extremely large.

The debt/equity ratio, reflects the solvency position of the business. The lower the value the more solvent the farm and emphasizes the success. The debt/equity ratio was 0.61 for the outright purchase option, 0.69 for the rent-to-purchase option, 0.49 for the cash rental option and 0.46 for the share rental option.

TABLE 55

ANNUAL CHANGES IN NET CASH FLOW FOR ALL TREATMENTS

Simulation Year	Base	Treatments 1	2	3	4	5	6	7
	(Dollars)							
1965-1966	-20,367	-26,520	-20,911	-26,659	-21,051	-15,672	-14,053	-15,778
1966-1967	-99	-6,760	-1,414	-8,162	-1,316	3,266	5,020	3,344
1967-1968	5,152	-360	6,066	2,411	7,056	13,311	13,427	13,385
1968-1969	-2,424	-6,343	-1,371	-6,095	-1,202	601	194	566
1969-1970	-19,828	-23,343	-18,332	-23,359	-18,688	-10,093	-10,036	-9,963
1970-1971	10,516	10,791	11,075	10,421	11,100	51,489	3,767	51,366
1971-1972	39,477	44,242	37,231	43,451	35,496	-27,919	33,622	9,520
1972-1973	137,197	144,055	138,309	142,631	137,022	111,402	121,138	74,446
1973-1974	-55,337	-48,573	-56,176	-50,456	-57,052	-31,822	-39,222	-49,887
1974-1975	39,074	42,475	37,173	45,098	39,876	33,468	27,193	43,459
1975-1976	34,546	38,278	35,904	38,247	35,980	48,834	44,214	47,353
1976-1977	75,472	78,969	79,181	78,920	78,902	66,823	65,883	69,734
1977-1978	289	4,652	628	4,532	499	5,833	3,704	6,638
1978-1979	-35,520	-33,546	-36,147	-33,544	-36,109	-41,727	-42,352	-39,962
1979-1980	-24,735	-25,303	-21,588	-25,325	-21,904	-23,607	-22,983	-23,918
1980-1981	23,711	24,911	22,962	24,886	23,654	28,047	24,292	28,618
1981-1982	31,043	31,931	29,372	31,910	29,374	22,823	20,683	24,204
1982-1983	30,309	30,954	31,967	31,416	32,050	43,084	40,765	42,374
1983-1984	23,352	24,913	24,694	25,089	25,146	17,006	17,026	17,729

TABLE 55 (continued)

Treatments								
8	9	10	11	12	13	14	15	16
(Dollars)								
-14,159	-14,502	-14,208	-14,608	-13,728	-16,420	-16,126	-16,526	-15,646
5,098	1,236	4,404	1,314	3,476	-428	2,739	-351	1,811
13,501	12,844	13,085	12,918	13,158	11,900	12,141	11,974	12,215
159	323	-36	289	349	386	26	351	411
-9,905	-10,455	-10,404	-10,324	-10,273	-10,689	-10,638	-10,559	-10,508
51,143	12,700	11,218	12,569	11,088	9,143	7,661	10,512	8,224
-10,431	37,919	37,266	37,746	37,094	30,695	30,043	29,006	28,674
83,886	136,202	134,262	135,840	133,900	100,718	98,778	97,838	98,415
-56,271	-50,456	-50,588	-50,911	-51,042	-35,890	-36,022	-34,028	-35,973
56,253	29,957	28,992	30,692	29,728	20,688	19,723	21,378	20,458
65,478	44,015	44,089	44,021	44,095	39,166	39,239	39,239	39,246
65,894	62,421	63,549	62,429	63,557	40,375	41,502	40,408	41,510
3,674	3,303	3,042	3,292	3,030	2,798	2,537	2,820	2,525
-42,361	-36,116	-35,185	-36,105	-35,174	-22,626	-21,695	-22,591	-21,684
-22,976	-23,145	-22,575	-23,141	-22,570	-22,286	-21,716	-22,260	-21,712
24,296	21,845	21,521	21,848	21,523	17,031	16,706	17,052	16,709
20,689	28,457	28,064	28,457	28,065	22,818	22,426	22,834	22,426
40,760	27,038	26,853	27,035	26,849	21,539	21,354	21,549	21,350
17,030	-102,262	-101,691	-102,262	-101,691	16,890	17,461	16,902	17,461

TABLE 55 (continued)

LEGEND:

P	- Outright Land Purchase Option.
RTP	- Rent To Purchase Option.
CR	- Cash Rent.
SR	- Share Rent.
FCAF	- Interest Rate Charged By Farm Credit Corporation.
IR	- Annual Rate Of Inflation.
STD/LTD	- Short Term Debt/Long Term Debt.
MTD/LTD	- Medium Term Debt/Long Term Debt.

1. P x FCAF x STD/LTD.
2. P x FCAF x MTD/LTD.
3. P x IR x STD/LTD.
4. P x IR x MTD/LTD.
5. RTP x FCAF x STD/LTD.
6. RTP x FCAF x MTD/LTD.
7. RTP x IR x STD/LTD.
8. RTP x IR x MTD/LTD.
9. CR x FCAF x STD/LTD.
10. CR x FCAF x MTD/LTD.
11. CR x IR x STD/LTD.
12. CR x IR x MTD/LTD.
13. SR x FCAF x STD/LTD.
14. SR x FCAF x MTD/LTD.
15. SR x IR x STD/LTD.
16. SR x IR x MTD/LTD.

