AN ECONOMETRIC ANALYSIS OF SUNFLOWER PRODUCTION IN MANITOBA

A Thesis Submitted to the
Faculty of Graduate Studies in Partial
Fulfilment of the Requirements for the
Degree of Master of Science

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and Farm Management
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ABSTRACT

Sunflower production has fluctuated widely over the past 20 years because of variations in yield and the number of hectares seeded each year. This has resulted in uncertainty of availability of supply to the processing industry, fluctuating income levels to producers and hesitancy in developing effective Government programs.

In this thesis the problem of variation in the supply of sunflower seed in Manitoba was analyzed by attempting to identify the factors which determine the allocation of the land to the crop. The objectives of the study were to explain the variation in aggregate sunflower seed supply and to predict the seeded hectarage of sunflowers in response to the factors identified as deterministic. These were accomplished by formulating and estimating suitable econometric models to measure producers' response.

The empirical analysis used time-series data and the regression techniques to estimate the parameters of the relationships specified in the four models tested. It incorporated annual data for the period 1955 to 1973 to explain the variation in the seeded area of sunflowers and data from 1974 and 1975 to test the predictive ability of the model.

The sunflower/rapeseed model tested the hypothesis that producers allocate their resources among alternative enterprises based on the relative gross returns among the enterprises by comparing the "expected" gross receipts from sunflower production to the "expected" gross receipts from rapeseed production. Also included was the amount of precipitation in the critical planting period. The sunflower/rapeseed model was used because it was postulated that it represented the major non-Board alternative of producers.

The second model tested the same hypothesis by examining the relationship between the "expected" gross receipts from sunflower production compared to the "expected" gross receipts of wheat. This model also included the precipitation variable. It was postulated that this model represented the comparison to the most important Board alternative and is the "benchmark" to which producers relate alternatives. Both these models were tested in the static and distributed lag form.

The "expected" gross receipts relations among crops were deterministic in the allocation of resources among the alternative crops. This 'prima facie' economic rational however, was not the most important criteria identified by the quantitative results of the models. From the results it was determined that the quantity of land seeded in the previous time period was the most influential factor. The author interpreted this relationship in terms of the psychological reaction in total to the broad management successes or failures in the previous time period. In conclusion, it was stated that the institutional affect must be incorporated into the economic relationships if actual on-farm criteria are to be used to measure producers' responses.

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CHAPTER I

INTRODUCTION

A. INTRODUCTION

Manitoba's sunflower industry originated with a small co-operative venture in 1946. Since then the value of farm production of sunflowers has increased from $.6 to $8.8 million in 1973.[1] Annual production, however, has been extremely variable. Average yields have varied between 426 kilograms per hectare to 1,067 kilograms per hectare and seeded hectarage has fluctuated between 1214 and 76889 hectares.[2] Little research has been conducted on the factors causing these variations. This study is an investigation in this direction. It attempts to explain and predict the production of sunflowers in Manitoba.

The purpose of this chapter is to put into context the importance of this investigation. The chapter describes the sunflower industry in the Province. It outlines the effect and importance of supply fluctuations to the producer, processor, Provincial and Federal Governments.

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[1] 1973, 1974 Yearbooks, Manitoba Agriculture, Manitoba Department of Agriculture, Queen's Printer for the Province of Manitoba, p. 69.

[2] Ibid.

It specifies the objectives of the study and the analytical procedure to be used to achieve these objectives. In conclusion the organization of the balance of the study is presented.

B. THE SUNFLOWER INDUSTRY IN MANITOBA

A wartime shortage of vegetable oils brought about the first commercial production of sunflowers in Manitoba. During World War II all the Manitoba production was processed in Ontario. By 1946, the Rhineland Consumers' Co-op, which was initially formed in 1931 as the Rhineland Agricultural Society, had expanded to include an oilseed processing co-op.[3] Post wartime shortages of vegetable oil caused prices to increase. The favourable economic conditions encouraged farmers in Manitoba to expand sunflower production which provided most of the raw seed for the processing plant.[4] In addition to processing sunflower seed, Co-op Vegetable Oils (C.V.O.) was instrumental in developing research in sunflower breeding for Canada. C.V.O. undertook a research program to develop rust resistant strains following an outbreak of rust in 1951. In

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[3]Robert Meyers, Spirit of the Post Road, (The Federation of Southern Manitoba Co-operatives, 1955), p. 110.

[4]Meyers, ibid., p. 121. In 1943, 2024 hectares were planted; in 1949 a total of 24281 hectares were planted to sunflower.

1953 the Federal Department of Agriculture took over the breeding program at the Morden Experimental Station. The incorporation of Co-op Vegetable Oils to process sunflower seed in Manitoba and its petition to Ottawa to undertake the breeding program, were key stages in the development of the sunflower industry in Manitoba.

Sunflower production has diversified the agricultural base within some regions in Manitoba.[5] Sunflowers extend the crop rotation, are grown on a wide range of soil types, are comparatively drought resistant, and require relatively less nitrogen and phosphorous than cereals. Soil moisture is conserved in the summer through the practice of row planting; and in the winter the high stubble reduces wind erosion and holds snow on the fields.[6] Another benefit of incorporating sunflowers in the farm plan is its complementarity to other farm operations. The crop is usually sown early in the spring and is harvested in late September and October, therefore allowing the work load on the farm to be spread over a longer period of time.

In addition to the agronomic benefits of diversification and conservation, sunflowers contributed to the financial viability of the farming operation. The average gross returns in Manitoba from sunflowers for the period

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[5]Eric D. Putt, Sunflower Seed Production, Canada Department of Agriculture publication 1019, revised 1972.

[6]Putt, ibid.,pp. 9-15.

1955 to 1973 were $90.35 per hectare. The comparable returns for the major crops were as follows: wheat $98.73, oats $67.41, barley $76.66, flaxseed $78.30, and rapeseed $94.68.[7] Sunflower production does not require a large investment in specialized equipment; therefore the costs of productional sunflowers are similar to other grain crops.[8] Also the marketing arrangements within Western Canada favour the production of oilseeds for sale into the non-Board market. Sunflowers are marketed in the same manner that wheat, oats, and barley are marketed through the Canadian Wheat Board. That is, producers receive a guaranteed initial price plus a pooled final payment based upon the realized revenue from the operations of the processors in the marketing year. The major difference however is that the quota restrictions on deliveries of sunflowers are only regulatory, whereas in over supply situations the opportunity to deliver wheat, oats, and barley to the Canadian Wheat Board is restrictive. Similarly the quota restrictions on flaxseed, rapeseed, and rye are only regulatory to ensure orderly marketing through a limited handling system. This aspect of unrestrictive delivery opportunities is an important facet of producer

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[7] Manitoba Agriculture, op. cit., pp. 50-69.

[8] (a) W. J. Craddock, "Economics of Oilseed Production," Oilseed and Pulse Crops in Western Canada Symposium 1975, p. 684.

(b) Putt, op. cit., p. 8.

response in Western Canada and to the financial viability of farming operations.

Most of the sunflowers grown in Manitoba are processed for domestic use.[9] The crude oil is used in the manufacture of salad and cooking oil, the commercial preparation of peanuts, popcorn, and other related products, and as a carrier for liniments. The meal by-product of the oil extraction process contains approximately 20 percent protein and is used in the formulation of livestock feeds. Some sunflower varieties are sold as a confection seed, and for use in gourmet and pet foods.

The sole processing plant in Manitoba is located at Altona, 65 miles south-west of Winnipeg, Manitoba. The plant currently has the capacity to process 90 thousand tonnes of oilseeds per year. Between 1975 and 1977 a $3 million investment will increase the processing capacity to 180 thousand tonnes per year.[10] Since the decision to expand the processing capacity, Co-op Vegetable Oils has been purchased and incorporated as part of a new

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[9]Statistics Canada, Oilseeds Review, Catalogue 22-006 Quarterly, March 1975, p. 21. Over the period covered by the 1971-72 to the 1973-74 crop years approximately 82 percent of the sunflower seed produced was crushed in Canada.

[10]Department of Regional Economic Expansion Report, The Rapeseed Industry: Western Canada Saskatoon, Saskatchewan, July, 1974. The calculation assumes 100 percent capacity for 330 days per year and is based upon current capacity included in the Department of Regional Economic Expansion Report.

entity called CSP Foods Limited, a joint Manitoba Pool Elevators/Saskatchewan Wheat Pool venture. CSP Foods has greater access to supplies of raw materials and markets through its association with, and infrastructure of, the parent organizations. These factors could contribute positively to the future viability of CSP Foods as increased supplies of rapeseed, soybeans, and sunflowers will be required to keep the plant operating at full capacity. Attention will be focused on the procurement of supplies of raw materials and information regarding the determinants of the supply of sunflowers will be valuable to CSP Foods.

C. PROBLEMS

Sunflower production has varied widely, with the most dramatic changes having occurred in the past few years.[11] These wide fluctuations affect the oilseed industry generally and have specific implications for producers, processors, and Provincial and Federal Governments.

The Oilseed Industry in Manitoba

The production and processing of sunflowers and rapeseed were the key elements in the development of the oilseed industry in Manitoba. In the recent past sunflowers contributed 40 percent of the raw seed to the processing operation. The balance of the raw materials were

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[11] Manitoba Agriculture, op. cit., p. 69.

rapeseed and soybeans in the proportions of 40:20 respectively.[12]

CSP Foods has attempted to increase and stabilize the proportion of sunflower seed utilized in the crushing processes through different contractural arrangements. Prior to 1959 the price was established just before the harvest period of the same year; subsequently, could not influence plantings that year. From 1959 to 1974 CSP Foods utilized a contractual arrangement which included a guaranteed initial price plus a pooled final payment in attempting to expand production. Also, under this contractual arrangement CSP agreed to purchase the producers' total production of sunflowers from the hectarage specified in the contract. The advantages of this contractual arrangement were the guaranteed initial price known prior to seeding and the opportunity to market total production. In 1975 the price component of the contract was altered from a guaranteed floor price to a more flexible price mechanism. That is, the producer price for sunflower seed is based upon the rapeseed price and producers are paid 80 percent of the rapeseed price at time of delivery plus an unspecified pooled final payment. These contractual arrangements however have not stabilized the production of

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[12]Report to Resource and Economic Development Subcommittee of Cabinet, Re: Establishment of an Oilseed Processing Plant, The Government of Manitoba, p. 4, Winnipeg, 1974.

sunflowers and supply variability remains a problem to the industry.

CSP Foods markets sunflower oil at the consumer level under the trade name 'Safflo', a high quality vegetable oil. In this product market there appears to be scope for the expansion of the sale of sunflower oil. For example, in 1974 sunflower oil accounted for 3 percent of the total production of deodorized oils in Canada.[13] Also in the oil market there is a price premium of about 4 cents per kilo for the high quality sunflower oil. Both these factors favor the processing and sale of sunflower oil. Market development and an increased market share however are hindered by the uncertainty of supply of sunflower seed to process. In this study an attempt is made to identify the factors which influence producers' allocation of land to sunflowers and to explain the variability of supply. If these objectives can be achieved and CSP Foods can influence producers' decisions to increase and stabilize sunflower production, then it could expand its operations and actively seek a greater share of the domestic market through the promotion and sale of sunflower oil.

Processing

The oilseed processing industry in Canada is entering a new stage of development; a period of active

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[13]Statistics Canada, Oils and Fats, Catalogue 32-006 Monthly, December 1974, pp. 6-8.

competition both between processors individually and between processors as a group and the exporters for the procurement of domestic supplies. For the 1974-75 crop year the respective production of flaxseed, rapeseed, soybeans, and sunflowers are estimated to be 350, 1164, 300, and 12 thousand metric tonnes.[14] In examining the domestic supplies available to processors in Western Canada, the soybean production located in Eastern Canada can be deducted, leaving a total of 1526 thousand tonnes of raw seed for processing. If Canada continues to export oilseeds in the raw form at the 1970-1974 average level of 1172 thousand tonnes, it leaves a net total of 354 thousand available for processing in Western Canada.[15]

Existing firms are increasing their capacity and new firms are entering the industry. At present the oilseed industry in Western Canada has the capacity to crush 659 thousand tonnes per year. Furthermore, by 1976, plans have been announced for the construction of increased capacity which will supplement the current capacity by 426 thousand tonnes per year.[16] This will give Western

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[14]Statistics Canada, Field Crop Reporting Series--No. 19, Catalogue 22-002, p. 3.

[15]Canada Grains Council, Statistical Handbook 1975, pp. 70-71. Includes exports of flaxseed and rapeseed only.

[16]The Rapeseed Industry: Western Canada, op. cit., p. 8.

Canada the capacity to crush 1085 thousand tonnes per year in 1976. Given that the 1974-75 production pattern was relatively normal and that the residual of 354 thousand tonnes available for processing was normal, there will be a shortfall of some 731 thousand tonnes of oilseeds to keep all the plants working at full capacity.

CSP Foods, the only crushing operation in Manitoba, will have increased its capacity from 90 to 180 thousand tonnes per year by 1977. If CSP expects to continue to crush rapeseed, sunflower seed, and soybeans in the proportions of 40:40:20 after expansion,[17] it will have to purchase 72 thousand tonnes of rapeseed or 37 percent of total Manitoba supply basis 1974-75 production figures. In order to be able to crush the same proportion of sunflower seed, it will have to increase the production of sunflower seed to 72 thousand tonnes, 60 thousand tonnes above the 1974-75 figure of 11.8 thousand.[18] Information with respect to factors which influence the production of sunflowers would allow CSP Foods to provide incentives and develop effective crop procurement programs to achieve this level of supply availability.

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[17] Report to Resource And Economic Development Subcommittee of Cabinet, Re: Establishment of an Oilseed Processing Plant, op. cit., p. 4.

[18] Manitoba Agriculture, op. cit., p. 69.

The Production of Sunflower

The wide fluctuations in the supply of sunflowers concern producers, processors, and the Provincial and Federal Governments. At the farm level sunflower production has important agronomic and financial implications. The additional income contributed to the farming operation from the sale of sunflower seed is important to farm viability because recent accelerating land values quickly increase the opportunity cost associated with the practice of summerfallow. In addition, the rising costs of machinery, materials, services and labor are spread over a larger number of productive hectares thus enabling producers to better utilize their productive capacity and reduce their per unit costs.[19] In terms of its adaptability to the farm plan, the production of sunflowers complement the production of other grains normally grown in Manitoba because of its long maturation period and late harvest. Also, sunflower production extends the crop rotation, controls weeds, and conserves moisture.

With the agronomic and financial benefits of including sunflowers in the crop rotation, it must be maintained price competitive with alternative crops. Investigation into what relative price levels must be available for producers to economically include sunflowers to their farm plan is an important aspect of future supply.

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[19] Manitoba Agriculture, op. cit., p. 103.

In response to the two main problems of Canadian agriculture, as most producers see them, Governments at the Provincial and Federal levels are interested in stabilizing and increasing a diversified agricultural base. These problems are,

1. low farm incomes, and
2. uncertainty as to the future.[20]

The Task Force analysis has been supported by Government programs to stabilize and diversify production since it was tabled.

The Provincial Government has addressed these two problems in its Guidelines for the Seventies. Stated in the Guidelines is "that low agricultural incomes are primarily the result of lack of economic power of farmers".[21] The Government's direct action to improve low farm incomes include the establishment of marketing boards for farm products and central purchasing agencies for farm supplies. With respect to the second problem, the Provincial Governments' stabilization effort has gone into the Farm Diversification Program; the livestock and milk expansion schemes have approximately 60 million dollars outstanding

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[20] Canadian Agriculture in the Seventies, Report of the Federal Task Force on Agriculture, Ottawa (December 1969), p. 13.

[21] Guidelines for the Seventies, Volume 1, Introduction and Economic Analysis, the Province of Manitoba, Winnipeg (March 1973), p. 82.

in loans.[22] The intention of this program is to diversify the productive base in order to decrease the effects of "boom and bust" cycles that have characterized agriculture in the past. It could be complemented by a strong diversified crop production base which would increase total output on Manitoba farms. Sunflowers are a crop that could raise farm incomes and contribute to stabilizing the farm sector. Investigation into producers' reactions to producing the crop could contribute to this end, and possibly lend information to policy and program development.

The Federal Government views a strong agricultural base as a means of reducing its price support programs and increasing incomes to Canadians.[23] These objectives are being sought through various programs, one of which is increased sunflower production. The Government is supporting this program through research and development into new varieties at the Crop Development Centre in Saskatoon, and through on-going research at the regional stations of the Department of Agriculture. Also, the Department of Regional Economic Expansion is financially supporting the expansion of the processing plant at Altona.[24] In order

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[22]Ibid., p. 94.

[23]Canadian Agriculture in the Seventies, op. cit., p. 29.

[24]The Rapeseed Industry: Western Canada, op. cit., p. 10.

that the expansion program be economically viable, increased supplies will have to be purchased from producers. The effectiveness of these research and expansion programs could both be aided by additional information regarding producers' response to sunflower production.

In order to develop and implement policies and programs which satisfy the goals of producers, processors, and Governments, knowledge of production response for sunflowers must be improved and the deterministic factors identified. With this knowledge the various levels of involvement in the industry would have the opportunity to effect changes in policy and programs, and expand production. This study is an investigation into sunflower production response and will provide some insight into the problems posed in this section.

D. THE OBJECTIVES

The problems outlined in the previous section hinge on producers' expectations and reactions. In this study the static and distributed lag models are used in attempting to measure these phenomena. The purpose of the study is to quantitatively represent the producers' decision making environment in explaining and predicting sunflower production. The specific objectives may be stated as follows:

1. to explain the variation in aggregate sunflower supply,

2. to formulate and estimate an econometric model to predict the seeded hectarage of sunflowers in response to various factors.

E. THE ANALYTICAL PROCEDURE

The empirical analysis will assume the form of a single equation regression technique.

A static and a distributed lag model will be used in estimating the coefficients of the selected explanatory variables. In the static model the coefficients of expectation and adjustment are both assumed to be 1; that is, producers expect last year's price to continue in the future and make complete adjustment in their intentions from year to year. The distributed lag model implies that producer response is spread over a number of years. The single equation method will be used since all the variables postulated to be deterministic in obtaining a value for the dependent variable are predetermined.

The analysis will use time series data at the Provincial and National level. The study will analyze data from 1955 to 1973, a period of time in which the number of hectares of sunflowers planted fluctuated widely. It is hypothesized, however, that no significant structural change has occurred and that these fluctuations can be adequately represented by a well specified model. The equations obtained from the correct formulation of the model will be used to predict the seeded hectarage of sunflowers for 1974 and 1975. These will be compared to actual seedings and the predictions evaluated.

F. ORGANIZATION OF THE STUDY

The remainder of the study is organized as follows. Chapter II includes a discussion of the theoretical economic and statistical aspects of supply response which are related to this study. Also, the institutional framework is discussed and the review of literature is presented in Chapter IV. The results of the empirical analysis are discussed with reference to the objectives of the study. The same chapter discusses the implications of the findings and usefulness of the results.

CHAPTER II

THE THEORETICAL AND INSTITUTIONAL FRAMEWORK OF PRODUCER RESPONSE

A. INTRODUCTION

The objectives of this study are to explain the variation in the aggregate supply of and to predict the actual production of sunflowers. This requires knowledge of the economic and institutional environment in which producers make decisions. It also involves the identification of and incorporation of controllable and non-controllable factors to represent the producers' decision making framework.

This chapter introduces and discusses the theoretical economic considerations of measuring the supply of an agricultural commodity. In view of the difficulties involved in attempts at obtaining empirical estimates of the theoretical relations, a more pragmatic method of measuring producers' response is adopted. This involves the identification of important "supply shifters" and the methodology of statistically relating these to actual producer on-farm decision making. In order that a realistic conceptual model for this statistical measurement be developed the institutional milieu in which producers make decisions is detailed. This includes not only a description of the key institution in the Canadian grains industry, but also the various marketing alternatives of producers. In conclusion, previous studies which have been undertaken within this economic and institutional framework are evaluated.

B. THE SUPPLY FUNCTION

The Theoretical Supply Curve

The basic theory of production hinges on the static production function of the individual firm. It is from this physical relationship, incorporated along with factor prices, that the various cost curves can be constructed. The supply curve of an individual firm in a purely competitive market will be determined by the shape of the marginal cost curve and is that portion which lies above the average variable cost curve (Figure 2.1)[25] The aggregate supply curve for any commodity can be obtained by the horizontal summation of the marginal cost curve of

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[25] For a description of the physical relationship, cost relationship, and supply curve for the firm and industry, see:

(a) R. H. Leftwich, The Price System and Resource Allocation, Holt, Rhinehart and Winston, 1966, pp. 98-182.

(b) H. H. Liebhafsky, The Nature of Price Theory, The Dorsey Press, Inc., Homewood, Illinois, 1963, pp.119-246.

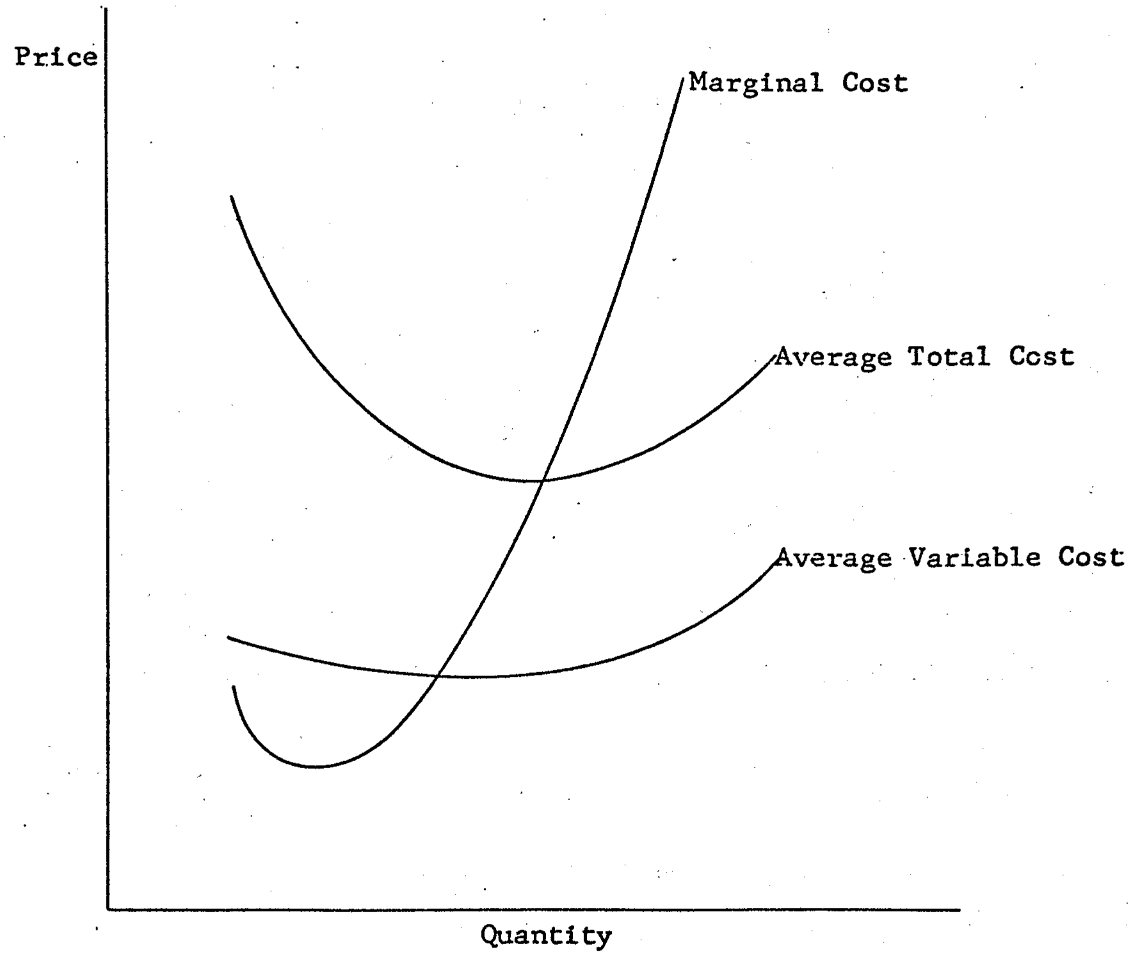

Figure 2.1

Cost Curve Structure of a Firm
in a Purely Competitive Market

all farms if known.[26] In practice however, this method of estimation of the supply function for individual commodities is subject to empirical limitations.

Changes in Supply

In the real world we are not directly concerned with the profit maximizing level of the individual farm or the industry but with shifts in the aggregate supply curve of the industry. There are many factors, both controllable and non-controllable, which influence the aggregate response of producers and cause a shift or result in a shift in the supply curve. It is these factors which can be quantified to measure the changes which are of interest to analysts in their evaluation of producer supply response.

Some of the controllable factors which have been identified as deterministic in supply response are: (1) technological change, (2) flexibility of fixed factors, and (3) changing costs and returns.

When analysts argue about "shifts" in the supply curve they implicitly include the "ceteris paribus" assumption of a constant state of the arts. This assumption refers to the complex set of factors which include the technical parameters of production, managerial abilities, and the institutional setting in which the firm operates.

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[26]Earl W. Kehrberg, "Determination of Supply Functions from Cost and Production Functions," Agricultural Supply Functions, edited by E. O. Heady et al. (Ames, Iowa, Iowa State University Press, 1961) pp. 139-150.

In the real world however, we expect these factors to change continuously and consequently would result in more than a parallel shift in the supply curve.

Structural change is the result of changes in one or more of the factors included in the "ceteris paribus" conditions. Usually the assumption of a smooth continuous change in these phenomena is made and introduced into supply analysis by the proxy, time trend. This variable presumably accounts for shifting effects not adequately accounted for by other variables in the equation that have shown a relatively constant pattern of change over time. In the case in the production of sunflowers in Manitoba it is postulated that the "ceteris paribus" conditions have not changed at a significantly different rate for the various crop alternatives, and it is concluded not to be the critical factor in producers' annual production plans.

Another factor which is becoming increasingly important as farms today become more capital intensive is the degree of flexibility which producers have to adjust their output levels. This factor however does not restrict or limit the production of sunflowers as it has been previously stated that its production requires little specialized equipment.[27] Therefore, limitations with regard to fixed investment in capital equipment is not an important factor in determining the production level of

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[27]Putt, op. cit., p. 8.

sunflowers.

A third factor which is important in the overall supply response for a particular commodity is changing costs and returns per hectare. Figure 2.1 represents the conventional presentation of the cost curve structure of farms in a purely competitive market. In the theoretical analysis of supply response it is the portion of the marginal cost curve above the average total cost curve which represents the supply curve for the industry. In the application of this conclusion, it must be remembered that it was assumed producers have full knowledge of their total variable and fixed costs. Therefore, producers are aware of what revenue level must be generated to defray the long run total costs of the farm. Therefore it is the formulation of the comparative levels of "expected" revenue among crops which alters the production levels on farms and determines the overall supply response for a particular crop.

This criterion is formulated by producers with imperfect knowledge as to the level of the most important factor, the price of the output.[28] It is the "expected" price and the subsequent "expected" gross revenue per

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[28]The other component of "expected" revenue is yield. The yield variability among crops however can be calculated and the uncertainty as to this aspect of "expected" revenue made known. This leaves the expected price as the only uncertainty in the formulation of "expected" revenue.

hectare which is the main determinant of the production plans of producers. Therefore, in formulating a production response model, producers formulation of price expectation should be explicitly included. Those price expectations can depend solely on the price in the previous time period or on a number of past prices.

C. PRICE EXPECTATION MODELS

Producers formulate production plans based upon their conceptualization of "expected" price per unit of output. But producers' expectations are not directly observable and therefore cannot be included in the specification of an empirical model to measure producers' response. It is required, therefore, to replace these expectational variables by observable variables. Towards this end it is possible to utilize two statistical models, one which assumes that producers' expectations are based solely on the price in the previous time period, and a second in which producers' expectations are based upon a weighted average of past prices with the weights declining from recent to less recent time periods.[29]

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[29] Nerlove, M., The Dynamics of Supply: Estimation of Farmers Response to Price. Baltimore: John Hopkins Press, 1958, pp. 51-65. This discussion is based on Nerlove's interpretation and development of a restrictive and general expectations model.

The Static Model

The traditional static model assumes that $0^*_t = 0_t$ and $P^*_t = P_{t-1}$, that is, it assumes producers fully adjust to their desired output level each season according to the price level in the preceding season. This representation of producers' response phenomena interpreted in terms of Nerlove's "price expectation model" and "output adjustment model" impose the constraints that, $\beta =$ the coefficient of expectation and $\alpha =$ the coefficient of adjustment, are both equal to 1. It is the most limiting case of response model specification and is referred to as the static model or the simple cobweb model. It can be formulated simply by utilizing observable price variables in the previous time period to represent producers' expectations. The crop sunflower conforms to the limiting conditions of $\beta = 1$ and $\alpha = 1$. That is, it is a small proportion of total cropland and requires little specialized equipment allowing producers to fully adjust their production plans yearly to the long term "normal" level of prices, that being equal to the price in the previous time period.

The Dynamic Model

In reality however, producers' notion of the long run "normal" level of prices is constantly changing; so is their actual output. This implies that neither the coefficient of expectation, β, nor the coefficient of adjustment, α, are equal to 1, and that both a price and output lag exist in actual producer decisions. However, analysts have found it expedient to assume either the coefficient of expectation, or the coefficient of adjustment equal to 1. If it is assumed that $\beta = 1$, so that $P_t^* = P_{t-1}$ and $0 < \alpha < 1$, then the model is referred to as a partial adjustment model. Conversely, if it is assumed that $\alpha = 1$, so that $0_t^* = 0_t$ and $0 < \beta < 1$, it is referred to as the adaptive expectation model. Either assumption permits the analyst to interpret producer response solely in terms of a distributed price or output response.

In the case of sunflowers it is reasonable to assume that producers can fully adjust the current hectarage to their desired or long run equilibrium hectarage (i.e. assume $\alpha = 1$). This is because of the small proportion of cropland occupied by sunflowers, the limited capital requirements to produce the crop, and the scope of production alternatives available to producers. The assumption that $\alpha = 1$ allows an unambiguous estimate of β. This estimate is interpreted in terms of Nerlove's price expectation model which states that producers adjust their expected "normal" price level by β, which is proportional to the difference between the actual and the expected normal price levels in the previous period.[30] This implies that the price to which producers respond is a weighted

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[30]Nerlove, M., Ibid., p. 53.

average of past prices with the weights declining from recent to less recent periods. The rate of decline of the weights depends on the value of β, the coefficient of expectation. If β is close to 1, then the weights decline sharply and only a few past prices are important. If β is close to 0, a great many past prices are given consideration by producers when formulating their expectations and their production plans. By utilizing Nerlove's general price expectations model, also called the distributed lag model because producers' response is spread over several time periods, it is possible to incorporate a dynamic phenomenon into the measurement of response.

D. THE INSTITUTIONAL FRAMEWORK

A vitally important facet of producers' supply response in Western Canada is the institutional structure in which they formulate production plans and make management decisions. This section outlines the key institution affecting farming decisions, the Canadian Wheat Board, and some of the key aspects over which it has control. Following this, some background information on the two major markets available to producers and their characteristics is presented. This is done to facilitate the review of literature and to help justify the specification of the model chosen in the study.

The Canadian Wheat Board

The Canadian Wheat Board was established as a Crown Agency in 1935 under Prime Minister R. B. Bennet by the passage of the Canadian Wheat Board Act. Under the Act of 1935 the Wheat Board was given the responsibility of marketing wheat on an optional basis. In 1943 the Canadian Wheat Board became a compulsory Board for wheat only, and in 1949 the Act was extended to include oats and barley. Since then revisions and modifications to the Wheat Board Act have made the Wheat Board the sole marketing agency for wheat, oats, and barley entering the export market and the domestic food grains market. The Wheat Board also has direct influence on the marketing of rapeseed, flaxseed, rye, and other special crops through administrating delivery quotas and boxcar allotments. In the process of administrating these responsibilities many of the programs implemented by the Wheat Board affect all producers and have an influence upon the allocation of land to various crops. They include: (1) the initial payments, (2) the delivery quotas, and (3) the control of grain movement.

The concept of the initial payment stems from the first Canadian Wheat Board established in 1919 and retained in the 1935 Act establishing the present Canadian Wheat Board. The initial payments on wheat, oats, and barley handled by the Board are established annually and guaranteed by the Government of Canada in respect of the basic grade of each of these grains. These initial payments, paid to producers at the time of delivery of their grain are, in effect, a floor price for each of the grains. This guarantee gives the producer some assurance against any disasterous price declines. This fact is an important aspect of this study. Between 1955 and 1973 the initial payments contributed the largest portion of producers' "expected" gross receipts[31] and are an important factor when producers formulate their production plans.

Another important aspect of the Canadian Wheat Board operations is the administration of the grain delivery quota system. The purposes of the quota system are to ensure that the correct grains and grades are in export position and to equitably allocate grain delivery opportunities. Over the period of the analysis the quota systems have changed from a Unit Quota System, to a Specified Acreage System, and to the current Assignable Quota System.[32] These different systems have necessitated adjustment by producers in farm planning because the provisions to deliver various grains under the Unit Quota and Specified Acreage Systems have favoured the production and delivery of wheat.[33] For example under the Unit Quota

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[31] Appendix B of this study, Table A.13, p. 120.

[32] The Canadian Wheat Board, Annual Reports of the Canadian Wheat Board, 1955 to 1973, Winnipeg.

[33] Canadian Agricultural in the Seventies, op. cit., p. 63.

System producers were able to deliver a 100 units of any combination of wheat, oats, and barley. The initial prices however did not ensure equal total revenue among crops as wheat was always favoured. The result of this was a glut of various grades of wheat in commercial positions as the quota system did not always reflect market demands. Therefore in attempting to maximize income producers formulated production plans taking into account the institutional component of their marketing opportunities and allocated their land accordingly.

Once grain is delivered to the country elevator, the Wheat Board controls its forward movement to terminal positions at the Lakehead, Pacific Coast Ports, Churchill, Eastern Canada, and interior and domestic mills. Shipping orders issued to the elevator companies control the movement of grain from country elevators to terminal and export positions. Whenever export demand is low and congestion at terminal positions occurs these shipping orders are restricted and the movement of grain through the system reduced. In these periods producers seek alternatives which do not necessarily move through the formal commercial and institutional channels. One of these alternatives is sunflowers. It is not subject to restrictive quotas and can be delivered directly to the processing plants. This affords producers the opportunity to sell their total production.

Marketing Alternatives

The markets in which producers can sell their grain may be classified generally as Board and non-Board. The Board market is defined to include the sale of wheat, oats, and barley for the export market and for the domestic food grains market. The Canadian Wheat Board enters into contractual agreement with the various grain companies which own the country elevator system to purchase these deliveries on account for the Wheat Board. The Wheat Board pays producers through the grain companies for their deliveries in two installments,[34] an initial payment at the time the grain is delivered to the elevator and a final payment normally about eighteen months after the grain is harvested. Therefore, producers do not know the total price received for grain sold to the Wheat Board when selecting crops for the upcoming year. Delaying the payment causes some rigidity in the cropping pattern as producers formulate their production plans with a combination of Wheat Board prices.

Another facet of the Board market which is important to producers' decision making is the volume of grain that they have been able to deliver to the elevators. The volume of grain which can be marketed at any one time

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[34] In certain years, adjustment and interim payments have also been made by the Canadian Wheat Board prior to the final payment being made.

or in any one crop year[35] is determined by a system of grain delivery quotas. The delivery quota levels are established by the Wheat Board to regulate the flow of grain into the commercial elevator system and to allocate among producers equal delivery opportunities. When export sales are depressed or stocks are at unusually high levels, however, producers may not be able to sell all their grain in the Board market at Wheat Board prices. This aspect of marketing regulation is important because producers may not realize their potential receipts. The undelivered balance of their production is either carried over on farm to the subsequent crop year, or used as feed on the farm, or sold to the non-Board market.