TABLE 56

SUMMARY NET WORTH AND SELECTED INDICATORS FOR ALL TREATMENTS OVER THE TWENTY-YEAR RUN

Treatment	Minimum	Maximum	Standard Deviation	Standard Error	Coefficient of Variation
			Dollars		
Outright Purchase Base	66,145	545,027	180,895	40,449	0.65
Rent to Purchase Base	34,340	357,718	118,739	26,551	0.61
Cash Rental Base	66,145	143,968	28,319	6,332	0.27
Share Rental Base	66,145	143,970	28,740	6,427	0.27
Mean of All Bases	58,193	297,671	89,173	19,940	0.45
1. P x FCAF x STD/LTD	66,145	658,407	220,192	49,236	0.58
2. P x FCAF x MTD/LTD	66,145	577,040	192,426	43,028	0.61
3. P x IR x STD/LTD	66,145	658,418	219,495	49,081	0.58
4. P x IR x MTD/LTD	66,145	576,418	191,448	42,809	0.60
5. RTP x FCAF x STD/LTD	66,145	408,257	133,408	29,831	0.61
6. RTP x FCAF x MTD/LTD	66,145	337,167	104,414	23,348	0.55
7. RTP x IR x STD/LTD	29,551	404,632	133,188	29,782	0.64
8. RTP x IR x MTD/LTD	27,040	337,167	112,073	25,060	0.61
9. CR x FCAF x STD/LTD	66,145	143,923	26,258	5,871	0.24
10. CR x FCAF x MTD/LTD	62,491	110,594	17,347	3,879	0.19
11. CR x IR x STD/LTD	66,145	143,923	26,258	5,871	0.24
12. CR x IR x MTD/LTD	66,145	110,594	17,378	3,886	0.19
13. SR x FCAF x STD/LTD	66,145	143,925	26,263	5,873	0.24
14. SR x FCAF x MTD/LTD	62,478	110,597	17,356	3,881	0.19
15. SR x IR x STD/LTD	66,145	143,964	26,368	5,896	0.24
16. SR x IR x MTD/LTD	62,239	110,597	17,458	3,904	0.19

TABLE 56 (continued)

Treatment	Net Farm Worth	Surplus	Growth	Current Ratio	Debt/ Equity Ratio	Change in Net Worth
			Dollars			
Outright Purchase Base	280,436	124,700	19,941	4,007	1.15	23,944
Rent to Purchase Base	194,007	129,419	15,346	5,858	0.81	14,579
Cash Rental Base	106,850	143,300	3,996	6,674	0.42	3,796
Share Rental Base	106,504	103,269	3,996	4,516	0.42	3,796
Mean of All Bases	171,949	125,172	10,820	5,264	0.70	11,529
1. P x FCAF x STD/LTD	377,009	164,437	31,172	1.16	0.45	29,613
2. P x FCAF x MTD/LTD	317,004	164,452	26,889	58.96	0.77	25,545
3. P x IR x STD/LTD	378,355	197,879	31,172	1.18	0.44	29,614
4. P x IR x MTD/LTD	317,254	197,377	26,856	58.45	0.77	25,514
5. RTP x FCAF x STD/LTD	219,614	155,450	18,006	2.04	0.49	17,100
6. RTP x FCAF x MTD/LTD	191,220	162,132	14,264	7,565	0.58	13,551
7. RTP x IR x STD/LTD	209,411	173,000	17,815	1.92	0.72	16,924
8. RTP x IR x MTD/LTD	183,501	174,072	14,264	5,858	0.98	13,551
9. CR x FCAF x STD/LTD	110,879	156,289	3,994	4,524	0.35	3,794
10. CR x FCAF x MTD/LTD	91,856	157,131	1,948	6,688	0.62	1,851
11. CR x IR x STD/LTD	110,879	165,161	3,994	4,524	0.35	3,794
12. CR x IR x MTD/LTD	91,817	165,930	1,948	6,674	0.62	1,851
13. SR x FCAF x STD/LTD	110,898	116,315	3,994	4,535	0.35	3,794
14. SR x FCAF x MTD/LTD	91,875	117,156	1,950	6,706	0.62	1,851
15. SR x IR x STD/LTD	110,598	125,049	3,996	755	0.36	3,796
16. SR x IR x MTD/LTD	91,789	125,903	1,949	5,838	0.62	1,851

TABLE 56 (continued)

LEGEND:

P	- Outright Land Purchase Option.
RTP	- Rent To Purchase Option.
CR	- Cash Rent.
SR	- Share Rent.
FCAF	- Interest Rate Charged By Farm Credit Corporation.
IR	- Annual Rate Of Inflation.
STD/LTD	- Short Term Debt/Long Term Debt.
MTD/LTD	- Medium Term Debt/Long Term Debt.

1. P x FCAF x STD/LTD.
2. P x FCAF x MTD/LTD.
3. P x IR x STD/LTD.
4. P x IR x MTD/LTD.
5. RTP x FCAF x STD/LTD.
6. RTP x FCAF x MTD/LTD.
7. RTP x IR x STD/LTD.
8. RTP x IR x MTD/LTD.
9. CR x FCAF x STD/LTD.
10. CR x FCAF x MTD/LTD.
11. CR x IR x STD/LTD.
12. CR x IR x MTD/LTD.
13. SR x FCAF x STD/LTD.
14. SR x FCAF x MTD/LTD.
15. SR x IR x STD/LTD.
16. SR x IR x MTD/LTD.