The non-Board market is defined as the market in which wheat, oats, barley, rapeseed, flaxseed, and rye are not purchased on account for the Canadian Wheat Board. That is, the Wheat Board is not formally involved in the purchase or the establishment of the price of these grains. For sales in the non-Board market the producer normally receives the full payment for the amount delivered at the time of delivery. The payment for the above grains is generally derived from the futures contract prices on the Winnipeg Commodity Exchange, commodity contracts, or direct bargaining between parties. For ease of description the non-Board market is subdivided into the formal and in-

[35]The Canadian crop year extends from August 1 until July 31 of the following year.

formal sectors.

The formal sector includes wheat, oats, barley, rapeseed, flaxseed, and rye not purchased on Wheat Board account but marketed through the country elevator system. The bulk of these grains are priced through the futures commodity market and usually move through the system under the regulation of the Wheat Board. The prices of wheat, oats, and barley are influenced by the Wheat Board's initial payments which establishes a floor price[36] on the Winnipeg Commodity Exchange while rapeseed, flaxseed, and rye prices are established on the Exchange free of Board pricing policy. The Wheat Board regulates the volume of grain which can be marketed at any one time, although the quotas for non-Board grains are not restrictive as to total delivery opportunity during the year. These distinctions, pricing and final delivery opportunities are important aspects of producers' decision making when formulating production plans.

The informal sector includes sales from one farmer to another, to feed mills, and other secondary users. The grain is marketed without Wheat Board regulation[37] and

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[36] In actual fact the initial price is not a floor price below which the Exchange prices cannot fall, but producers might not deliver any grain at the prices offered by the "open market" if the Board Market price is higher.

[37] In 1962, the Canadian Wheat Board divested itself of marketing regulation in the informal non-Board market but producers are required to assign hectarage in their overall quota allotment for delivery into the specialty market under current regulations.

there are no delivery restrictions other than user demand. The price for grains sold into this market is established by direct bargaining between parties. The price is usually below the levels in the Board and non-Board markets as this sector represents the residual market. Therefore, the price received for grains in this informal sector may be considered as the opportunity cost of holding the grain on farm and farm stocks are valued at this level.

The informal non-Board market is particularly important to producers in times of depressed exports and delivery restrictions when producers do not realize their potential gross receipts. That is, under certain market conditions producers do not have the opportunity to deliver all their grain, thus they do not realize the total revenue which would be possible if they could sell their total production. Under conditions when producers cannot realistically expect to sell all the grain they produce, they formulate production plans on "expected" gross receipts. That is, plans are formulated taking into account market restrictions, and their effect on the level of realized total revenue. Therefore in studies of producer response where these phenomena have been in effect, the criteria of "expected" gross receipts level should be represented as accurately as possible. This involves the formulation of a model which takes into account the "expected" gross receipts from both the Board and non-Board markets.

E. REVIEW OF LITERATURE

During the late 1960's and early 1970's several studies analyzed the allocation of Canadian farm land between agricultural crops. Schmitz,[38] Capel,[39] and Anim-Appiah[40] specified econometric models that explained or predicted annual wheat hectarage, while Paddock[41] predicted annual rapeseed hectarage. These studies incorporated various price and non-price variables in static and distributed lag models to represent the economic environment within which producers formulate production plans. The following review of these studies focuses upon variable definition, level of aggregation, and form of the equation used in their model specifications. These specifications with the results of the estimations, are presented in Table 2.1 of this study.

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[38]A. Schmitz, "Canadian Wheat Acreage Response," Canadian Journal of Agricultural Economics, Vol. 16, No. 2 (June 1968), pp. 79-86.

[39]R. Capel, "Predicting Wheat Acreage in the Prairie Provinces," Canadian Journal of Agricultural Economics, Vol. 16, No. 2 (June 1968) pp. 87-89.

[40]J. Anim-Appiah, "Aggregate Versus Disaggregate Acreage Supply Response Models for Prairie Wheat and Barley." Unpublished Ph.D. Thesis, University of Manitoba, 1972.

[41]B. Paddock, "Supply Analysis of Rapeseed Acreage," Canadian Journal of Agricultural Economics, Vol. 10, No. 1, (July 1971), pp. 110-117.

Table 2.1

Summary Presentation of the Review of Literature

	A. Schmitz	R.E. Capel	J. Anim-Appiah	B. W. Paddock
Equation Form	19 static-linear 6 dynamic-linear	2 dynamic-log	9 static-linear 4 dynamic-linear	2 static-log
Dependent Variable	Wheat Area Seeded$_t$	Wheat Area Harvested$_t$	Wheat Area Seeded$_t$	Rapeseed Area Seeded$_t$
Explanatory Variables				
PRICE	1. CWB final payment in t-1 for wheat.	1. March average CWB IWA price for No. 2 Northern at Fort William.	1. CWB final payment in t-2 for wheat.	1. Price of rapeseed in t-1.
WHEAT STOCKS	2. On farm stocks in Canada as of July 31 in t above 2.7 million.	2. Total visible wheat supplies at the end of February divided by the annual average of total wheat production in the previous 5 yrs.	2. On farm stocks in the Prairies on March 31 in t plus a dummy variable if the level of stocks in the 5 year period preceeding t.	2. . .
WHEAT EXPORT SALES	3. . .	3. . .	3. . .	3. Wheat exports for the current crop year.
PRICES OF	4. Flax price in t-1	4. . .	4. . .	4. Flax price in t-1
WEATHER	5. . .	5. . .	5. Six-month average rainfall prior to seeding	5. . .
TREND	6. Proxy for capital availability and technology.	6. . .	6. Proxy for technological, institutional, and unspecified seculor influences on seeded area.	6. Proxy for improvements in technology.
RESULTS	7. Static: R^2 = 0.855 D.W. = 2.09 E = .45? - .377	7. Static: . .	7. Static: R^2 = 0.923 D.W. = 2.69	7. Static: R^2 = 0.943 D.W. = 2.59 E = 2.59
	Distributed Lag: R^2 = 0.795 D.W. = 1.58 ES = .420 - .754 EL = .622 - 1.30	Distributed Lag: R^2 = 0.804 - 0.824 D.W. = 1.25 - 1.58 ES = 0.66 - 0.74 EL = 1.21 - 1.49	Distributed Lag: R^2 = 0.897 D.W. = 2.98	Distributed Lag: . .

NOTES:

1. R^2 = percentage of the variation in the independent variable explained by the explanatory variables
2. D.W. refers to the Durbin Watson Statistic
3. E refers to the static model's price elacticity
4. ES refers to the distributed lag model's short run price elactisity
5. EL refers to the distributed lag model's long run price elasticity (These elasticities are calculated at the mean value of prices and quantities).
6. All the variables are significant at the 10 percent probability level or better.

Variable Definition

In specifying the models the analysts attempted to represent the hypothesis that producers allocate their land based on "expected" gross receipts among crops. It is this hypothesis which is common to the studies and is represented by different variable selection and definition. The models were specified by representing "expected" gross receipts to producers indirectly through the use of aggregate proxy variables.[42] In using wheat prices, wheat stocks, wheat export sales, and rapeseed prices jointly, the authors intended to represent the "expected" gross receipts on-farm of producers from wheat and rapeseed production. The prices of competitive crops were included in two of the studies to represent a choice of producers in the form of "expected" gross receipts from the production of alternative crops.

This representation of "expected" gross receipts results in a vague picture of on-farm decision making and is in fact not very tangible to the individual producers. An "expected" gross receipts variable defined at the farm level would better represent the underlying hypothesis and improve the above supply response models. To achieve this,

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[42] John Helliwell, "Assessing the Role for an Agriculture Sector in an Aggregate Econometric Model," National and Regional Economic Models of Agriculture. Edited by Roger Eyvindson, Economics Branch Publication 72/9, Agriculture Canada. pp. 105-117. Proxy variables are dangerous because they may give misleading measures of the influence for which they stand proxy, and also they lead to biases in other important coefficients.

"expected" gross receipts are defined in this study to include realized gross receipts from marketing wheat through the Canadian Wheat Board plus opportunity gross receipts. Opportunity gross receipts are defined as the revenue which producers could expect to receive from the sale of their stocks net of Wheat Board sales. By weighting the gross receipts by realized and opportunity prices and volumes, a realistic approximation of on-farm "expected" gross receipts for wheat can be formulated. Alternative crops and their "expected" gross receipts can also be incorporated in a similar manner into the model, with the decision variable represented as "expected" relative gross receipts among crops.

Level of Aggregation

The studies included in this review of literature used annual data at the Prairie and National level to estimate the models. Although this facilitates the specification of the models, there are drawbacks to using aggregated data.[43] Aggregation reduces the effect of the variability in data between regions which is of importance to commodity studies. Particular regions have particular characteristics, and if the analyst is able to represent these in the model formulation the results generated more accurately depict actual producer decisions and situation.

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[43]The data used in the studies were aggregated over time and space resulting in a macro representation of daily and locational variation.

Ideally producer response is analyzed for a relatively homogeneous area so that regional factors and conditions are accurately represented. Also, a disaggregated approach allows the results to be applied directly to policy and programs within the region. These aspects are particularly relevant to the analysis of sunflowers as most of the production is located in one region, Manitoba.[44] In particular the production of sunflowers is concentrated in Census Division 2 and 7 and should be analyzed independently because of the particular characteristics of the region such as the number of production alternatives and growing conditions. A regional analysis would be better able to represent the producers' decision criteria and production conditions.

Equation Form

The models were estimated in the static and distributed lag forms with linear and non-linear functional relationships specified. These forms and specifications are examined in terms of the coefficient of multiple determination (R^2)[45] and the elasticity coefficient

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[44] In 1974 the total Western Canadian sunflower production was located in Manitoba. For further details with regard to the producing regions please refer to Appendix A, page 99 of this study.

[45] The coefficient of multiple determination is defined as the percentage of the variation of the dependent variable explained by the explanatory variables.

(E).[46]

R^2. Schmitz and Anim-Appiah specified the relationships as linear; that is, they postulated proportional and independent changes in the explanatory and dependent variables. They estimated the equations in the static and the distributed lag models, with the latter used to take account of the length of time in the adjustment processes of economic behaviour and to render them dynamic. The distributed lag form usually improves the explanation of the variation in the dependent variable, but this was not the case in the above studies. The static model yielded superior results in terms of R^2 in both studies.

An explanation of this is that the area allocated to wheat in period t-1 is not influential in explaining the area allocated in time period t. This is supported by the hypothesis that relative gross receipts among crops is the producers' decision criteria. That is, total area seeded to a crop in the previous year is not a good measure of "expected" gross receipts and cannot explain the marginal changes in land allocated to various crops. Also, producers' intentions and productive capacity may allow instantaneous adjustment from year to year and that the aggregate response and adjustment may not deviate widely

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[46]Elasticity is the ratio of the relative change in the dependent variable divided by the relative change in the independent variable under "ceteris paribus" conditions.

from historical patterns or may not be distributed over a number of past years.

Paddock and Capel specified their equations in a non-linear log functional form and estimated them in the static and distributed lag models respectively. Paddock justified the log functional form estimation because it achieved consistently better results than the linear form in terms of R^2, standard error of the regression coefficients, standard deviations and in significance, while Capel appears to have selected the methodology which achieves maximum efficiency in prediction. Neither of the analysts have stated the economic "a priori" justification of the non-linear functional form or the estimation consequences.

The non-linear functional form implies that the inter-relationships between variables is non-proportional over certain ranges of values. This may be precisely the relationship which one would specify to represent producer decision making, as deviations from "normal" values are important in marginal production changes. However, the analysts have not explained this inter-relationship nor interpreted the results as being a product of joint causes and effects. The effects of this functional form has implications in terms of interpreting the empirical estimations for use in explanation or policy formulation because of the joint dependency of the variables. Also, the relative importance of the variables included in the estimation may be overstated because the estimated parameters of most Cobb Douglas production function form are large relative to their standard error.[47] Overall, this functional form would be expected to yield superior results in terms of R^2 because of the inter-dependencies in the producers' decision making criteria.

Elasticity. The results of the two studies (Schmitz and Capel) which calculated the price elasticity of wheat and Paddock's elasticity for rapeseed cannot be interpreted as the responsiveness of hectarage allocation to a price change in the crops. This is because of their hypotheses and assumptions under which the models were specified and the elasticities calculated. The analysts calculated the own-price elasticity under "ceteris paribus" conditions. This isolated the effect of price and specified a price-quantity relationship which involves movements along a supply curve and is reversible. The effect of a change in product price however cannot be isolated from other factors such as sales level, stocks held on-farm, and alternative crops which compete for the same resources. Also, the analysts postulated that the explanatory variables were inter-dependent and collectively explained producers' response in terms of the allocation of land to various crops. These factors render the interpretation of

[47] L. R. Klein, Introduction to Econometrics, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, p.101.

the elasticity coefficient somewhat tarnished as a strict response measure.

The consequence of the inter-dependency of the variables dampens or accentuates the effect of prices, correspondingly under or over estimating the elasticity. In effect part of the change in the on-farm stocks, export sales, and the prices of alternative crops are incorporated in the price variable causing it to be over or understated. The estimated price effect is likely to be smaller if in fact all other factors were held constant. Another aspect of elasticity measurement which must be considered is the relationship of the crop under study to the industry. Short run elasticities tend to be lower for a crop such as wheat which occupies a large proportion of the cropland and is grown in areas where alternatives are limited. Conversely, elasticity coefficients tend to be higher for crops which are produced as a sideline enterprise and planted on only a small portion of total hectarage.

The above qualifications require that care be taken in interpreting the elasticity coefficients. The interdependence of the explanatory variables require that the supply function be considered a response relation which specifies an output response to a price change, not holding other factors constant. This response may involve both movements along a supply curve and shifts in the supply curve, and is not reversible. The inter-dependency of the variables and context of the commodity are important factors in the interpretation of elasticity coefficients if the empirical estimates are to be used to explain supply variation or recommend policy.

CHAPTER III

MODEL SPECIFICATION AND ESTIMATION

A. INTRODUCTION

In the previous chapter the theoretical and institutional framework within which producers formulate production plans was outlined. The econometric models which are developed in this chapter are based on that framework. The models attempt to express quantitatively the influence of price changes, market opportunities, institutional factors, and managerial expectations upon production decisions.

The hypothesis, which constitutes the basis for the models, is that producers allocate their land among alternative enterprises based upon the relative "expected" gross receipts. This hypothesis is tested using ordinary least squares (OLS). Also, the coefficients of the parameters of the models are estimated so that predictions of the future levels of production can be made. What is of importance is that these models are well specified with accurately defined variables so that they will, as closely as possible, approximate the real world.

Section B of this chapter discusses the conceptual model with respect to the supply response for an agricultural commodity. From amongst the many factors which influence producers' final planting decision, the ones which are postulated to be deterministic in the allocation of land to the crop sunflower are selected. Section C describes in detail the definition of and formulation of the variables which were selected. In Section D the results of the estimation are presented and discussed. Section E introduces the concept of forecasting and its relevance to the study. The seeded hectarage of sunflowers is forecasted and compared to actual seedings.

B. THE CONCEPTUAL MODEL

This section discusses the conceptual model, upon which the econometric model is formulated to test the hypothesis of this study.

In a supply response model concerning movements along and shifts in the aggregate supply function over time, what is of interest is the response of total planned production to various economic and non economic factors. Planned production is made up of two components--yield and hectarage. Although producers can influence yields through the adoption of technological advances and management, realized production may differ considerably from planned production due to important non controllable factors such as weather. This discrepancy between planned and realized agricultural production has led many econometric investigators of agricultural supply response to approximate planned production by seeded hectarage.[48] The area actually seeded is under much greater control than is yield, thus providing a more concrete base from which to estimate production. This approximation of planned production by the area seeded is justified by two main factors:

1. that the actual yield of sunflowers has not demonstrated any discernible trend over time and that the yields of sunflowers are not more variable than those of wheat,[49]

2. that in the formulation of the "expected" gross receipts variables, yields are explicitly included.

Therefore, in considering production decisions it seems reasonable to assume that in any year the area that producers plan to seed is a measure of their intended supply.

The Dependent Variable

Prior to the conceptualization of the decision making environment which determines the seeded hectarage

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[48] This approximation is used in all of the studies included in the previous chapter, p. 34.

[49] (a) the multiple correlation coefficient of sunflowers yield regressed on the time trend variable was 16 percent and fell below the trend line in 10 of the 18 years from 1955 to 1973.

(b) the yield variability of wheat and sunflower were calculated over the past ten years and the coefficient of variability (standard deviation divided by the mean) were virtually identical at 15 percent. Although various estimates of yields could be made as the growing season progresses, from the producer point of view the risk attached to each crop should be similar and seeded hectarage a good measure of planned supply.

of sunflowers, some quantitative and qualitative aspects of the dependent variable land are discussed.

Sunflower production in Manitoba has not reached its physical limit, nor has the maximum seeded hectarage ever been approached. Agronomists state that "it is believed that Southern Manitoba could accommodate 202,430 to 303,640 hectares of sunflowers and still maintain an adequate rotation."[50] This statement dispels any doubt that there is a constraint in terms of land availability or rotational aspects for sunflower production. It allows wide flexibility in the area seeded imposing no constraints on plantings in terms of an aggregate response, although individual producers may encounter limitations.

Although planned production is estimated by seeded hectarage in this study, there are inadequacies in this method. First, land is only one of the many inputs in agriculture. All inputs should be incorporated into the variable to approximate planned production more adequately. Second, land is not a homogeneous factor. Soil type and productivity vary from hectare to hectare thus imposing various levels of potential on land. Third, the intensity with which the land is managed and the levels of management vary widely. These factors distract from seeded hectarage as a proxy for planned production, but it is still a more

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[50]The University of Manitoba, Principles and Practices of Commercial Farming, Faculty of Agriculture, Fourth Edition, 1974, Winnipeg, p. 158. The highest number of hectares seeded to sunflowers was 76889 in 1972.

reliable variable to explain and predict than total physical production which includes the vagaries of yield estimation. Also, these characteristics of land should be qualitatively included by the analyst in the interpretation of the quantitative estimates of producer intentions.