TABLE 57

ANNUAL CHANGES IN NET FARM WORTH FOR ALL TREATMENTS

Simulation Year	Base	Treatments 1	2	3	4	5	6	7
	(Dollars)							
1965-1966	17,793	23,941	18,282	23,941	18,282	13,111	11,394	13,111
1966-1967	20,232	30,364	22,038	31,864	22,038	10,411	7,364	10,411
1967-1968	16,255	30,886	28,127	33,537	33,950	3,630	631	3,630
1968-1969	-25,287	-7,522	-15,895	-8,296	-14,520	-7,943	-11,050	-7,943
1969-1970	-20,792	-892	-10,839	-1,025	-16,083	-3,411	-7,012	-3,411
1970-1971	4,713	25,539	11,802	24,941	9,210	-31,907	11,892	-31,907
1971-1972	-7,062	10,552	-3,062	10,149	-3,418	17,233	2,193	-20,484
1972-1973	109,302	122,824	111,180	122,487	111,278	86,722	67,863	89,716
1973-1974	130,934	139,905	133,690	139,617	133,600	83,318	68,720	90,960
1974-1975	23,781	30,113	27,501	29,871	27,847	25,232	15,424	29,463
1975-1976	18,518	22,278	21,475	22,072	21,366	7,977	1,264	12,948
1976-1977	25,953	27,465	24,746	27,186	24,494	19,907	12,181	23,068
1977-1978	28,583	26,733	27,421	26,602	27,666	19,616	13,481	22,324
1978-1979	15,777	12,458	15,034	12,346	15,309	19,349	13,948	21,642
1979-1980	28,754	26,249	24,659	26,152	24,666	23,377	17,208	25,328
1980-1981	29,228	25,769	25,499	25,687	25,437	19,392	14,994	21,050
1981-1982	23,591	19,327	21,192	19,257	21,125	19,749	16,819	20,262
1982-1983	20,738	15,127	16,388	14,753	16,378	8,132	7,143	9,445
1983-1984	17,869	11,142	11,655	11,133	11,645	8,220	6,565	8,876

TABLE 57 (continued)

Treatments								
8	9	10	11	12	13	14	15	16
(Dollars)								
11,394	11,611	11,219	11,611	10,634	11,611	11,219	11,611	10,634
7,364	10,527	7,479	10,527	7,863	10,518	7,470	10,518	7,854
631	3,773	691	3,773	892	3,815	733	3,815	934
-11,050	-7,827	-11,050	-7,827	-11,050	-7,865	-11,088	-7,865	-11,088
-7,012	-3,302	-7,012	-3,302	-7,012	-3,267	-6,977	-3,267	-6,977
-35,608	3,295	607	3,295	607	3,351	664	1,851	-30
-4,824	-2,532	-5,588	-2,532	-5,588	-2,632	-5,688	-2,471	-5,236
80,095	21,623	20,991	21,623	20,991	21,613	20,981	22,132	21,220
100,932	20,644	19,972	20,644	19,972	20,644	19,972	20,792	19,972
25,499	5,298	5,535	5,298	5,535	5,634	5,871	5,780	5,871
1,264	-8,710	-8,520	-8,710	-8,520	-9,055	-8,865	-8,938	-8,865
12,181	4,817	3,620	4,817	3,620	4,851	3,654	4,952	3,654
13,481	5,938	4,955	5,938	4,955	5,938	4,955	6,023	4,955
13,948	-4,984	-6,935	4,984	-6,935	4,984	-6,935	-4,913	-6,935
17,208	7,168	4,353	7,168	4,353	7,168	4,354	7,229	4,354
14,994	6,308	3,580	6,308	3,580	6,308	3,580	6,359	3,580
16,819	3,234	552	3,234	552	3,233	552	3,277	552
7,143	898	-1,780	898	-1,780	899	-1,779	935	-1,779
6,565	-1,900	-5,649	1,900	-5,649	-1,900	-5,649	-1,897	-5,649

TABLE 57 (continued)

LEGEND:

P	- Outright Land Purchase Option.
RTP	- Rent To Purchase Option.
CR	- Cash Rent.
SR	- Share Rent.
FCAF	- Interest Rate Charged By Farm Credit Corporation.
IR	- Annual Rate Of Inflation.
STD/LTD	- Short Term Debt/Long Term Debt.
MTD/LTD	- Medium Term Debt/Long Term Debt.

1. P x FCAF x STD/LTD.
2. P x FCAF x MTD/LTD.
3. P x IR x STD/LTD.
4. P x IR x MTD/LTD.
5. RTP x FCAF x STD/LTD.
6. RTP x FCAF x MTD/LTD.
7. RTP x IR x STD/LTD.
8. RTP x IR x MTD/LTD.
9. CR x FCAF x STD/LTD.
10. CR x FCAF x MTD/LTD.
11. CR x IR x STD/LTD.
12. CR x IR x MTD/LTD.
13. SR x FCAF x STD/LTD.
14. SR x FCAF x MTD/LTD.
15. SR x IR x STD/LTD.
16. SR x IR x MTD/LTD.

Summary Scenario Analysis

The results show that outright land purchase yielded the highest mean net worth of $347,405. This was followed by the rental purchase arrangement value of $200,936, 73 percent less than outright purchase. Cash rental and share rental arrangements provided values that were 243 percent lower than outright purchase and 98 percent less than that of rental purchase.

Cash rental land control arrangement showed the highest mean net cash flow of $144,525, four percent higher than rent-to-purchase, 12 percent higher than outright purchase and 29 percent greater than share rent arrangement. Table 58 displays the values of net farm worth by land control methods.

Variations between net income and net cash flow are due to the inclusion of changes in inventory, depreciation charges and unpaid operating expenses in net income but not in net cash flow. On the other hand, principal payments on debt are not included in income, and anticipated capital expenditures are included only indirectly whereas both are part of cash flow. Cash flow shows cash transactions while income shows depreciation charges.

While depreciation ideally should equal net capital expenditures over time for a grown business that is not longer expanding, for an expanding one capital expenditures would be expected to exceed depreciation. Thus, for an expanding farm, net cash flow normally exceeds net income. Where the converse is true, the explanations are as earlier stated.

TABLE 58

AGGREGATED TREATMENT MEANS FOR NET FARM WORTH BASED ON LAND USE CONTROL METHOD OF ARRANGEMENT FOR THE TWENTY-YEAR SIMULATIONS

Treatment	NET FARM WORTH									
	Minimum	Maximum	Mean	Standard Deviation	Standard Error	Coefficient of Variation	Surplus	Growth	Current Ratio	Debt/Equity Ratio
	$	$	$	$	$			$	$	
All Bases	58,193	297,671	171,949	89,173	19,940	0.45	--	10,820	5,264	0.70
Outright Land Purchase (1-4)	66,145	617,571	347,405	205,890	46,039	0.59	--	29,022	2,994	0.61
Rent to Purchase (5-8)	47,220	371,806	200,936	120,771	27,005	0.60	--	16,087	3,357	0.69
Cash Rent (9-12)	65,231	102,259	101,358	21,810	4,877	0.21	--	2,971	5,602	0.49
Share Rent (13-16)	64,252	127,271	101,290	21,861	4,888	0.21	--	2,972	6,127	0.46

CHAPTER X

SUMMARY OF RESULTS AND CONCLUSIONS

The purpose of this chapter is to summarize the results of the study in terms of the objectives set forth in Capter 1. It does this by firstly summarizing the methodological results of Chapter 6. These results deal with the objective of constructing, testing and validating the model as a representative Manitoba crop farm. Secondly, the results obtained from the deterministic execution and experimentation with the model under factorial analysis are summarized as they attest to the objectives outlined.