The Explanatory Variables

When producers are formulating production plans they take into consideration many factors, both economic and non economic. The major economic considerations are the "expected" gross receipt levels of alternative crops, the prices of other inputs used in conjunction with land, and the opportunity cost of the land.

In addition to these economic factors, producers take into consideration technical and institutional constraints when formulating their plans.[51] Problems of disease and pest control may impose limitations on the rotational pattern that producers adopt thus affecting their production plans. Policy and program changes effected through the Canadian Wheat Board also exert an influence of producers' plans. These may come about either in the form of direct Government programs such as the Lower Inventory for Tommorrow Program, or quota regulation changes which affect producers on-farm decision making.

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[51] Daniel B. Suits, The Theory and Application of Econometric Models, Centre of Economic Research, Athens, Greece, March 1963, pp. 110-112.

Another important factor which continually influences the long term direction of production is the varying rates of development and adoption of technological changes among crops and producers. Finally producers' initial production intentions may have to be modified because of the non controllable variable, weather.

Variable Selection

It was previously justified that the area that producers plant to seed is a good measure of their intended supply. Therefore, hectarage, rather than the production of sunflowers, was taken as the variable to be explained in this study.

Microeconomic theory suggests that purely competitive firms maximize profits. If we assume that producers are pure competitors, they must then operate to maximize profits to stay viable. This implies that producers allocate their resources among the enterprises that maximize net receipts for the farm. Therefore, assuming that all institutional and technical factors influencing the allocation of resources are included in the net receipts estimates for the alternative enterprises, then it should indicate how producers will behave. However, the unavailability of data and the limited time frame did not allow such a variable to be constructed for the econometric model.

A proxy variable is used, namely the "expected" gross receipts for each crop. The use of a gross receipts measurement to compare cropping alternatives is justified by the facts that either the costs of production among the crops are similar or the differences are known by producers so a comparison of alternatives can be made on a revenue basis.[52] Also the use of gross receipts as the variable to measure producer behavior still allows most technical and institutional factors to be included in the variable to represent the on-farm decision making process.

Although producers formulate specific plans as to the hectarage they intend to sow to alternative crops, the area that is actually seeded is influenced to a large extent by the condition of the land prior to and during the planting season. Unfavourable conditions may prevent preparation of land and timely seeding of crops, causing producers to alter seeding plans at the last moment. This facet of the decision making environment is particularly important for sunflowers because of its maturation period.[53] Therefore, in a production response analysis of sunflowers weather should be explicitly included in the function.

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[52](a) W. J. Craddock, op. cit., p. 684.
(b) E. D. Putt, op. cit., p. 8.

[53]<u>Principles and Practices of Commercial Farming,</u> op. cit., pp. 159-160. Sunflowers are approximately 120 to 130 days to maturity. It is recommended that they be sown from May 1 to June 1 as delayed seeding results in sharp yield reductions

Summary. The dependent variable selected in this study is the seeded hectarage of sunflowers; hectarage being used as a measure of intended supply. The factors which are postulated to influence the planned hectarage are: (1) the gross receipts of alternative crops, (2) the weather condition at seeding time. The omitted relevant factors are assumed to be random and are treated as a disturbance term.

C. VARIABLE DEFINITION AND FORMULATION

The functional relationship included the comparative gross receipts of alternative crops and the influence of weather. The formulation of these variables is discussed below.

Relative Gross Receipts

Gross receipts are defined in terms of total realized revenue from crop sales within the marketing year.[54] However, to simply compare the total gross receipts among crops in Manitoba is not a theoretically sound basis on which to compare alternatives because of the various number of hectares sown to each crop. In order that the gross receipts from alternative crops are evaluated on a comparable basis, the total receipts are divided by the

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[54]The crops sunflower, rapeseed, and wheat which are specifically included in this study are all marketed on the same crop year basis. The crop year extends from August 1 to July 31 of the following calendar year.

number of hectares sown to each crop and gross receipts measured on a per hectare basis. Also, rather than comparing separately the gross receipts of alternative crops, the concept of relative gross receipts is used.

In the model, the relative gross receipts concept was expressed as a ratio between the gross receipts of alternative crops. This method is useful because: (1) it allows the effect of price and volume movements to be incorporated into one variable preserving one degree of freedom, (2) it states specifically the relationship which was theoretically postulated to be the decision making criterion of producers, the relative returns between crops.

Sunflowers. The price for sunflower seed which CSP Foods can offer producers is determined within the oilseed complex in North America. This complex is dominated by soybeans which is priced on the Chicago Board of Trade and is beyond the control of CSP Foods. Another important aspect within this oilseed complex is the availability and substitutability of soybeans into CSP's processing operations thus offering a competitive alternative to sunflowers. In sum, CSP Foods is essentially a price taker with competitive alternatives and must be responsive to this fact in its attempts to influence sunflower production in Manitoba.

Since 1950 CSP Foods, formerly Co-op Vegetable Oils, has been the dominant buyer of sunflower seed and subsequently had the most influence in Canada's sunflower industry. As a buyer, CSP has entered into contractual agreements with producers whereby it agreed to purchase the total production from a specified number of hectares. The method of payment to producers under these contracts has been a combination of a guaranteed initial contract price plus a final payment. From 1955 to 1959 the initial price was established just before harvesting; subsequently did not influence the number of hectares contracted or seeded for the year in which it was announced. Since 1959 however, the initial price has been known prior to seeding and therefore producers have had a guaranteed floor price upon which to plan production. In addition to the initial prices, producers also received a final payment for deliveries during the crop year, dependent upon the realized earnings of the processing firm. This final payment is distributed to producers within six months of the close of the marketing year. The significance of this is that producers then have additional price information prior to the seeding time of the following year upon which to formulate an "expected" gross receipts figure for the production of sunflowers.

In the model, the "expected" gross receipts for sunflowers were determined by multiplying the production of sunflowers per hectare times producers' formulation of the "normal" price level. Although the deliveries of sunflowers are regulated throughout the year, producers historically have sold their entire crop within the marketing year. Therefore, annual production and marketing of sunflowers are synonymous. The "normal" price level which producers expect is formulated by combining the contract price from the current year plus the final payment from the previous crop year. The "expected" gross receipts of producers are thus formulated based upon the contract price in the current year, t, plus the final payment from the previous year, t-1, multiplied by the production per hectare in the previous year, t-1.

In order to complete the relative gross receipts variable it is necessary to include an alternative crop as a basis of comparison. The question to be answered is: "What crop or benchmark do producers use to make their comparative evaluations when formulating production plans for sunflowers?" Intuitively there are two alternatives: (1) rapeseed, which is the predominant oilseed in Western Canada and which could be regarded as the major alternative of the non-Board crops, or (2) wheat, which is historically the predominant crop grown in Western Canada and which could be regarded as the "benchmark" to which producers compare alternatives.[55] The "expected" gross receipts from

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[55](a) Statistics Canada, 1971 Census of Agriculture, Agriculture Manitoba, Catalogue 96-708, Volume IV-Part 3, Ottawa 1973. Wheat occupied 27 percent of the land seeded to crops in the study area.

(b) The University of Manitoba, Sunflower Production in Manitoba, Faculty of Agriculture, unpublished, Winnipeg 1976. In 1974, a survey of sunflower producers was conducted and showed that wheat was the crop to which producers compared alternatives.

both rapeseed and wheat marketings are formulated and tested as part of the ratio to "expected" gross receipts from sunflower marketings.

Rapeseed. Rapeseed production has expanded with the growing demand for vegetable oil and the competitive rate of return per hectare. Marketing procedures for rapeseed are similar to sunflowers with the exception of the method of payment. Under the system of payments for rapeseed in Western Canada, producers are paid the full payment for the volume sold at the time of delivery.[56] Therefore producers are able to formulate production plans in the subsequent year based upon the total realized price of the crop.

In the model it was postulated that producers' expectations as to a "normal" price level are based upon the price from the previous year. The "expected" gross receipts of producers from the production of rapeseed therefore, are based upon the final realized price in the previous year, t-1, multiplied by the production per hectare in the previous year, t-1.

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[56]The price level is generally determined on the futures market of the Winnipeg Commodity Exchange. From this market the price which is paid to producers for delivery to their local country elevator is determined by a Quotations Committee and is announced daily as a "street price." It is this "street price," minus the relevant freight, handling, and other marketing charges which is used to formulate the gross receipts for rapeseed. The use of the futures market by producers to hedge production is omitted in this study.

Wheat. In order to have a theoretically sound base upon which to formulate the gross receipts variable for wheat it is necessary to postulate what combination of initial, interim, and final payments are considered by producers to formulate their expectations as to a "normal" price level. Also, when formulating "expected" gross receipts from the production of wheat consideration must be given to the delivery opportunities, which, in certain years have been restrictive. These aspects of the timing of the payments to producers for wheat deliveries and their marketing opportunities are incorporated into the formulation of the "expected" gross receipts variable for wheat.

The Canadian Wheat Board attempts to achieve price stability to Prairie grain producers through a price pooling system which includes an initial, interim, and final payment. An initial payment is paid when producers deliver their grain to the primary elevator. It is set by the Canadian Government and is a government guaranteed price to the producers. If during the marketing year the Wheat Board realized price for the sale of grain is well above the initial prices, the government may authorize the Wheat Board to issue an interim payment to adjust the initial price in line with market levels. The Wheat Board's final payment is made after the year's crop has been sold, the pool has been closed, and expenses have been deducted for operations. Prices received throughout the year from the sale of each grade and grain are averaged out to form the basis of a per-tonne payment. Producers are then paid according to the number of tonnes of each grade delivered.

Between 1955 and 1973 the initial payment has been announced at two distinctly different times in the year. From 1955 to 1970 the Canadian Wheat Board announced the level of the initial payment of August 1, the beginning of each new crop year. An important factor to note is that over this time period producers were not aware of the initial price for the up-coming crop year until after they had completed seeding and therefore could not consider the new initial price in farm planning. In order to give producers more current information upon which to plan their farming operations the government advanced these announcements to prior to the seeding period (March 1) in 1971.

Under the pooling system of payments operated by the Canadian Wheat Board, the final payment on wheat marketed through the Board is not known or available to producers until approximately eighteen months after the harvest period.[57] Therefore, when production plans for the current year are formulated, producers are not aware of the final price obtained from marketings in the previous year.

The Wheat Board use a quota system whereby all

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[57]The interim payment is not a normal Canadian Wheat Board payment but is made in certain years to adjust the initial payment if price movements and future commitments justify such action. Since 1955 eleven interim payments have been made to producers. These were made within six months of the harvest period and in all cases prior to seeding the following year.

producers have an equal opportunity to sell their grain. The quota system controls the quantity of grain each producer can deliver at any particular time. The Wheat Board responds to market conditions through the year by uniformly increasing quotas to each permit holder as additional supplies are needed to meet sales commitments. These quotas are stated in terms of the number of kilograms per hectare a producer can deliver of a particular grade of grain. In certain years in the recent past these quotas have been restrictive, and producers were forced to carry-over surplus grain on the farm or dispose of it into the non-Board market.

In years when marketings to the Canadian Wheat Board have been restrictive, producers have sought alternative outlets for their wheat. These included sales to feed mills, feed lots, or on-farm usage with the price in these markets determined by the availability of supply and user demand. If we assume that producers determined the non-Board price they received for their sales on the same marketing year as the Wheat Board, they would not know their final realized price until after seeding. Therefore, in formulating their price expectations with respect to the non-Board market the price from the previous year (t-1) would have to be used.

In the model the "expected" gross receipts from wheat production are defined to include a combination of initial, interim, and final payments from marketings to the

Canadian Wheat Board, plus the evaluation of on-farm disappearance at the non-Board price. The "formal" part of the producers' "expected" gross receipts is made up of a combination of initial and final payments times the volume marketed through the Canadian Wheat Board. Producers' expectations with respect to the initial price from 1955 to 1970 are formulated based upon the initial price in the previous time period times marketings in the previous time period. Since 1971 producers' expectations have been formulated based upon the initial price in the current time period times marketings to the Wheat Board in the previous time period. In conjunction with the initial payment, whether it be from the current or previous time period, the final payment is used.[58]

Producers are not aware of the final payment on grain marketed through the Canadian Wheat Board until approximately eighteen months after the harvest period. That is, when producers are formulating their gross receipts expectations they are not aware of their realized gross receipts from the previous time period. Consequently the final payment from two years previous, times marketings from two years previous is used to formulate revenue

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[58]In the years when an interim payment was made, it was included in the formulation of expectations with respect to gross receipts and was lagged one time period. That is, the price in the previous time period was multiplied by marketings in the previous time period.

expectations from the final payment. This is justified by the fact that the final payment is received prior to seeding in time period t and has an influence on the "expected" gross receipts formulated by producers.[59]

The "informal" part of producers' "expected" gross receipts are formulated based upon sales into the non-Board market. The "expected" gross receipts from sales into the non-Board market are formulated by multiplying marketings in the previous crop year times price in the previous crop year times price in the previous crop year. The "expected" gross receipts from sales into this market plus the "expected" gross receipts from sales to the Wheat Board are combined to form a total "expected" gross receipts from the sale of wheat.

In sum, the relative "expected" gross receipts variable expresses the criterion function for the allocation of land between alternative crops. These relative "expected" gross receipts are expressed in the form of a ratio and it is hypothesized that the area allocated to sunflowers is directly related to the size of the ratio. That is, as sunflowers become more competitive in terms of "expected" gross receipts (i.e., the size of the ratio increases), the area planted increases.

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[59] Nerlove, N., op. cit., p. 212.

Precipitation

Whether the intentions of producers are fully realized is dependent upon the climatic conditions prior to and during seeding. Some of these conditions are rainfall prior to frost in the fall, snow cover, temperature, and precipitation in the planting period. These factors are particularly important for the crop sunflower because of its long maturation period compared to the other crop alternatives which producers have available to them.[60] That is, in order to achieve potential yields from the crop sunflower it is necessary that it be sown as early as possible in the spring.

For the model the amount of rainfall was considered to be the most important condition. Ideally, rainfall should be incorporated in both its absolute amount and the amount beyond a critical level. This is because additional rainfall beyond a certain level has greater than proportional effects on the condition of the land. This was not done in this study because of the difficulty in obtaining critical level data for various soils and crops. Therefore the absolute amount of rain that fell within the Red River Basin during May became the observation in the

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[60]Sunflowers are 120 to 130 days to maturity while wheat is 90 to 100 days and rapeseed is 80 to 110 days to maturity.

model.[61]

It is hypothesized that the area allocated to sunflowers is inversely related to the precipitation level. As the amount of rainfall in the month of May increases seeding is delayed and producers switch to alternative crops which require a shorter maturation period.

Summary

The hypothesis that producers allocate their land among alternative enterprises based upon the relative "expected" gross receipts among the enterprises was tested using two equations. These equations were tested by applying the regression technique to both the static and distributed lag form. The variables included in these equations were formulated based upon the preceding discussion using annual data from 1955 to 1973.

The first equation included the "expected" gross receipts ratio between sunflowers and rapeseed plus the precipitation variable in attempting to explain the supply of sunflowers.

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[61](a) The precipitation levels recorded at meteorlogical stations within the Red River Basin were summed and averaged.

(b) The equations were tested using the absolute amount above the mean and mode, the absolute amount squares, and in the log form but the best results were obtained using the simple absolute amount in the linear form.

The second equation included the "expected" gross receipts ratio between sunflowers and wheat and the precipitation variable.

The variables included in the estimation and their units of measurement were:

H = the number of hectares sown to sunflowers,

GRS = the "expected" gross receipts of sunflower production in dollars per hectare,

GRR = the "expected" gross receipts of rapeseed production in dollars per hectare,

GRW = the "expected" gross receipts of wheat production in dollars per hectare,

PM = the precipitation in May in millimeters.

D. RESULTS OF THE ESTIMATION

Introduction

In this section the linear regression results are presented. These results are evaluated based upon 'a priori' economic theory, statistical and econometric tests of significance.

In the presentation of the results, the bracketed statistics beneath each regression coefficient are the t-values. These were calculated by dividing the estimated regression coefficient by its standard error. To test the significance of the regression coefficients in the function the t-test for small samples was applied. The t-test is applicable if the assumptions of the linear regression model are satisfied. These are: the assumption of randomness, the assumption of zero mean, the assumption of constant variance, and the assumption of normality of the disturbance term.[62]

The coefficient of multiple determination, R^2, is defined as the percentage of the variation of the dependent variable explained by the independent variables. The value of R^2 lies between 0 and 1. The higher the R^2 the greater the percentage of the variation of the dependent variable explained by the regression plane. It is interpreted as the measure of the overall "goodness of fit" of the equation in explaining the dependent variable.

To test the assumption of ordinary least squares that the successive values of the random variable are temporally independent, the Durbin-Watson statistic was used.[63]

To test the significance of the overall regression equation the F-test was used. It tests the hypothesis that the explanatory variables do not influence the dependent variable.

Sunflower/Rapeseed Model

The first relation presented is the static form of

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[62] A. Koutsoyannis, Theory of Econometrics, The MacMillan Press Ltd., London, 1973, pp. 173-194.

[63] Ibid., pp. 206 - 210.

the equation for the sunflower/rapeseed model.[64] This model incorporated the "expected" gross receipts of sunflowers relative to the "expected" gross receipts of rapeseed, plus the precipitation variable.

$$H_t = \underset{(.903)}{16931.2} - \underset{(-1.502)}{211.9\overset{***}{PM}} + \underset{(1.053)}{19004.3\overset{****}{RR}} \qquad (3\text{-}1)$$

Std. Err. of Eqn.	Durbin-Watson	R^2	F-Value
18740	.51	.13	1.25

In equation (3-1) the signs on the coefficients of the independent variables were theoretically correct but neither regression parameter were very significant in the function.