The conclusions drawn from the results are then stated, followed by a discussion of the implications of the results and suggestions for further research.

Construction of A Model Representative of Crop Farm in Manitoba and Its Application

The construction of the model was achieved as shown in Chapter 5 and Appendix A. Therefore, the actual testing and validating are the germane results. These were done in Chapter 6. The attainment of this objective was satisfactorily displayed by debugging the model, both on a sub-routine basis and on the whole model basis. The process was a continuous one throughout the study. The second stage involved verification of the model, that is, ensuring that the model operated as envisaged during construction.

Verification was a long process achieved by testing the model under all the variations and flexible conditions built into it. This was extremely important since failure to test any situation created severe debugging, verification and validation problems.

Verification was assumed if the correct type of results as those normally obtained for farms from use of other techniques were obtained. Use was made of results generated by the Crop Simulator now in use at the Department of Agricultural Economics far a visual matching of the two results.

Validation of the model was achieved by matching simulated net worth results with actual case farm net worth, and simulated net income with case farm net income.

Impacts of Outright Purchase of Land With Debt Structure Relationships and Return Percentage on Productive Assets on Net Farm Income, Net Cash Flow and Net Farm Worth

Net Farm Income

i) The four treatments comprising scenario 1 had higher net farm incomes than the base with outright purchase option. All treatments were more efficient than the base in terms of gross ratio, rate of return on capital and rate of growth.

ii) Treatment 3; Outright Purchase - Rate of Return on Productive Assets Equal to the Annual Rate of Inflation - Short Term Debt/Long Term Debt attained the highest level of net farm income at $443,517; it had the highest overall mean of $225,367, attained the highest mean growth and maintained the highest growth throughout the run.

iii) Treatment 4; Outright Land Purchase - Rate of Return on Productive Assets Equal to the Annual Rate of Inflation - Medium Term Debt/Long Term Debt was ranked second. It achieved a net farm income that was 2 percent less than that produced by treatment 3. The value of net farm income was 8 percent higher than that of treatment 1; Outright Land Purchase - Rate of Return on Productive Assets Equal to the Interest Rate Charged by the Farm Credit Corporation of Canada - Short Term Debt/ Long Term Debt, and 10 percent higher than the value generated by treatment 2; Outright Purchase of Land - Rate of Return Equal to the Interest Rate Charged by the Farm Credit Corporation of Canada - Medium Term Debt/Long Term Debt.

iv) Treatment 2, outperformed the base by 27 percent in terms of attained net farm income, by 33 percent in terms of its overall mean and by 38 percent in terms of mean growth.

Net Cash Flow

i) All treatments (treatments 1-4) outperformed the base in terms of maximum net cash flow attained.

ii) Treatments 1 and 3 attained the highest value of $321,046. This value was 2 percent higher than that reached in treatments 2 and 4, and 2 percent higher than that reached by the base.

Net Farm Worth

i) Treatment 1 produced the highest value of net farm worth which was almost identical to that produced by treatment 3.

ii) Treatment 2 was the next best producing a maximum net worth that was 14 percent less than treatments 1 and 3, and 6 percent higher than treatment 4 and the base.

Impacts of Rent-To-Purchase Land Control Arrangement With Debt Structure Relationships and Return Percentage on Productive Assets on Net Farm Income, Net Cash Flow and Net Farm Worth

Net Farm Income

i) All treatments attained higher levels of net farm income than the base.

ii) Treatment 7; rental purchase land arrangement with rate of return on productive assets equal to the annual inflation rate and short term debt/long term debt, produced the highest level of net farm income of $390,753 and the highest mean of $197,371.

iii) Treatment 8; rental purchase land arrangement - rate of return on productive assets equal to the inflation rate - medium term debt/long term debt attained a level that was 10 percent less than treatment 7, and 5 percent and 7 percent more than treatments 5 and 6, respectively.

Net Cash Flow

i) Treatment 5; rental purchase land control with rate of return on productive assets equal to the interest rate charged by the Farm Credit Corporation of Canada and short term debt/long term debt attained the highest level of net cash flow and mean growth in net cash flow.

ii) Although treatment 6 produced the best mean net cash flow, the base gave a better performance than treatments 6, 7, and 8.

Net Farm Worth

i) Treatments 5 and 7 outperformed the base with maxima of $408,527 and $404,632, respectively.

ii) The base produced a net worth that was 6 percent higher than those of treatments 6 and 8.

Impacts of Cash Rental As a Method of Land Control With Rate of Return On Productive Assets and With Debt Structure On Net Farm Income, Net Cash Flow and Net Farm Worth

Net Farm Income

i) All treatments (9-12), attained a higher level of net farm income than the base.

ii) Treatment 11; Cash Rental Land Control Arrangement - Rate of Return Equal to Inflation Rate - Short Term Debt/Long Term Debt, was the best overall performer reaching a maximum of $354,651, having an overall average of $179,819, and displaying an average overall annual growth of $18,267.

iii) Treatment 12; Cash Rental - Inflation Rate - Medium Term Debt/ Long Term Debt was the second best performer. It attained a level of net farm income that was 97 percent of treatment 11 and an annual average growth of $18,093 almost the same as treatment 11.

iv) Treatment 9 had a maximum that was 97 percent of treatment 11, a mean that was 95 percent of treatment 11 and an annual growth that was 68 percent of treatment 11.

v) Treatment 10 had a maximum that was only 4 percent less than that of treatment 11, a mean that was only 6 percent less than treatment 11 and an annual average growth in net farm income that was only 4 percent less.