The value of the coefficient of multiple determination indicated that the set of explanatory variables explained 13 percent of the variation in the dependent variable, the seeded hectarage of sunflowers. This left a considerable proportion of the variation in hectarage unexplained and the F-value indicated that the equation was not significant at the 5 percent level in explaining the dependent variable. The Durbin-Watson statistic indicated that there

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[64]The estimated regression coefficient with 1 asterisk were significant at the 1 percent level, with 2 asterisks at the 5 percent level, with 3 asterisks at the 10 percent level, and 20 percent with 4 asterisks. The one-tailed t test was used to test the significance of the regression coefficients.

was positive serial correlation of the residuals at the 5 percent level of significance. This would be expected as the two crops are both within the oilseed complex and their prices would tend to move together, influencing the movement of the gross receipts of both crops in the same direction.

The second relation presented was the distributed lag form of the same model. It included the same variables as the static model represented by equation (3-1), plus the dependent variable lagged one time period.

$$H_t = \underset{(.359)}{3996.5} - \underset{(-1.759)}{148.5}\ PM^{***} + \underset{(1.036)}{11189.0}\ RR^{****} + \underset{(5.521)}{.81}\ H_{t-1}^{*} \qquad (3\text{-}2)$$

Std. Err. of Eqn.	Durbin-Watson	R^2	F-Value
11114	1.27	.71	12.54

The signs of the coefficients conformed with the theoretically hypothesized signs. In general, the magnitudes of the coefficients were larger in the static than the distributed lag model. The latter model however, explained a larger proportion of the dependent variable as the R^2 increased from 13 percent to 71 percent. Serial correlation in the residuals does not appear to be a problem as the value of the Durbin-Watson statistic fell in the inconclusive range at the 1 percent level of significance. The general expectations model expressed in equation (3-2) implies that the expected "normal" gross receipts ratio to which producers respond is a weighted average of past ratios with the weights declining from recent to less recent period. The rate of decline of the weights depends upon the value of β , the coefficient of expectation. If β is close to one, then the weights decline sharply and only a few past gross receipts ratios are important. If β is close to zero, a great many past ratios are given consideration. The value obtained for the coefficient of the lagged dependent variable was 0.81. This implied that the coefficient of expectation, β , equals 0.19. Thus the effects of a particular change in the gross receipts ratio can be expected to last for a period of eight years due to its declining influence on the expected "normal" gross receipts relationship. The F-value indicated that the equation was significant at the 1 percent level in explaining the dependent variable.

Sunflower/Wheat Model

The sunflower/wheat model was tested in both the static and the distributed lag form. The static form incorporated the "expected" gross receipts of sunflowers relative to the "expected" gross receipts of wheat, plus the precipitation variable.

$$H_t = \underset{(.923)}{17105.0} - \underset{(-1.373)}{183.9PM^{***}} + \underset{(.983)}{19061.6RR^{****}} \quad (3\text{-}3)$$

Std. Err. of Eqn.	Durbin-Watson	R^2	F-Value
18184.	.52	.13	1.17

In equation (3-3) the coefficient of the relative receipts ratio was estimated with the theoretically correct positive sign. The coefficient of the precipitation variable had the theoretically correct negative sign.

The value of the coefficient of multiple determination indicated that the set of explanatory variables explained 13 percent of the variation in the dependent variable. This was not an improvement over the static sunflower/rapeseed model and it still left a considerable proportion of the variation in the dependent variable unexplained. The F-value indicated that the equation was not significant at the 5 percent level in explaining the dependent variable. Despite the poor performance of the static form of the model the precipitation and relative gross receipts variable were significant at the 10 and 20 percent levels respectively.

The Durbin-Watson statistic indicated that there was positive serial correlation of the residuals at the 5 percent level of significance. This could possibly be caused by the fact that the "expected" gross receipts of both crops tended to move together over time. Although the opportunity to deliver wheat to the Canadian Wheat Board was restrictive in certain years and one would have hypothesized a decrease in the "expected" gross receipts from wheat marketings, this phenomenon was not strong. That is, as producers encountered restrictive delivery opportunities for wheat under the quota system, they planned the allocation of land on the farm so that total gross income would be maximized. This involved increased sunflower production to generate cash receipts from its production. Also under the Assignable Quota System producers had the opportunity to deliver wheat to the Canadian Wheat Board on the same hectarage seeded to sunflowers. Therefore, in actual fact sunflowers not only provided direct financial benefits from its sale but also indirect benefits as producers were able to realize revenue from wheat marketed on the same hectarage. This increased the delivery base for wheat and maintained the "expected" gross receipts from wheat production relatively stable vis-a-vis "expected" gross receipts from sunflower production.

The second relation presented was the distributed lag form of the same model. It included the same variables represented by equation (3-3), plus the dependent variable lagged one time period. Presented below are the results of this estimation.

$$H_t = \underset{(-.330)}{-3519.0} - \underset{(-.1.964)}{145.0\overset{**}{PM}} + \underset{(1.893)}{20158.5\overset{**}{RR}} + \underset{(6.616)}{.834\overset{*}{H}_{t-1}} \qquad (3\text{-}4)$$

Std. Err. of Eqn.	Durbin-Watson	R^2	F-Value
10337	1.69	.75	15.28

The signs of the coefficients conformed with the theoretically hypothesized signs; although the constant term had an incorrect sign it was not significant. The distributed lag model explained a larger proportion of the variation in the dependent variable than did the previous static model. The value of the coefficient of multiple determination increased from 13 to 75 percent. The level of significance of the precipitation and of the relative gross receipts increased to 5 percent while the dependent variable lagged one time period was significant at the one percent level.

The value of the coefficient of the lagged dependent variable was 0.83. This result was very similar to that estimated in the sunflower/rapeseed model (3-2). This implied that the coefficient of expectation, β , equals 0.17. This means that the expected "normal" gross receipts ratio is formulated taking into account the ratio over the past nine years.

Also, this variable, hectarage lagged one time period, was the most significant of the explanatory variables and implies a rigidity in the cropping pattern. This rigidity could be due to non economic criteria and the institutional framework within which producers make decisions. Non economic criteria could include such things as agronomic practices, managerial expertise, traditional farm plans, and the influence of neighbouring producers on individual farm plans. These factors, weighted together in conjunction with the "prima facie" economic criteria, were used to decide upon the allocation of land to various crops. However, to incorporate the influence of non economic criteria plus the institutional framework within which producers plan and allocate their land was not possible within a conventional econometric analysis. In spite of this limitation the F-value indicated that the equation was significant at the one percent level in explaining the dependent variable. Also serial correlation does not appear to be a problem as the calculated value of the Durbin-Watson statistic fell just below the bound of the theoretical value at the five percent level of significance.

To summarize, economic theory stresses the role of maximizing net income in determining supply response. In this study it was hypothesized that the decision criterion was the relative "expected" gross receipts between crops as the costs of production were assumed to be similar. It was also hypothesized that producers' intentions were modified at the time of planting by the vagaries of weather. The results of this study, however, suggest that other non economic criteria are also vitally important in the allocation of land to alternative crops in order to maximize the net income of the producers. One such criterion which is thought to be of utmost importance if the effect of marketing opportunities offered through the Canadian Wheat Board. That is, producers allocate their land to various crops in order to accommodate the institutional restrictions and expand their expectations regarding opportunities to market wheat.

E. PREDICTIONS VERSUS ACTUAL PLANTINGS

Introduction

The two objectives of this study were: (1) to explain the variation in the seeded hectarage of sunflowers (2) to predict the seeded hectarage of sunflowers. This was accomplished by specification of an econometric model to represent the producers' decision making framework at the farm level. In using the econometric method to represent this phenomenon we are concerned with measuring the predictions of economic theories, with testing hypotheses against the facts and not with developing a model which will yield maximum or minimum solutions.

The first objective of this study was to theoretically measure the movement of the dependent variable based upon economic theories and hypothesized criteria in order to explain its movement. This objective was evaluated in the previous section in terms of statistical and econometric criteria. The second objective of the study was to extrapolate beyond the sample and to forecast or predict the level of the dependent variable using the same model. This would provide a second test for the model through the comparison of the predicted and actual values of the dependent variable.

Since model specification involves many choices, the possibilities for error are also numerous. The statistical and econometric tests in the previous section indicated that the models were not superior in terms of explaining the dependent variable. This may be due to what is referred to as specification errors. Some of the more common specification errors are reviewed below and each may account for a portion of the "mis-fit" of the model in explaining the number of hectares seeded to sunflowers each year.

Specification error may occur because of the time period over which the analysis was conducted. In selecting a particular time period for analysis it is usually assumed that the parameters have not changed within that time period (i.e., no structural change). This condition was fulfilled by the variables included in the model but not by the decision-making environment in which the "expected" values of the variables were formulated. Of particular importance was the impact on producer decision making were changes effected by the Canadian Wheat Board.[65] It is postulated that these changes have been important to producers and account for a portion of the explanation of the allocation of land to various crops. Another important aspect of specification error is the possible omission of a relevant explanatory variable. However, this error is

[65]Of particular importance were the influences of the various quota systems employed by the Canadian Wheat Board. The Unit Quota, Specified Quota System, and the Current Assignable System all have had an impact on farm planning and the allocation of land to various crops.

usually brought to light through the examination of the residuals by the Durbin-Watson test and it proved inconclusive in the distributed lag form of both models. Also, other errors in the specification of the model are usually detected through the relevant statistical and econometric tests. These were reviewed previously and no specific errors in the model specification resulted.

A second method for appraising results is to use the estimated equation to forecast forthcoming values of the dependent variable and then to observe whether the forecasts are accurate or not. However, the comparison of the predicted value of the dependent variable to its actual values as a basis to evaluate the performance of a model may have several shortfalls. Some of these are:[66] Firstly, if the particular relationship for the particular sample of data is not representative of the true population relationship, then the estimated regression coefficients would bias the forecast. Secondly, forecasts are usually based on the point estimates of the structural parameters, and the random terms have been set equal to zero (which is their mean value) in the period of the forecast. However, there are reasons to expect the values to deviate from this point value. Such reasons are: (a) the random variable u, which is set equal to its mean value of zero in the forecast period, may assume a value different than zero; (b) the

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[66] A. Koutsoyiannis, op. cit., p. 476.

coefficients used in the forecast are estimated values of the true parameters obtained from a sample, thus they are subject to a sampling error. Thirdly, if the values assumed by the exogeneous variables are not realized in the period of the forecast, the forecast will not be realized. Fourthly, if the structural coefficients change in the period of the forecast, the model must be modified accordingly otherwise it is unsuitable for forecasting. Fifthly, if any of the "ceteris paribus" conditions change when estimating the model (i.e., agricultural policy, farm numbers, farm size) again the model must be modified before being used for forecasting.

The results of the analysis in this study were evaluated against the objectives of the study. These results were evaluated in terms of explanation of the movement of the dependent variable and in terms of the accuracy of the forecast.

Sunflower/Rapeseed Model

In the previous section (D) of this chapter, the results of the statistical estimation of the equations were presented and discussed. These results were used to calculate the forecast values of the dependent variable. Although this was not truly a forecast in the sense of the real time frame because the events have already occurred, they do represent a forecast in terms of the model. These point forecasts (for 1974 and 1975) of the dependent variable involved the insertion of the relevant values of the independent variables into the estimated equation to compute the forecast value of the dependent variable.

In Figure 3.2 the estimated values of the dependent variable, seedings of sunflower each year, as computed from equation 3-1 by the ordinary least-squares technique, are compared with the actual values for the period sampled (1955 to 1973). The estimated values of sunflower hectarage generally deviated widely from the actual values. The largest deviation between actual and estimated hectarage occurred in 1972 when estimated hectarage was 28465 hectares, 48423 under the actual figure of 76889 hectares. The standard error of the estimate was 18740 hectares. A second method used to evaluate the ability of the model to explain the movement of the dependent variable is a prediction-realization diagram.[67] This diagram was used to isolate so-called 'turning point errors' as this provided an indication of the model's ability to capture changes in the direction of the dependent variable. Under this method points lying in quadrants II and IV show that the model predicts the direction of the change in the dependent variable correctly, whereas points lying in quadrants I and III show that the forecast was opposite to realization. The results show that equation 3-1 estimated the turning points of the dependent variable correctly in

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[67]A. Koutsoyiannis, op. cit., p. 480.

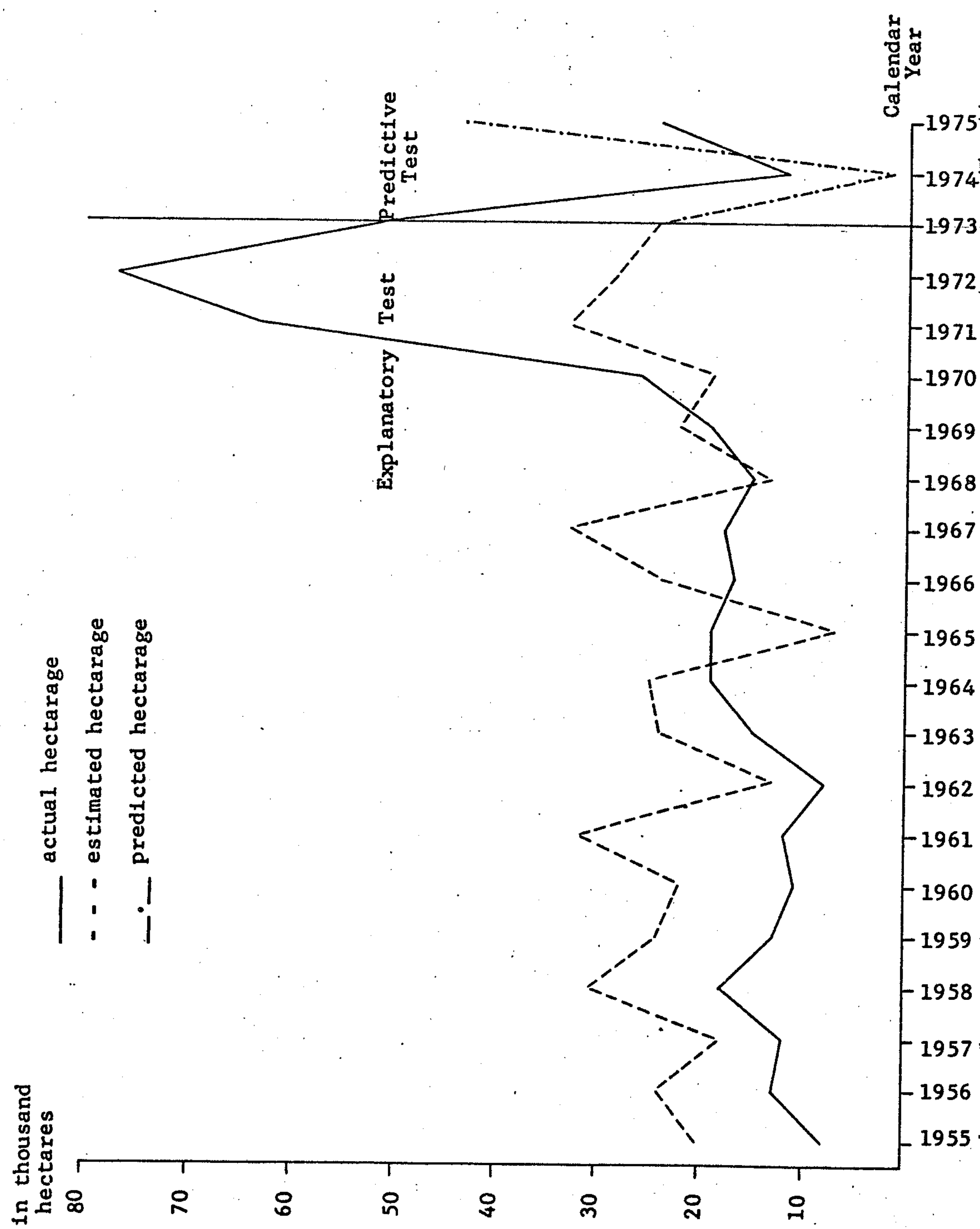

Figure 3.2

Comparison of Actual and Estimated Sunflower Hectarage
Computed from O.L.S. Estimates of
Equation 3-1, 1955 to 1973

16 out of the 19 years although in certain years the deviation from the 'perfect forecast line' was large.

The equation estimated was used to calculate the seeded hectares of sunflowers in the 1974 and 1975 planting seasons. The known values of the independent variables were inserted into the estimated equation to calculate the value of the dependent variable. Actual hectarage of sunflowers in 1974 was 12140 hectares compared with a predicted value based on the model of 2366 hectares. In 1975 the actual hectarage was 24282 compared with 43520 hectares predicted by the model. In the forecast period the correct turning points were predicted although the actual levels of the movements were not accurately captured. However, this may not be solely the fault of the model because the actual hectarage figures are based upon a survey conducted by Statistics Canada and are subject to revision. Consequently, since the actual levels of sunflower hectarage may change, it would be expected that some change would result in the difference between the predicted and actual levels for 1974 and 1975.

Figure 3.3 represents the ordinary least-squares estimated value of sunflower hectarage compared with the actual values from 1955 to 1973. These values were computed from equation 3-2 and deviate considerably less than the results derived from equation 3-1. The largest deviation of estimated seedings from actual seedings was 28688 hectares compared to 48423 hectares estimated by equation

3-1. In the distributed lag form of the model, (3-2), this deviation occurred one year earlier in 1971, compared to 1972 for the static form of the model (3-1). This is postulated to have happened because of the strong influence of previous hectarage on the dependent variable. The standard error of the estimate declined to 11114 hectares. The results of equation 3-2 show that it correctly estimated 16 out of 19 turning points of the dependent variable. However, again in certain years the deviation from the 'perfect forecast line' was large.

The seeded hectarage of sunflower was estimated for 1974 and 1975 using equation 3-2. In 1974 the predicted value of 33166 hectares was considerably larger than the actual value of 12140. In 1975 the predicted value was 28559 hectares, 4277 hectares greater than the actual value of 24282. The inclusion of the variable, seeded hectarage from the previous time period, was mainly responsible for this improvement in forecasting and is postulated to represent the non economic criteria taken into consideration by producers.