Net Cash Flow

i) There were no significant differences in the levels of net cash flow generated by the four treatments (9-12).

ii) The base attained the highest net cash flow followed by treatments

9, 11, 10 and 12 in that order. The difference between the highest and lowest maxima was only $894.

Net Farm Worth

i) Treatment 9; Cash Rental Land Control with a Farm Credit Corporation Interest Rate and Short Term Debt/Long Term Debt produced a level of net farm worth almost identical to that of the base at $143,923. The value of the base was $143,968. Treatment 9 had a mean of $110,594 compared to $106,850 for the base. Treatment 11 gave essentially the same result.

ii) Treatments 10 and 12 produced identical levels, $110,594.

Impacts of Share Rental Method of Land Control Arrangement With Debt Structure Relationships and Rate of Return On Productive Assets On Net Farm Income, Net Cash Flow and Net Farm Worth

Net Farm Income

i) All treatments, 13-16 attained higher levels of net farm income, higher overall mean net income, highest annual mean growth and higher rates of return on capital than the base.

ii) Treatment 15; Share Rental Land Control Arrangement with Rate of Inflation and Short Term Debt/Long Term Debt attained the highest net farm income of $269,836, and the highest mean of $138,251.

iii) Treatment 16; Share Rental Land Control with Rate of Return Equal to the Inflation Rate and Medium Term Debt/Long Term Debt generated the second best maximum, 1 percent less than treatment 15.

iv) Treatment 13; Share Rent with Rate of Return Equal to the Farm Credit Corporation of Canada Lending Rate and Short Term Debt/Long Term

Debt was the second worst performer but with an attained income of only 4 percent less than the maximum reached by treatment 15. The worst performer was treatment 14 with an attained income only 5 percent less than that of treatment 15.

Net Cash Flow

i) There were very slight but insignificant differences between all treatments and the base.

ii) The highest net cash flow of $241,762 was attained by treatment 14 and the lowest of $241,183 was reached by treatment 15, a difference of less than 0.5 percent.

Net Farm Worth

i) The base run attained the highest net farm worth of $143,970. This value was essentially the same reached by treatment 13 ($143,925) and treatment 15 ($143,964). The least value was attained by treatment 14, $110,597.

General Results

Net Farm Income

i) Of the four bases run, cash rental base generated the highest mean value of net farm income. This was 6 percent higher than that generated by the rent to purchase base, 10 percent higher than the outright base and 36 percent more than share rental.

ii) Scenario 1, the outright purchase method of land control, generated the highest mean of $207,310 and attained the highest level of net farm income amounting to $411,346.

iii) The mean level of net farm income attained by the outright purchase method was 11 percent more than that generated by the rent to purchase method, 19 percent higher than cash rental and 56 percent greater than the $133,125 mean net farm income generated by the share rental method.

iv) By attaining the highest level of net farm income, the outright purchase method outperformed rent to purchase by 9 percent, cash renting by 18 percent and share renting by 56 percent. Its attained net farm income level was greater than that achieved by the base by 40 percent.

v) Outright land purchase had the lowest capital turnover ratio of 0.42 while rent to purchase had a ratio of 0.71, the base 1.00 and cash rental and share rental ratios were both 1.44.

vi) Cash renting generated the lowest gross ratio of 0.46, followed by rent to purchase with 0.49, the base with 0.53, outright purchase with 0.55 and share renting with 0.60.

vii) Outright land purchase returned only 38 percent on investment compared to cash renting of 107 percent, share renting of 83 percent, rent to purchase of 54 percent and the base of 59 percent.

viii) Outright land purchase generated the highest mean level of growth in net farm income. The value of $21,234 was 10 percent greater than rent to purchase, 28 percent higher than cash renting and 58 percent more than share renting.

ix) The ability to survive and avoid bankruptcy surrogated by the value of surplus was greatest for the outright land purchase method of land control. Its ability to do this was 9 percent, 12 percent, 49 percent and 45 percent superior respectively, than rent to purchase, cash rent, share rent and the base.

Net Farm Worth

i) Outright land purchase attained the highest level, $671,571, of net farm worth. This quantum was 66 percent greater than rent to purchase, 503 percent greater than cash rent, 385 percent greater than share renting and 107 percent larger than that attained by the bases.

ii) Outright land purchase maintained the highest level mean net farm worth, amounting to $347,405. This surpassed the values for rent to purchase, cash rent, share rent and the base by 73 percent, 243 percent and 102 percent, respectively.

iii) Outright land purchase achieved a superior level of mean growth over the twenty years than the other methods of land control arrangement. It was 80 percent better than rent to purchase, almost 900 percent higher than cash rent and share rent, and 268 percent higher than the base.

iv) The current ratio was lowest for the outright purchase option and extremely large for the other methods including the base.

v) Cash rental and share rental with debt/equity ratios of 0.49 and 0.46 were more solvent than outright purchase, rent to purchase and the base. All treatments provided better solvency positions than the base.

Net Cash Flow

i) Outright land purchase method of land control attained the highest level of net cash flow. The value of $317,588 was higher than rent to purchase, cash renting, share renting and the base by 3 percent, 6 percent, 32 percent and 10 percent, respectively.

ii) Cash renting maintained the highest mean level of net cash flow. It was larger than rent to purchase by 4 percent, outright land purchase by 12 percent, and share rent by 29 percent. The base mean level of net cash flow was 10 percent less than that of cash renting.

iii) Outright land purchase maintained an average annual growth level of net cash flow of $16,369. This was 8 percent more than rent to purchase, 71 percent better than cash rent, 38 percent higher than share rent and 25 percent better than the base.

CONCLUSIONS

Although very many conclusions can be drawn from the results of this study, only the essentials are summarized here. Again, the conclusions are presented in accordance with the objectives.

Construction and Testing of Model for Suitability As a Representative of Crop Farms in Manitoba

This objective was attained very satisfactorily. The evaluation of the model shows that its flexibility permits wide use in different situations. Because the model used the systems (modular) approach, with incorporation of subroutines other than crop farms, for example, incorporating livestock features, the model could be utilized in livestock sector analysis. Moreover, the model is well suited for use in planning, forecasting, policy evaluations such as impacts of programs on the welfare of the farm family. Its use in impacting effects of variables on income measures was demonstrated.

Impacts of Alternate Farmland Use Control Arrangement On Performance Measures

The four farmland tenure arrangements had differential effects on the amounts of the performance criteria attained and the ability of the farm operation to maintain high levels of income. The magnitude of the impacts depended on the criterion variable. Overall, the general thrust was to increase the value of the performance variable.

If the objective (goal) of the farm operator was the maximization of net cash flow, then farmland use control would increase the value. If the goal was to maintain a high mean level of net cash flow over the life of the farmer, then cash rental was the best method and share renting was the worst.

If the goal was the attainment and maintenance of high levels of net farm worth, outright land purchase would be the superior option of procurement. In terms of solvency position, cash rent and share rent were superior to outright purchase and rent-to-purchase.

In terms of all aspects of net farm income, maximization, maintenance of high mean levels, avoiding bankruptcy, growth and survival, outright land purchase option was the most beneficial option of land use control arrangement.

Farmland is a very important input in agricultural production and especially for crop farms requiring large acreages to generate increased revenue. Therefore, it is reasonable to expect that regardless of the tenure arrangement, increasing use of farmland will generate increased income, ceteris paribus. Similar rationale can be expected for cash flow and net worth since cash flow depends on net income. One will expect net worth in general to increase with increasing control of farmland. Under purchase/rental, dependent on the purchase year, the operator puts out a small amount of capital each year up to the year of purchase. That initially increases his cash flow and allows for generation of income through better ability to plan and take advantage of immediate bargains.

Different levels of factors exerted differnt effect on each performance variable. When net cash flow was the performance variable there was statistically no difference between effects of rental-purchase and outright purchase and between cash rent and share rent.

The findings of this study allows the conclusion that all methods of land control arrangements had positive effects on the levels of net farm income, net cash flow and net farm worth generated by the farm business. It was shown further that outright purchase land control arrangement in combination with debt structre relationships and the additional return on productive assets significantly influenced the levels of net farm income attained, the level of net farm income maintained, the rate of growth of net farm income, the rate of return on capital invested, the efficiency of production and capital invested and the survival of the farm.

While the outright land purchase method combined with debt structure ratios and rate of return on assets to improve the overall performance of the farm business, different combinations affected each performance criterion differently. Consequently, the choice of performance criterion to be effected will determine the appropriate combination of debt structure ratio and rate of return on productive assets to use with the outright land purchase method.

The rent-to-purchase method, in combination with debt structure ratios and rates of return on productive assets, enhanced the levels and maintenance of net farm income. However, the net cash flow generated was only superior to the base when rent-to-purchase combined with short term debt/long term debt and FCAF. In other cases, the base outperformed the treatments. Caution is necessary in effecting the use of rent-to-purchase if the intention is to affect net cash flow. A similar caution is required with regard to the net farm worth.

From the results generated by the cash rental experiments, it is concluded that in combination with the debt structure ratios and rate of return, the cash rental method generated higher levels of net farm income and higher performance of the farm business. But, the results also lead to the conclusion that cash rental did not influence the net cash flow nor did it show any superiority in net farm worth over the base.

Share rental arrangements augmented the value of net farm income and the overall performance of the farm if the performance criterion is net farm income. However, there were no clear benefits in terms of net farm worth and net cash flow.

In general, the results of the study suggest that the outright land purchase method was superior to the other methods of land use control arrangement in generating the highest levels of net farm income, net cash flow and net farm worth in combination with the two debt structure ratios and two rates of return on productive assets. Rent-to-purchase was the next best choice.

It is also concluded that the land purchase method maintained the highest mean levels of net farm icnome, net farm worth, mean growths in income, net worth and net cash flow. However, cash renting was able to maintain the highest mean level of net cash flow.

Impacts of Rates of Return On Productive Assets On Performance Variables

From the analysis of the results generated it is concluded that the higher the rate of return on productive assets received by the farmer the greater the level of net farm income attained and the higher the mean level maintained. However, rate of return did not appear to influence net cash flow significantly.

Impacts of Debt Structure On Peformance Variables

Debt structure ratio influences the net cash flow and a structure of constrained medium term debt/long term debt was more important than short term debt/long term debt. A corollary conclusion is that the farm business needs an adequate availability of short term credit (capital) to cover operating expenses and avoid deficits in the first eight years, more than it would medium term capital. However, as the farm business expands, proper structuring of both types of indebtedness, but especially medium term debt, becomes more important.

Debt structure affects the level of net farm worth achieved. Short term debt/long term debt in the presence of outright purchase of land and rate of return on assets augment net worth; more net worth is obtained than from the ratio of medium term debt/long term debt.

Constraining medium term debt tends to restrict the rate of expansion and slows down the growth of assets. Constraining short term debts tends to appreciate asset value.

Survival of the Farm Business

There was no instance of firm failure in the model. The firm failed when its net cash flow was negative or when it became insolvent. In fact, the outstanding results throughout was the healthy financial state of the business as was represented by the criterion variables, changes in net worth, and levels of farm surpluses, debt/equity ratios. return on productive assets and rate of growth.

The healthy financial state of the treatment farms compared with the control farm could be explained on the basis that in the case farm and controls farmland tenure arrangement(s) or ratios of arrangements, debt structure and rate of return were not optimum to provide for increased levels of surplus, cash flow, income and net worth. The model forced decisions with respect to the variables as dictated by the financial state of the operation. Thus, if available retained earnings and other available potential capital did not provide the borrowing capability to purchase outright then that alternative form of arrangement dictated by the financial situation operates. In other words, better management was a direct result of the decisions incorporated in the model.