Sunflower/Wheat Model

In figure 3.4 the estimated values of the dependent variable, as computed by the static form of the sunflower/wheat model (equation 3-3), are compared with the actual values. The estimated values of sunflower hectarage generally deviated widely from the actual values, particu-

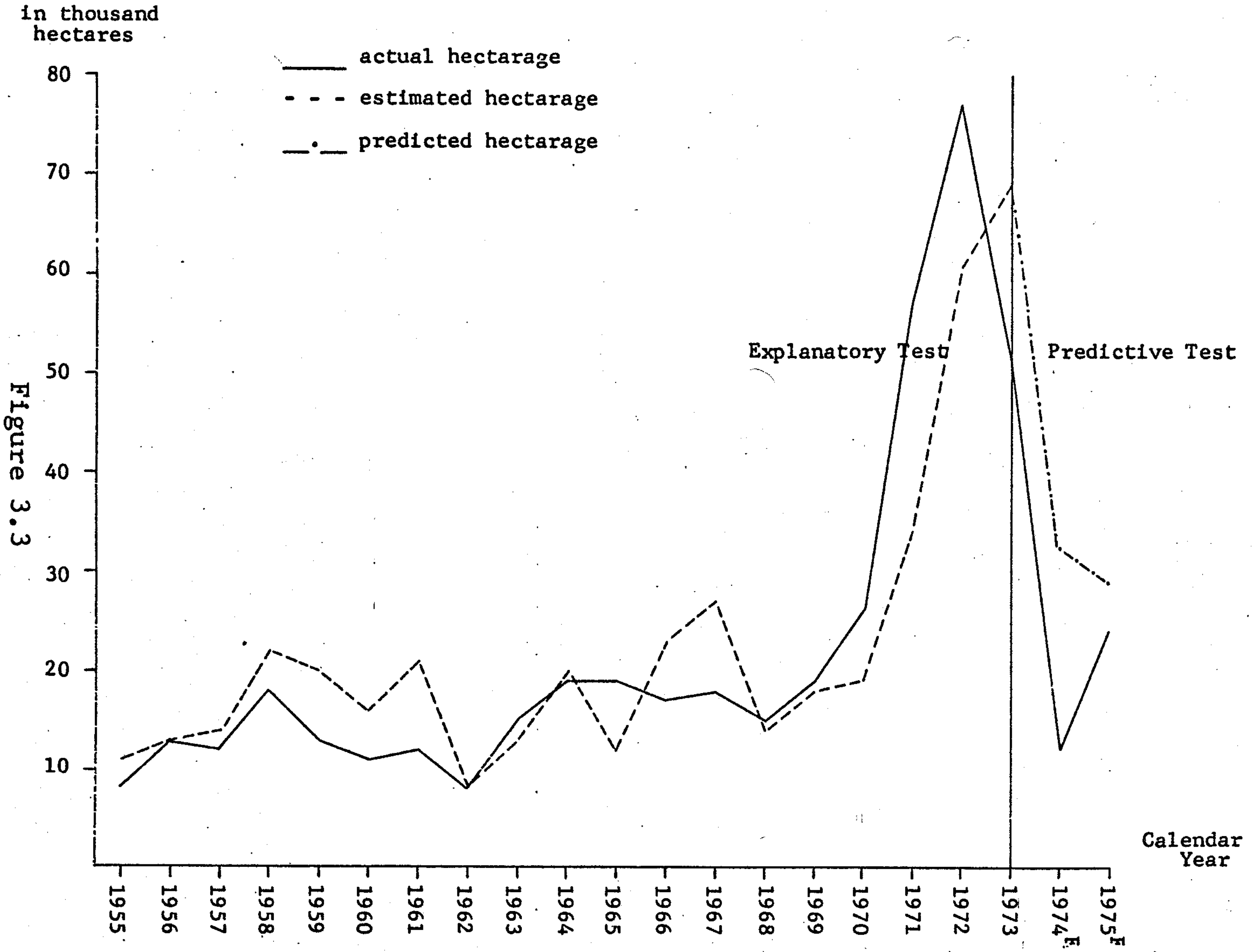

Figure 3.3

Comparison of Actual and Estimated Sunflower Hectarage Computed from O.L.S. Estimates of Equation 3-2, 1955 to 1973 larily in the years 1971 through 1973. The largest deviation occurred in 1972 when estimated acreage was 45515 hectares below the actual value of 76889 hectares. The standard error of the estimate was slightly below the standard error for equation 3-1 (static sunflower/rapeseed model). An examination of the predictive-realization diagram show that equation 3-3 correctly estimated the turning points of the dependent variable in 16 out of the 19 years.

The estimated equation 3-3 was used to predict the seeded hectarage of sunflower for 1974 and 1975. The 1974 predicted value was in the same direction as the actual value of the dependent variable but declined from a lower estimated level. The 1974 predicted value was 7210 hectares compared to the actual value of 12140 hectares. The 1975 predicted value of 43556 hectares was almost double the actual level of 24282 hectares with a resultant high error between the two levels. This large increase in hectarage is attributed to the inclusion of the highest sunflower/wheat gross receipts ratio over the period of the analysis.

Figure 3.5 represents the estimated values of the dependent variable computed from the distributed lag form of the sunflower/wheat model (equation 3-4). Similar to the distributed lag form of the sunflower/rapeseed model, the estimated values of sunflower hectarage deviated widely from the actual values through the years from 1970 to 1973. Also the largest deviation, 29126 hectares, occurred one

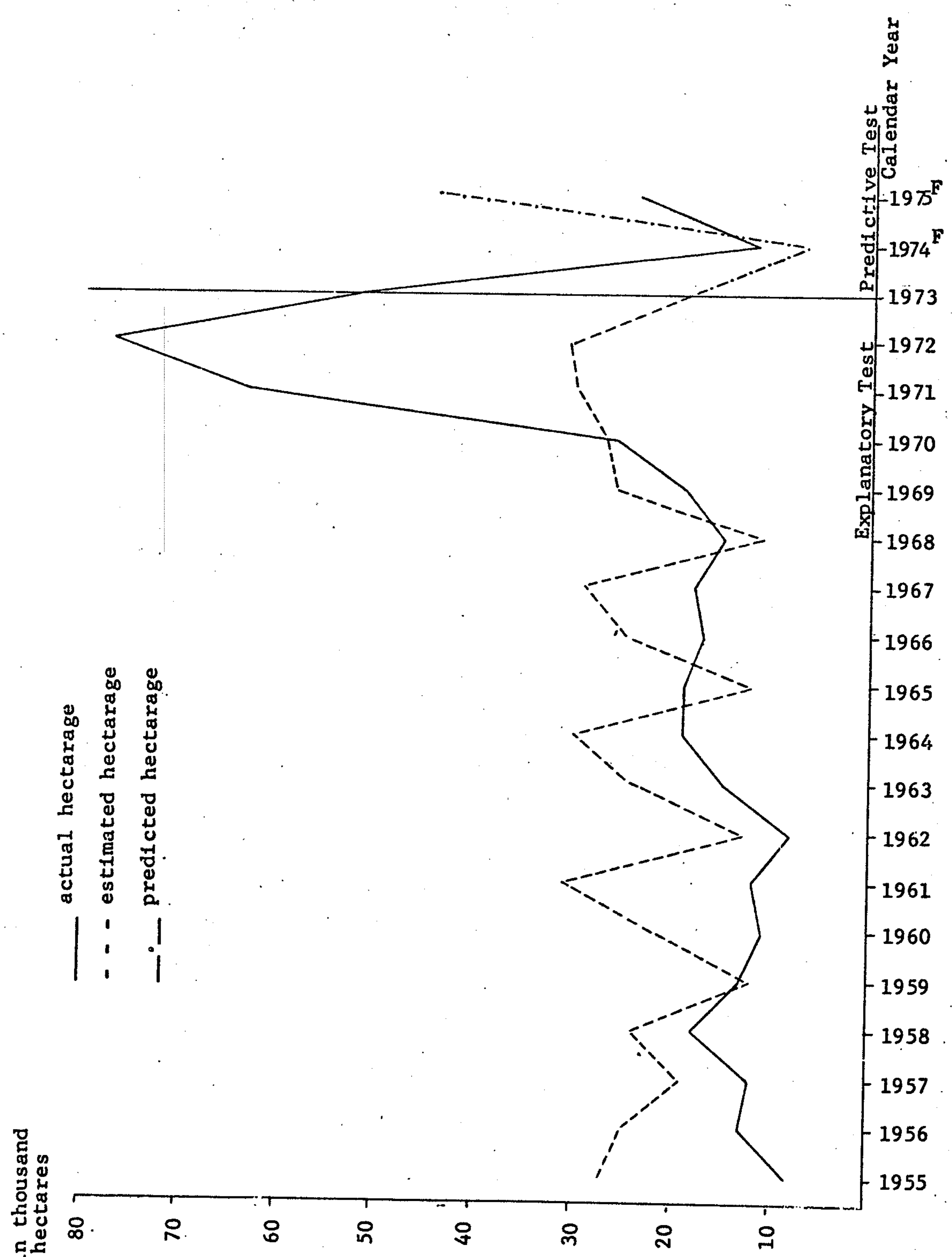

Figure 3.4

Comparison of Actual and Estimated Sunflower Hectarage Computed from O.L.S. Estimates of Equation 3-3, 1955 to 1973

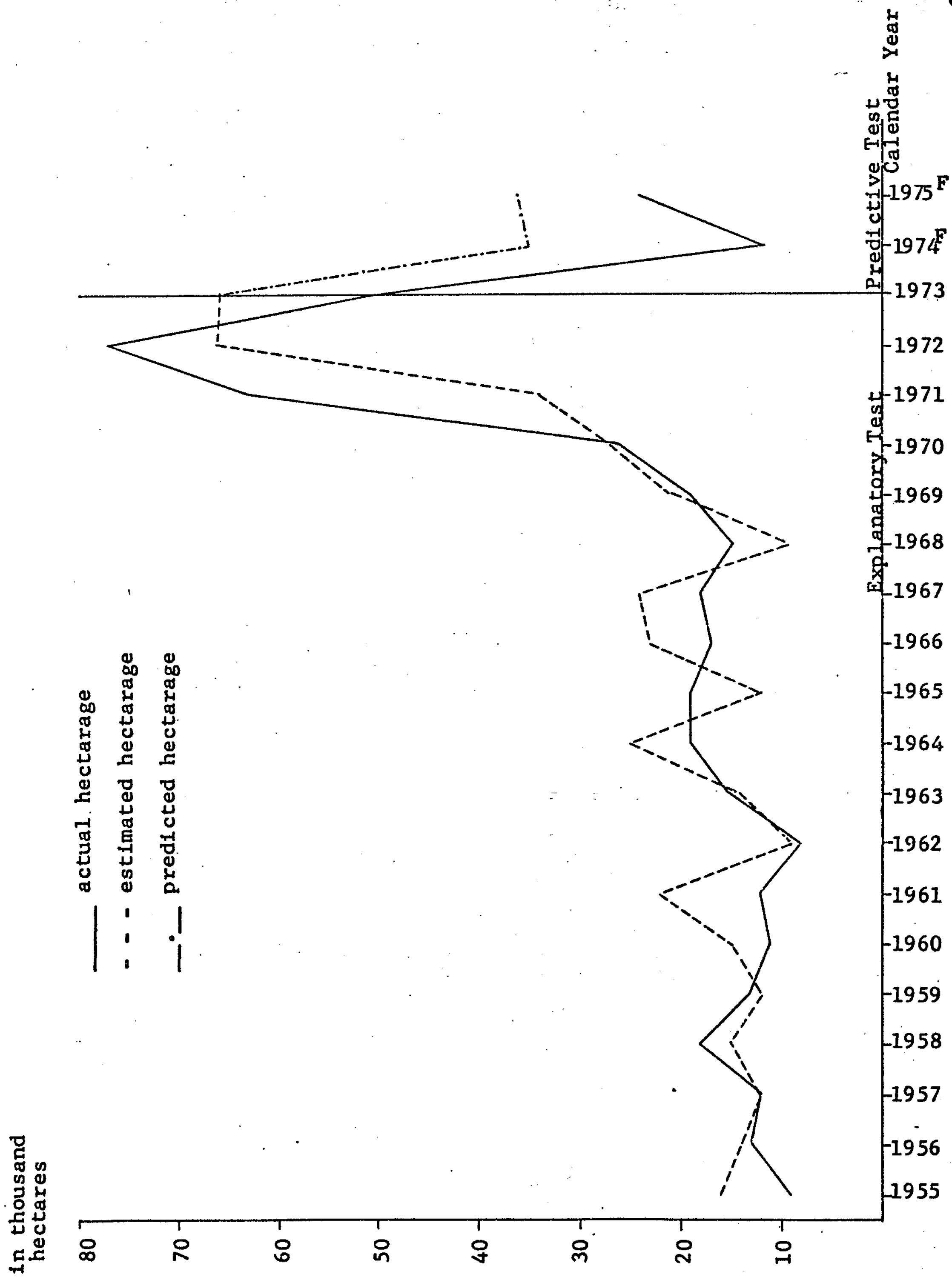

Figure 3.5

Comparison of Actual and Estimated Sunflower Hectarage
Computed from O.L.S. Estimates of
Equation 3-4, 1955 to 1973

year later than in the static form of the same model. An examination of the predictive-realization diagram show that equation 3-4 correctly estimated the turning points of the dependent variable in 15 out of the 19 years. However, the standard error of the estimate was the lowest of all the equations tested in this analysis.

The dependent variable was estimated for 1974 and 1975 in the same manner as the previous equations. The resultant prediction for 1974 was 22592 hectares above the actual level of 12140, whereas the 1975 prediction was 12180 hectares above the actual level of 24282 hectares. This is attributed to the strong influence of previous hectarage of seedings in the current time period as estimated by equation 3-4.

Implications of the Results

Table 3.2 presents the elasticities computed from equations 3-1 through to 3-4 which are based on the static and distributed lag price expectation models.

When the static price expectation model was used the results indicated that the elasticity of response to changes in the relative gross receipts between the commodities was .239 at the peak and 1.744 at the trough. This result was similar for both the sunflower/rapeseed and the sunflower/wheat models.

Table 3.2

The Range of Elasticities Based on the Static and Distributed Lag Models[a]

Models			Elasticities	
Static			Peak	Trough
Equation 3-1		Short Run	.239	1.738
3-3		Short Run	.240	1.744
Distributed Lag				
Equation 3-2		Short Run	.140	1.023
		Long Run	.742	5.388
3-4		Short Run	.253	1.844
		Long Run	1.494	10.850

[a]The elasticities were calculated at the high and the low level of seeded hectarage over the time period from 1955 to 1973.

When the elasticities were calculated based on the distributed lag price expectation model both the short run and long run response were derived. The sunflower/rapeseed gross receipts ratio elasticity ranged from .140 to 1.023 in the short run and from .742 to 5.388 in the long run. The elasticities based upon the sunflower/wheat model ranged from .253 to 1.844 for the short run and from 1.494 to 10.850 for the long run.

Empirical estimates of the elasticity of response are useful to those who have the responsibility for forecasting future supplies, or for making marketing and policy decisions. In the case of the sunflower industry in

Manitoba two general conclusions with respect to producers' response can be drawn. These are: (1) that in the long run the elasticity at the low point (trough) of seedings is roughly five times as high as the elasticity at the high point (peak), (2) that in the long run the elasticity of response to changes in the sunflower/wheat ratio is numerically twice the elasticity of the sunflower/rapeseed ratio.

Two major implications of these conclusions are: (1) that when sunflower hectarage is low a greater response to changes in the relative gross receipts ratio can be expected compared to when the hectarage is high, and (2) that the producers are more responsive to relative changes in gross receipts between sunflower and wheat than between sunflower and rapeseed.

The significance of these implications to the processors and Governments who attempt to stabilize or increase the area seeded to sunflowers is that they must be cognizant of the historical perspective of the current level of seedings and of the price expectations of the producers for wheat. If these two factors are known the response in the sunflower hectarage to changes in the receipts ratio can be measured and marketing and policy decisions modified accordingly. That is, if sunflower hectarage is at a relatively low level, a 10 percent increase in sunflower hectarage can be expected for every 1 percent increase in the relative gross receipts ratio in favor of sunflowers. Conversely, if sunflowers are at a relatively high level, a 1.49 percent increase can be expected for the same 1 percent increase in the relative gross receipts. With this information pricing decisions can be made not only with respect to the oilseed complex, but also with respect to the relationship of sunflowers to other crops in the growing region.

These results however should be interpreted and used with caution because of the high standard errors of the equations. Equation 3-4 achieved the lowest standard error at 10337 hectares, which results in a wide range of variability. That is, any policy decisions or pricing strategies adopted to influence the seeded hectarage of sunflowers cannot be measured reliably by the model developed in this thesis.

CHAPTER IV

SUMMARY AND CONCLUSIONS

A. INTRODUCTION

The purpose of this chapter is to present a brief overview of the discussion of the previous three chapters and to state the conclusions from the study which appear to be justified on the basis of the results found in Chapter III. It evaluates the usefulness of the results and some of the implications of the results to their usefulness in evaluating supply response. In conclusion some recommendations as to future research are made.

B. THE STUDY IN REVIEW

The introduction to this thesis pointed out that the area of land seeded to sunflowers each year has fluctuated widely over the past 20 years. However, little research has been conducted into the specific factors which have caused these variations. This was the justification for this study and provided the basis of the objectives of this study. The specific objectives were:

1. to explain the seeded hectarage of sunflowers;
2. to predict the seeded hectarage of sunflowers.

It was postulated that a quantitative study into sunflower production could provide useful information to producers, processors, and Governments. It was also explained that the empirical analysis used to achieve the above objectives and to generate this information would be the single equation regression technique.