Expenses for withdrawals were strictly determined as were other expenses which the farmer might not consciously identify and control. Better financial analysis, and investment criteria were operative in the model.

All these factors are cost reducing culminating with better management, higher income, surplus for investment and net worth when the base situation is subjected to the influences of the factors and levels used in this study.

IMPLICATIONS OF THE STUDY

The results of this study have a number of implications that may be of assistance to policy makers. These are discussed below.

Implication for Land Policy

Many Canadian provinces have been especially concerned about land use and ownership. Many of them have enacted land use and ownership legislations and although operating for many years, most of the provinces have been amending these acts recently. Implied in these legislations and amendments are the policy concerns for land as a scarce resource. This concern is due to lack of acceleration of land productivity research and in the broadening of the arable land base. This generates a need for rationalization of use of available land and expansion of land supply to increase farm output and income.

But most of these policies at present appear to be based on qualitative norms such as nationality, percent foreign control composition of buyers, assessed value for municipal taxation purposes, and transfer rights.

This study indicated that the type of farmland control use or tenure arrangements has significant impacts on the net income of farmers. Moreover, the impacts vary with the combination of type of debt structure and type of rate of return received. The net income measures used to evaluate the performance of the tenure arrangement varies with type of control arrangement.

One of the implication of the above results for land policy concerns the rationalization of land utilization in terms of type of farmland use control. Thus, the results of this study may be incorporated with present provincial land use and ownership policies to develop a stronger, quantitatively - oriented policy that will also include distribution and conservation policies. For example, The Saskatchewan Farm Ownership Act, passed in May 1974 was amended in 1978 and 1980 in order to place further constraints on foreign ownership of farmland.

The legislation regulates foreign ownership on the basis of assessed value and an area of 160 acres. The results of this study may be used to restrict ownership on the basis of type of tenure arrangement. Agricultural land is being eroded by transfer to other uses and by speculation. Inventory can be taken of this situation to keep it in proper perspective.

In Manitoba, The Farm Lands Protection Act, passed in 1977, has been repealed and replaced by the Farm Lands Ownership Act assented to in 1983 and will be coming in force in 1984. The change emphasizes 'ownership' more than 'control'. The stated aim is to preserve the land resource for use by the current and subsequent future generations of Manitoba residents. Its design was to restrict speculation in farmland thus strengthning the family farm, advancing rural development and providing the opportunity for Manitobans to acquire farmland in Manitoba. In effect, the Act restricts non-residents of Manitoba and non-farm corporations from acquiring more than 10 acres of farmland in Manitoba.

The results of this study imply that a more technically sound policy approach can be taken to restrict the use and abuse of farmlands. Since the Act does not address the question of tenureship, that is, is it better from the farmer's and economic standpoints to set the goal as outright ownership ? By controlling the type of land use arrangement, policy could be developed to achieve more effective use, control and conservation of farmland. The foregoing in combination with adequate return will assist in stemming rural migration as agriculture will become more competitive in line with other economic sectors-resources employed in agriculture must earn competitive rates.

As shown previously, different arrangements affect the farm operation differently. If land inventory in different use is taken, then dependent on the perspectives of government policy, the specified quantum of land named by the policy could be brought into or taken out of production to meet productive and conservation objectives. Utilizing the results and implications shown in this study may be used as contributors of policy instruments to safeguard agricultural lands.

Implication for Resource Adjustment and Productivity

Rental-purchase arrangements, share-renting and cash renting have such good performances with respect to net worth, net cash flow and net income, that a policy to encourage and foster these types of farmland tenure arrangement instead of outright purchase may serve to ease the financial plight of farmers. New farmers are required to put out a large amount of capital in order to avail themselves of the factors of production. Outright ownership requires the largest outlay of capital of these productive inputs. If the farmer can be convinced of the financial saving by foregoing purchase of land for rental-purchase or renting and the relatively high level of income attained and maintained by these methods, then agricultural production will tend to become more profitable. More importantly, more and younger farmers may be encouraged to enter the sector.

Consequently, greater efficiency in production results and with the high net cash flow, better planning may be achieved. Ultimately, the farming sector may benefit from higher returns for the farmer's fixed resources. The public may obtain lower-priced food and less efficient resources may transfer out of agriculture into areas where they may command higher returns. This type of policy will influence the number and sizes of farms. No longer will it be necessary to enlarge farm excessively, for as agriculture becomes more efficient in production, smaller size will be able to generate adequate income for the farmer. Given such policies farm families may choose to stay on the farm, strengthening the rural community while preserving the family farm, and stemming the outmigration of people to urban areas.

Given the potential scarcity of productive agricultural land in Manitoba, and the call by policy makers for increased grain production in the next decade to meet anticipated demand, the results of this study may contribute to the development and implementation of the agri-food strategy.

The implication is that whereas the family farm remains an essential structural component of agriculture, ownership of farmland will be relegated to a position of lesser importance.

Implication for Farm Credit and Financial Management

The Farm Credit Corporation helps Canadian farmers in establishing and developing viable farm businesses by making long term mortgage credit. It can restrict lending in order to allocate funds to the most deserving. The terms and conditions of loan are worked out between borrower and lender but basic conditions are set. There is no basic condition about the debt structure and/or rate of return on resources.

As the results of this study showed, the type of debt structure relationship and the rate of return significantly influence the financial health of the farm business. Therefore, the incorporation of the results of this study into the policy of the Farm Credit Corporation may contribute to the objective of the corporation.

The Farm Credit Corporation, along with other provincial and private lending institutions may utilize the results of this study to become active in formulating new guidelines for credit by incorporating debt structure. This may serve to ensure that credit needs of the sector, especially short term and medium needs, are met by quick response on the part of these institutions.