Chapter II provided the theoretical base for the study. That is, it postulated the economic theory upon which it was hypothesized that producers make decisions. It included the traditional microeconomic assumption that profit maximization is the objective of the producers and that they allocate their resources, namely land, in such a manner as to achieve the highest net returns.

Supply response was discussed in terms of some of the factors which caused shifts in the supply curve. The one which was identified as being most important in the allocation of resources to various crops was the comparative costs and returns among them. Some statistical aspects of measuring producers' response were discussed. These included a description of both the traditional "static" model and the more flexible "dynamic" distributed lag model. The distributed lag model was examined in some detail with regard to producer "expectations" and the measurement of the response phenomenon.

Chapter II also discussed the institutional framework within which producers must make decisions when planning the allocation of their land to alternative crops. This was done to facilitate the specification of the model used in this study and to provide some background to the review of literature. No previous studies had been carried out in the area of supply response for the crop sunflower so that response studies of other crops grown within the same economic and institutional framework were evaluated. This was done with the objective of helping to justify the variable selection and definition used in the sunflower response study.

Chapter III's purpose was to specify the econometric model based on the theoretical relationships presented in Chapter II. This included the conceptualization of the hectarage response equation used in this study. A detailed examination of the formulation of the "expected" gross receipts variable for the crops included in the study was undertaken. This was necessary as it was hypothesized that this one variable embodied the economic decision criterea considered by producers in the allocation of their land to various crops.

The hypothesis of this study, that producers allocate their land among crops on the basis of comparative "expected" gross receipts, was tested using two models. The first compared the "expected" gross receipts between sunflowers and rapeseed in both the static and distributed lag form. The second compared the "expected" gross receipts between sunflowers and wheat, again both in the static and distributed lag form. The sample period considered in the analysis was the years from 1955 to 1973 with the years 1974 and 1975 being used to test the predictive ability of the model. The results of the statistical estimation were presented in this chapter.

The results of the estimation process were not as satisfactory as was expected when the model was specified. The regression coefficients displayed the expected signs but their magnitudes were not as large as expected. The statistical fits on the distributed lag form were superior to the static form in both models. However, these were not exceptional and a considerable proportion of the variation in the dependent variable was left unexplained. Although not demonstrating a good "fit" the model performed fairly well in the estimation of the 'turning points' of the dependent variable from 1955 to 1973. Also, in the period used to test the predictive ability of the model, the 'turning points' were estimated correctly in all cases except the 1975 forecast based upon equation 3-2, although the difference between the estimated level of planting and the actual level of planting was significant. The poor explanation and prediction of the model were explained in terms of the institutional milieu which producers encounter when allocating their resources to various crops. This explanation was supported by the empirical results through the significance and interpretation of the dependent variable lagged one time period. This was, that producers not only take account of "prima facie" economic criteria when allocating resources but also their non economic environment. This involved numerous factors including tradition, rotations, and the institutional arrangement in Western Canada and that producers seek their best alternatives in terms of maximizing returns to the farm.

C. CONCLUSIONS AND IMPLICATIONS

The hectarage sown to sunflowers each year was found to be influenced not only by quantifiable economic criteria but also by non economic criteria. This fact was exemplified in this study by evaluating on-farm decision making basis economic criteria only. However, the relatively unsatisfactory statistical results in terms of the empirical estimation left many questions unanswered and dampened the usefulness of the model.

Some conclusions which can be drawn from the results are:

1. that producers are rational economic beings and that the comparative gross receipts among crops are to a certain extent influential in the allocation of their resources. It was also determined that the relative gross receipts between sunflowers and wheat was the most significant factor affecting the number of hectares sown to sunflowers each year.

2. that the hectarage in the previous time period was the most influential factor on the allocation of land in the current year. However, an exact interpretation of what particular phenomena this variable represented is very

uncertain. The author interpreted this relationship in terms of the psychological reaction in total to the broad management successes or failures in the previous time period. That is, over time producers have developed a cropping pattern and expectations with regard to undertaking such action which has developed into "habit." This is related to and justified by the long term economic viability of the farming operation and is an important factor in annual planting decisions.

3. that despite the fact that producers plan and allocate their land in an economic manner there remains a degree of uncertainty and influence through the vagaries of weather. In this study only one particular detail of the total physical externalities was included and it proved influencial in producers' ultimate allocation of their resources.

4. that the long run elasticity of response as determined by the models specified in this study are numerically five times as great when sunflower hectarage is at a low level as opposed to when it is at a high level. Also that the elasticity as determined by the sunflower/wheat model was numerically twice as great as the elasticity determined by the sunflower/rapeseed model.

5. that analysts who undertake to measure the response of producers, and processing firms or Governments who wish to stabilize and expand the productive base for sunflowers must be fully cognizant of the institutional

framework and its effects upon farm planning and management results.

The hypothesis which was tested in this study and the method of formulation of the decision variables were the particular aspects of this study which made it conceptually different from previous models.[68] This included the specific enunciation of the decision making phenomenon and the attempt to measure it at the farm level. However, the quantitative results of the analysis dampened the conceptual improvements. Nevertheless there are some implications which can be drawn from the analysis. These include:

1. the limitations of the single equation regression technique. Since regression studies are necessarily tied to the past they cannot predict in light of new variables and structures unless these changes are known to the analyst, then at best a proxy dummy variable can be used. Also there appears to be no satisfactory method for incorporating major changes in technology, institutions, and government policy into regression approaches. This limits the usefulness of the conventional econometric technique in this study as the impact of the Wheat Board's policy was postulated and concluded to be important in farm planning.

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[68]The studies which were reviewed in Chapter II, Section E of this study all utilized proxy variables to estimate the relationship between macro parameters and an individual or sectoral hectarage allocation.

2. the method of payment to producers. In order to obtain an estimate for the dependent variable specified in the model, specific values of the various independent variables must be specified in the model. Since the values of the independent variables may not be known until shortly before planting period however, it may be necessary to estimate a value which can be used to obtain a forecast for the dependent variable. An error in the estimated value of an independent variable will be reflected in an error in the predicted value of the dependent variable. This implication is particularly relevant to the specific definition of the variables used in this study. Each year the Canadian Wheat Board pay the final payment in January, announces the initial payment and expected quota levels for the forthcoming crop year in March, leaving little time for oilseed processors to adjust the contracts and promotional activities to stabilize sunflower hectarage. Also, an influencial factor is the amount of precipitation in May. The best selection of a value for this variable would be a random digit although it could mean a significant error in the prediction period.[69]

3. the elasticity of response. Based on the

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[69] This is the reason the 1976 hectarage was not predicted basis this model. The final payment, the initial payment, the amount of precipitation are all unknowns and any speculation on their levels does not seem to serve a purpose at this time.

results of this study it appears that the current level of sunflower hectarage is a vitally important factor affecting the response of producers to changes in the gross receipts of sunflowers relative to changes in the gross receipts of rapeseed and wheat. That is, when sunflower hectarage is low vis-a-vis historical levels, a greater response to changes in relative gross returns can be expected than when sunflower hectarage is high compared to historical levels. The implication of this conclusion is that, when attempts are made to stimulate production the "prima facie" economic rational must be complemented by a realistic assessment of the degree of response attainable based upon the historical context of the production level.

4. the farm plan. It appears that the crucial factor in the allocation of land among crops is done within a total farm plan. The farm plan takes special recognition of the institutional structure of the Canadian Wheat Board and its effect on marketing opportunities. Therefore, in order to develop a model to account for land allocation the institutional effects on farm planning must be included in the model.

D. FURTHER RESEARCH

The hypothesis examined in this study concerned the allocation of land to alternative crops based upon "prima facie" economic criteria. It included one other aspect, that of rainfall, as it was hypothesized that this was important in modifying producers intentions. The empirical estimates, however, were not as good as expected and further research into the area of on-farm decision making is required. The study was beneficial in the sense that it isolated some factors concerning producer decision making which require closer examination. These include:

1. a qualitative or if possible a quantitative examination of the effect on the institutional arrangement in Western Canada on farm planning and producer decision making. This area of assessment has been lacking in previous studies and was not directly addressed in this one.

2. a recursive programming approach, or an econometric approach with flexibility bounds may be able to capture the decision process more adequately if the model is correctly specified. This may provide the scope to include the details of decision making encountered by producers.

3. an attitudinal study involving the identification of producers' goals and decision making processes so that future studies more closely approximate the actual on-farm situations.

A P P E N D I C E S

APPENDIX A:- DESCRIPTION OF THE STUDY AREA

A. GENERAL FEATURES OF THE PRODUCING REGION

Location

Sunflower production in Manitoba is concentrated in the southern portion of the Province. This main production area includes the municipalities of Dufferin, Morris, Montcalm, Rhineland, Roland, Stanley, Thompson, North Cypress, South Cypress, Victoria, South Norfolk, and North Norfolk.[70] These municipalities coincide with the Federal Census Divisions 2 and 7, and are illustrated in figure A.6 (Map of Southern portion of the Province with municipalities and Census Divisions delineated).[71] This area not only included the largest portion of sunflower production in Manitoba, but also Canada. Table A.3 presents the hectarage and production of sunflowers in Manitoba in relation to the total national levels.

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[70] This statement is based on records of firms in Manitoba which contracted with growers in 1972. These municipalities included over 75 percent of the growers who contracted to grow sunflowers in 1972 with these firms.

[71] Census Division 7 also includes the municipalities of Elton, Cornwallis, and Oakland but very little sunflowers have been grown in these areas.

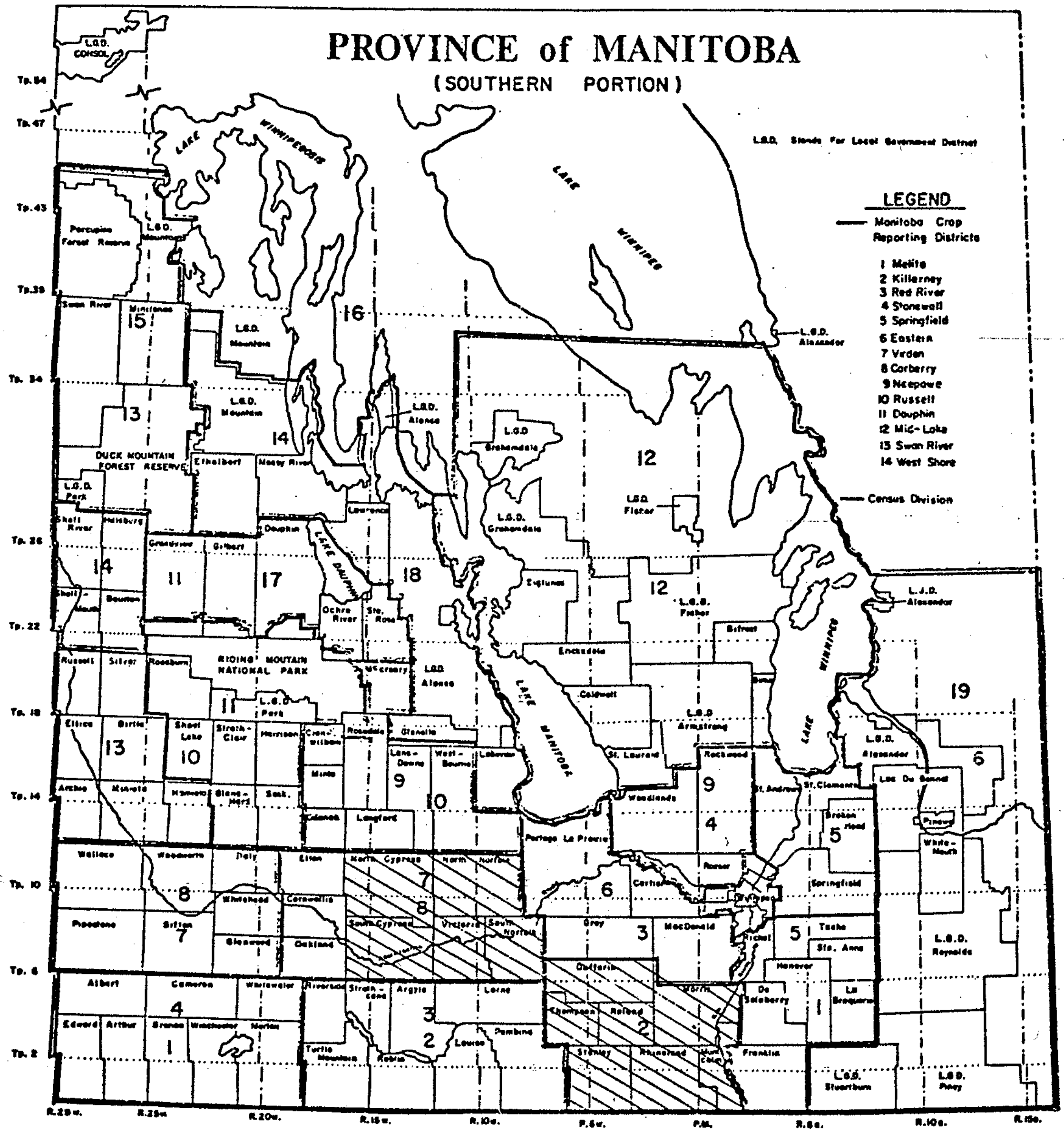

Figure A.6

Location of the Main Sunflower Production Area Within Manitoba

Table A.3

Sunflower Area, Production, and Perspective

Year	Area			Production		
	Canada	Manitoba	Percent	Canada	Manitoba	Percent
	..thousands of hectares..			..thousands of kilograms..		
1974	12.1	12.1	100	11.8	11.8	100
1973	52.2	50.6	97	41.2	39.7	96
1972	87.8	76.9	88	77.1	68.9	89
1971	96.7	62.7	65	76.6	52.6	69
1970	28.5	26.3	92	25.1	23.4	93
1969	19.4	19.4	100	15.4	15.4	100
1968	16.2	14.9	92	11.2	10.9	97
1967	18.5	17.8	96	16.3	15.9	98
1966	21.4	17.4	81	17.8	15.6	88
1965	27.5	19.4	71	13.2	11.9	90
1964	31.7	19.4	61	14.0	11.4	81
1963	15.4	13.4	87	16.3	14.2	87
1962	9.3	8.3	89	7.9	6.9	87
1961	10.1	8.5	84	9.1	7.6	84
1960	10.3	7.7	75	9.9	6.9	70
1959	16.9	10.1	60	16.8	9.1	54
1958	19.7	18.2	92	10.0	8.8	88
1957	14.2	14.2	100	8.8	8.8	100
1956	13.4	13.4	100	7.5	7.5	100
1955	8.1	8.1	100	6.5	6.5	100
1954	8.1	8.1	100	6.3	6.3	100

Source: Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue Number 21-003, Ottawa, 1954 to 1974.

Physical Features

The features of this region which support the production of sunflower include the land base and climatic conditions. Agronomists estimate that there are between 202430 and 303640 hectares of arable land in Manitoba which could produce sunflower. They state that "sunflower prefers sandy well-drained soils which heat up quickly in the spring".[72] These conditions are met to a large extent in Census Divisions 7 and 2. Specifically, the area which coincides with Census Division 7 has sandy to sandy loam soil with level topography and favourable climate conditions. Census Division 2 is characterized by clay to clay loam soils with level topography. Although the soil in Census Division 2 is not ideally suited for sunflower production, it has developed because of the producers' association with the processing co-op and favourable climate conditions. In particular, the favourable climate condition which directly influences plant growth and yield potential is temperature. The frost free period is one facet of temperature's influence in this region and it ranges from 130 to 140 days, sufficiently long to allow the sunflower plant to mature. The accumulation of heat units over this time period however, is as much a factor affecting physiological development. One of the methods

[72] Principles and Practices of Commercial Farming, op. cit., p. 158.

which is used to evaluate the effect of temperature on plant growth is the degree day system.[73] This system assumes that plant growth starts at 5.5 degrees Celsius, and that a certain number of degree days above 5.5 must be accumulated if the crop is to mature. Figure A.7 illustrates the distribution of heat units in Manitoba. Comparing figure A.7 with figure A.6, it is evident that the region of maximum heat units and the region which produces sunflowers coincide very closely.

B. AGRICULTURAL CHARACTERISTICS[74]

Land Use

In 1971, the total area in farms in Census Division 2 was 497670 hectares, of which 461382 were improved. In Census Division 7, there were 543195 hectares in farms, of which 378230 hectares were improved. Presented in Table A.4 is the land use pattern within the two Census Divisions. An interesting feature to note is the high percentage of improved land under crops in these areas, with Census Division 2 at 87 and Census Division 7 at 72 percent respectively. In part, this is attributed to sunflower

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[73] Ibid., p. 14.

[74] Statistics Canada, 1971 Census of Canada, Agriculture Manitoba, Catalogue 96-708, Volume IV--Part 3, Ottawa 1973. The information used in this section was gleaned from the 1971 Census of Canada publication.