In so far as the structuring of loans are concerned, both government and lending institutions can develop policies that will assist the producer to better manage his liquidity, since the optimal level of debt structure ratio will vary for individual cases. Extension workers and farm advisors will play the leading role in such exercises. The results presented here were obtained from a short term liability/long term liability ratio of .1429 and a medium term liability/long term liability ratio of .2857. However, a whole series of ratios can be obtained from the model which is coded to handle seven ratios. It is not inconceivable for a policy to insist on a specific relationship between the current liabilities/long term debt or medium term liabilities/long term debts. These debt structures may affect the loan security and the farmer's ability to repay loans. Credit institutions may be able to determine the ability of a farmer to repay loans and thus evaluate the risk of nonpayment or possibility of foreclosure in the future.

Implications for Farm Income Instability and Welfare

The Western Grain Stabilization Program introduced in 1976 was designed to provide income stability for grain producers. Participants are guaranteed that the net cash flow from grain receipts will stay above the previous five-year average. The program, therefore, recognizes net cash flow as the critical problem. The results of this study support the use of cash flow as a more sensitive farm income measure than net farm income and net farm worth. These results have implications for the operation of the program especially if the farmer operates his business utilizing the factor combinations proposed. These generated a greater net cash flow than the control farm implying that the cost of the program may be significantly reduced as net cash flow in any participating year may always be greater than the previous five year average.

There appears to be the need for harmonization of stabilization programs and policies of the Federal and Provincial governments in order to prevent balkanization with its consequent reduced efficiency and productivity. With the incorporation of the net cash flow as the functional performance measure for stabilization purposes, harmony may be attained. This may help in reducing the cost of these programs to a lower level than the current $400 million Federal contribution to stabilization programs.

Recalling that observation of Loyns that farmers are poorly paid for their efforts, are poorer than the rest of society and are about to exodus farms because of inadequate returns, another implication of the findings of this study is that the above concerns might be more seriously addressed by incorporating higher returns to the farmer for his resources. This will improve his returns, thereby raising the level of income and enticing farm families to stay on the family farm.

Moreover, W.J. Anderson's concern that agriculture should become more efficient and as competitive as other industries for resources so that its rate of return could equal those set by the general level prevailing in the economy, would be addressed.

It is concluded that if appropriate farmland control arrangement, return percent on productive assets and debt structure management are effected, farm operations will provide adequate returns to the farm operator. Eventually the perceived low income problem will cease to exist among bona fide farm operators.

Farm operators that continue to show inadequate returns, could quite justifiably be considered under 'social poverty' not 'farming poverty' and be dealt with under universal programs.

Farm income variability and farm cash flow variability while persisting due to the nature of farming uncertainties of weather and prices, will be rendered at higher levels similar to participants in other sectors.

It should also be pointed out that the findings support the view espoused by Kraft that purchase of land allows the farmer to capture unearned appreciation of land and higher net worth than renting.

The results of this study also suggest that net cash flow is very variable, is a critical aspect of the overall financial problem confronting farmers, and is the income measure in more immediate need of resolution. This may have implications in terms of equitability in distribution and levels of income. Some of the inequalities in ownership of income earning resources may be dissipated.

LIMITATION AND USES OF THE MODEL

The farm simulator constructed is both general and versatile. Although, it was constructed to represent a crop farm, it can be adapted with minimal computer programming to deal with mixed enterprises. It deals with very many aspects and options as far as crop farms are concerned; gives detailed cost of production analyses, complete financial picture, complete detail of the farm organization, acreage allocation, crop rotation, lists numbers of and types of each loan, and several other details. One area of

Other improvements of the model may be invoked as one works and updates it. The model, being a whole farm representation is amenable to additions of modules. Another area of improvement can be the addition of subroutines to deal with fertilizer use and including the effects of moisture stress on crop yields.

With respect to the need for further research the stochastic simulation results may be improved in terms of hypotheses significance and magnitude of impacts by running more replicates (hundreds) of each treatment. The precision of the statistics especially the significance levels will be improved.

The major limitation encountered with the model were those specified in the discussion of simulation in Chapter II. The size of the model posed severe practical problems, the most severe of which was the quantity of computer time required to run the model and print out results for the twenty year run. This was especially long when several alternative decisions, such as effecting all land control options, were executed in one run. In the final stages of the study it was necessary to identify only the specific tables required to be printed and store these on tape for later use.

Inability to get the detailed results printed for twenty years meant that once it was ascertained that the model was working well, the results were held in 'save' and studied there before directing the printer to print out the essential tables. The drawbacks with this situation were:

i) it was very tedious and time consuming.

ii) if anything went wrong after the results were observed, but before printing, the user was not aware. In order to correct for this, several tables containing intermediate data were printed. This is an area for further research work dealing mainly with programming efficiency. Use of FORTRAN language also posed a small inconvenience due to its rigid rules.

iii) high cost for computer time.

The model used in this study and results obtained therein may :

1. Contribute towards regional development policy in that the Department for Regional Economic Expansion through the Agricultural and Rural Development Act, Prairie Farm Rehabilitation Act, and General Development Agreement have aided in agricultural development in Canada. These programs together with others in transportation, manpower and employment have generated the socio-agrico-economic-environment for agricultural production. Incorporating the results of this study in the model may assist in rationalizing

these stabilization programs and in evaluating their impacts on income and employment.

2. Contribute towards a strategy for market development encompassing increasing efficiency of production.

3. Contribute to regional self-sufficiency objectives by its effect on efficient resource utilization alluded to earlier.

5. Contribute towards an overall strategy for strengthening supply base:

   i) it may contribute towards the conservation and upgrading of the farmland base,

   ii) it may contribute towards the development of management systems and restructuring of many farms, both technically and from busines management in order to ensure continuity of the family farm,

   iii) it may contribute to the development of strategies to meet the demand for and supply and availability of funds' to finance productive investments in agriculture,

   iv) it may contribute towards the maintenance of adequate human resources in rural communities.

   v) it may contribute towards the transfer of technology by utilizing the model and various results generated as a demonstration plot of better production and management methods.

6. Contribute in forecasting and impact studies.

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