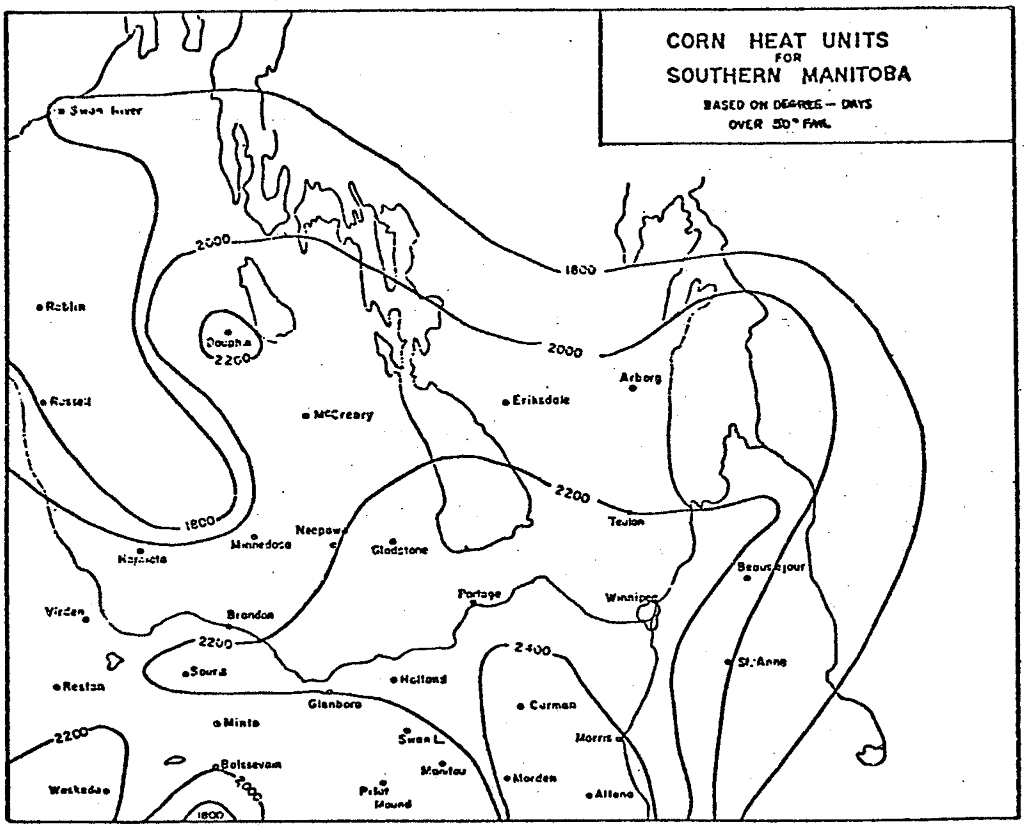

Figure A.7

Map Illustrating the Distribution of
Heat Units in Manitoba

production and the choice of alternatives which producers have available to extend rotations.

Table A.4

Improved Land Use

Census Division	Crops	Summerfallow	Pasture	Other
	..................hectares..................			
2	399885	43105	8958	9433
7	273730	68058	27980	8459

The crop mixture in these areas is dominated by the traditional Board grains of wheat, oats, and barley. They made up 59 percent of the area under crops in Census Division 2 and 63 percent of Census Division 7, with wheat being the highest single crop on both Census Divisions in 1971. Comparatively, sunflowers occupied nine percent of the area in Census Division 2 and five percent in Census Division 7. The breakdown of the main crops is presented in Table A.5.

Farm Size, Number, Investment

There were 3,135 farms in Census Division 2 with an average of 159 hectares in improved land per farm. In this Census Division the average investment per farm was 65,800 dollars. In Census Division 7 there were 2,153 farms with an average of 252 improved hectares per farm and an average investment per farm of 69,000 dollars. A detailed breakdown of these figures is included in Table A.6.

Table A.5

Area of the Various Crops Grown
in the Study Area

Crop	Census Division 2	Census Division 7
	..............hectares...............	
Wheat	111810	66994
Oats	50361	45430
Barley	69274	59384
Mixed Grains	11418	8485
Rye	1295	7640
Buckwheat	13857	2493
Tame Hay	19458	35353
Flaxseed	27329	11283
Sunflower	35466	13654
Rapeseed	27657	10804
Others	31048	12213

Table A.6

Farm Numbers, Size, and Investment
in Census Divisions 2 and 7

Census Division	Number of Farms	Total Improved Land	Land and Buildings	Machinery and Equipment	Livestock and Poultry
		hectares	....	$'000	....
2	3135	497650	152869	40205	13242
7	2153	543195	97903	30301	20477

APPENDIX B

Data and Results

Table A.7

Meteorological Data--Red River Basin
Precipitation in May

Year	Precipitation
	.....average in millimeters.....
1955	52
1956	57
1957	44
1958	11
1959	103
1960	46
1961	25
1962	151
1963	74
1964	47
1965	96
1966	41
1967	25
1968	93
1969	51
1970	86
1971	33
1972	33
1973	62
1974	136
1975	39

Source: Environment Canada, _Meteorological Observations in Canada_, Month of May, Ottawa, 1955 to 1974.

Table A.8

Expected Revenue Per Hectare From Sunflower[a]

Year	Hectares[b]	Yield[b]	Initial Price[c]	Final Price[c]	Expected Revenue[d]
1954	8094	835	-	6.614	-
1955	8094	911	-	7.165	55.23
1956	13354	596	-	6.614	65.27
1957	12140	448	-	8.818	39.41
1958	18211	482	-	8.818	39.50
1959	12950	538	4.409	3.306	63.75
1960	11331	897	7.165	1.366	56.32
1961	12343	785	7.165	2.204	76.52
1962	8296	840	8.267	2.777	82.19
1963	14973	1065	8.267	1.036	92.76
1964	19425	588	8.267	2.645	99.07
1965	19425	616	8.267	4.827	64.15
1966	17442	666	8.818	3.968	84.04
1967	17806	897	8.818	-	85.15
1968	14973	727	6.614	3.086	59.32
1969	19425	794	7.716	4.607	78.52
1970[e]	26304	897	7.716	6.371	112.65
1971	62725	841	7.716	4.916	126.35
1972	76889	897	7.716	7.693	106.23
1973	50585	785	8.818	13.271	148.09
1974	12140	972	13.227	30.863	208.00
1975	24282	-	15.432	-	499.97

[a]The expected revenue from sunflowers per hectare was calculated by multiplying the yield per hectare from the previous time period (t-1) times the initial payment (contract price) in the current time period (t), plus the yield per hectare from the previous time period (t-1) times the final payment from the previous time period (t-1), (i.e., $\text{Yield}_{t-1} \cdot \text{Price}_t + \text{Yield}_{t-1} \cdot \text{Final Price}_{t-1} =$ Expected Revenue).

[b]Yield is reported in kilograms per hectare.

Source:

Statistics Canada, Field Crop Reporting Series, Catalogue Number 22-002, Ottawa, 1954-1975.

(Footnotes Continued)

Table A.8 (Continued)

[c]Prices paid for sunflower seed by Co-op Vegetable Oils Limited from 1954 to 1974. Prior to 1959 the initial price was established just before harvesting of the same year; subsequently, could not influence plantings that year. Therefore, the final payment from the previous year was used to formulate expected revenue. Since 1959 the initial contract has been known prior to seeding and was incorporated into the expected revenue calculation for that year in addition to the final payment from the previous time period.

In 1975, the contract price used to calculate the expected revenue per hectare was offered by Cargill Grain Company.

All prices are reported in cents per kilogram.

Source:
Financial Statements from CSP Foods and Cargill Grain Company.

[d]Expected revenue is reported in dollars per hectare.

[e]The 1970 planting intentions were modified by the Lower Inventory For Tomorrow Program. Under this Government programme producers were paid $14.82 per hectare for each hectare they reduced their wheat hectarage from the previous year. This payment was added to the expected revenue of sunflowers as any area planted to sunflowers that year qualified for payment.

Table A.9

Expected Revenue Per Hectare From Rapeseed[a]

Year	Hectares[b]	Yield[b]	Final Price[c]	Expected Revenue[d]
1954	3642	897	.083	-
1955	2833	729	.088	74.45
1956	11776	930	.079	64.15
1957	11129	701	.066	73.47
1958	8498	673	.063	46.26
1959	4856	841	.088	42.39
1960	13354	810	.088	74.00
1961	11857	689	.079	71.28
1962	13031	1009	.077	54.43
1963	18211	947	.110	77.69
1964	33993	981	.119	104.17
1965	58679	930	.108	116.73
1966	68796	692	.108	100.44
1967	58679	889	.079	74.73
1968	36826	1170	.082	70.23
1969	79317	1001	.105	95.94
1970	161872	1009	.103	105.10
1971	235119	1158	.094	103.92
1972	190200	1014	.136	108.85
1973	161872	1079	.257	137.90
1974	202300	953	.286	277.30
1975	263051	907	-	272.55

[a]The expected revenue from rapeseed per hectare was calculated by multiplying the yield in the previous time period (t-1) times the final price in the previous time period (t-1). That is, expected revenue is lagged one time period.

[b]Yield is reported in kilograms per hectare.

Source:

Statistics Canada, Crop Reporting Series, Catalogue Number 22-002, Ottawa, 1954-1975.

[c]The price per kilogram of rapeseed used to calculate the expected gross receipts per hectare was the annual realized price at the farm level. This is the price paid

(Footnotes Continued)

Table A.9 (Continued)

to producers at the country elevator with freight, handling, and other marketing charges deducted.

Source:
Manitoba Department of Agriculture, 1974 Annual Yearbook, Winnipeg, 1975.

[d] Expected revenue is reported in dollars per hectare and is derived by multiplying yield from t-1 times final prices from t-1.

Table A.10

Total Plantings, Marketings, Stocks, and Production of Wheat in Manitoba

Crop Year	Seeded Hectares[a]	Marketings Through C.W.B.[b]	On-Farm Disappearance[c]	Stocks On-Farm at July 31[d]	Production[e]
1953/54	902	951524[i]	224305	217746[ii]	1284703
1954/55	839	647632	266902	81654	778443
1955/56	834	869025[ii]	241616	108837	1137860
1956/57	877	1057757	232389	326619	1507893
1957/58	860	1107103	270141	244964[i]	1295590
1958/59	965	1235764	402776	217746	1611322
1959/60	1053	1285655	339275	244964	1652150
1960/61	1112	1253837	406477	353837	1769188
1961/62	1144	865269	337778	54436	903647
1962/63	1165	1618127	238160	163309	2074033
1963/64	1219	1318372	358274	81654	1594991
1964/65	1321	1809853	324060	190528	2242787
1965/66	1295	1848285	331899	136091	2125748
1966/67	1384	1761758	298666	190528	2114861
1967/68	1399	1725476	307729	571584	2414262
1968/69	1323	1571529	314697	1088731	2397931
1969/70	942	1346162	286935	1088731	1633097
1970/71	520	943903	392514	517147	764833
1971/72	962	1455797	367827	707675	2014153
1972/73	987	1670440	779205	136091	1878062
1973/74	1214	1610642[i]	501497	136091	2112139
1974/75	1092	1280783	719760	54436	1551442
1975/76	1193	-	-	-	1918889

[a]Seeded hectares of all spring wheat excluding Durum, plus an estimate of relatively small area of winter wheat for which annual estimates are not available separately by province other than Ontario.

Source:
Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue Number 21-003, Ottawa, 1953 to 1975.

(Footnotes Continued)

Table A.10 (Continued)

[b]Marketings of hard red spring wheat at primary elevators in Manitoba in tonnes.

Source:

(i) Canadian Grain Commission, Grain Statistics Weekly, Grain and Statistics Division, Winnipeg. 1953-1955, 1973-1974.

(ii) Statistics Canada, Grain Trade of Canada, Agriculture Division, Crop Section, Catalogue Number 22-201, Ottawa. 1956-1972.

[c]On-farm disappearance in tonnes calculated as follows: stocks on-farm as of July 31st of the previous crop year plus the production of the current crop year minus marketings to primary elevators minus stocks on-farm at July 31st of the current crop year.

[d]Stocks on-farm in tonnes as of July 31st in Manitoba.

Source:

(i) Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue Number 21-003, Ottawa, 1957-1974.

(ii) Statistics Canada, Grain Trade of Canada, Agriculture Division, Crops Section, Catalogue Number 22-201, Ottawa, 1953-1956.

[e]Production of hard red spring wheat in Manitoba in tonnes.

Source:

Statistics Canada, Crop Reporting Series, Catalogue Number 22-002, Ottawa, 1954-1975.

Table A.11

Total Marketings Through the Various Market Outlets per Seeded Hectare[a]

Crop Year	Seeded Area	Marketings Through C.W.B.	On-Farm Disappearance
...thousands of hectares...		...kilograms per hectare...	
1953/54	902	1054.9	248.6
1954/55	839	771.9	318.1
1955/56	834	1041.9	289.7
1956/57	877	1206.1	264.9
1957/58	860	1287.3	314.1
1958/59	965	1280.5	417.3
1959/60	1053	1220.9	322.1
1960/61	1112	1127.5	365.5
1961/62	1144	756.3	295.2
1962/63	1165	1338.9	204.4
1963/64	1219	1081.5	293.9
1964/65	1321	1370.0	245.3
1965/66	1295	1427.2	256.2
1966/67	1384	1272.9	215.7
1967/68	1399	1233.3	219.9
1968/69	1323	1187.8	237.8
1969/70	942	1429.0	304.6
1970/71	520	1815.1	754.8
1971/72	962	1513.3	382.3
1972/73	987	1692.4	789.4
1973/74	1214	1326.7	413.0
1974/75	1092	1172.8	659.1
1975/76	1193	-	-

[a]These figures were derived from Table A.10 of this Appendix by dividing total marketings through the Canadian Wheat Board and total on-farm disappearance by the number of hectares seeded in that particular year. This was done to put the expected wheat marketings on the same basis as the sunflower and rapeseed marketings so that gross receipts per hectare could be formulated on a comparable basis.

Table A.12

Prices

Crop Year	Initial t	Initial[a] t-1	Interim[b] t-1	Final[c] t-2	Non-Board[d] t-1
	............dollars per tonne..................				
1953/54	-	43.72	11.75	8.81	59.88
1954/55	-	43.72	3.67	3.67	49.96
1955/56	-	43.72	3.67	2.20	48.12
1956/57	-	43.72	3.67	5.51	52.17
1957/58	-	43.72	3.67	4.04	47.76
1958/59	-	43.72	3.67	3.30	48.49
1959/60	-	43.72	3.67	4.40	49.96
1960/61	-	43.72	3.67	3.67	50.70
1961/62	-	43.72	3.67	3.30	59.15
1962/63	-	43.72	3.67	11.02	64.66
1963/64	-	47.39	-	15.06	62.45
1964/65	-	47.39	-	13.59	62.82
1965/66	-	47.39	-	17.26	59.88
1966/67	-	47.39	-	14.32	60.62
1967/68	-	47.39	-	18.37	65.39
1968/69	-	54.74	-	18.00	60.25
1969/70	-	54.37	-	4.00	48.12
1970/71	-	47.02	2.68	-	45.55
1971/72	45.55	-	-	4.04	52.17
1972/73	45.55	-	-	6.24	50.33
1973/74	74.58	-	11.02	5.14	68.33
1974/75	74.58	-	55.11	14.69	157.98
1975/76	74.58	-	55.11	30.49	137.77

[a]The initial payments have been announced at two different times of the year over the period which this analysis covered. From 1955 to 1971 the initial payment level was announced on August 1, the beginning of each new crop year. The timing of this announcement did not allow producers to take account of this new information to revise their planting intentions for that year. It is for this reason that from 1955 to 1971 the initial payment has been lagged one time period as this is the only information available upon which producers could formulate expectations. From 1971 onwards the initial prices have been

(Footnotes Continued)

Table A.12 (Continued)

announced prior to seeding in the same year allowing the producers to take account of this new price when formulating expectations. The price schedule used was the Canadian Wheat Board payments for No. 1 Northern Wheat and No. 1 Canada Western Red Spring Wheat basis in store Thunder Bay or Vancouver. From the schedule of initial payments the average handling and transportation charges for Manitoba have been deducted. All prices are reported in dollars per metric ton.

Source:
The Canadian Wheat Board, Annual Report of the Canadian Wheat Board, Winnipeg, 1975.

[b]Interim payments include both interim and adjustment payments. The timing of these payments is that they follow the harvest to which the initial payments are related but prior to the next seeding period, (i.e., all payments have been made in either October, November, December, January, February, or March) and hence are relevant to the formulation of producers' expectations as they come in the critical planning period. These payments are lagged one time period as the date of payment can only influence subsequent year's seedings and not seedings in the crop year in which they are announced.

Source:
The Canadian Wheat Board, Annual Report of the Canadian Wheat Board, Winnipeg, 1975.

[c]Final payments for the production of wheat are made 18 months after the crop has been harvested or a full 22 months after the seeding period. That is, when producers are formulating their expectations for seeding in time period t they do not have the final payment from production in the previous time period (t-1) upon which to revise their expectations and the relevant receipts factor is the final payment lagged two time periods (t-2) as it comes in the critical planning period.

Source:
The Canadian Wheat Board, Annual Report of the Canadian Wheat Board, Winnipeg, 1975.

[d]The non-Board price is the price which producers expected to receive in the informal non-Board market for sales or the price at which on-farm disappearance of grain was valued. As this final value was not known to producers until the close of the crop year in which their production

(Footnotes Continued)

Table A.12 (Continued)

was sold, the value placed on on-farm disappearance is lagged one time period (t-1). That is, the non-Board price from the previous crop year was used by producers to formulate their expectations as this is the only information upon which they have to base their decisions.

Source:

Statistics Canada, Handbook of Agricultural Statistics, Part I--Field Crops, Catalogue Number 21-507, Ottawa.

________, Quarterly Bulletin of Agricultural Statistics, Catalogue Number 21-003, Ottawa.

Table A.13

Total Expected Revenue Per Seeded Hectare of Wheat

Crop Year	Initial Payment[a]	Initial Payment[a]	Interim Payment[b]	Final Payment[c]	Non-Board Receipts[d]	Total Expected Revenue[e]
	................dollars per hectare.............					
1954/55	-	-	-	-	-	-
1955/56	-	33.74	2.83	2.32	15.30	54.19
1956/57	-	45.55	3.82	4.25	15.55	68.73
1957/58	-	52.73	4.42	4.20	12.65	74.00
1958/59	-	56.28	4.72	3.98	15.23	80.21
1959/60	-	55.98	4.69	5.66	20.84	87.17
1960/61	-	53.37	4.48	4.69	16.33	78.87
1961/62	-	49.29	4.13	4.02	21.61	79.05
1962/63	-	33.06	2.77	12.42	19.08	67.33
1963/64	-	63.45	-	11.38	12.76	87.59
1964/65	-	51.25	-	18.19	18.46	87.90
1965/66	-	64.92	-	18.66	14.68	98.26
1966/67	-	67.63	-	19.61	15.53	102.77
1967/68	-	60.32	-	26.21	14.10	100.63
1968/69	-	67.51	-	22.91	13.42	103.66
1969/70	-	64.58	-	4.98	11.44	81.00
1970/71	-	67.19	3.82	-	13.87	84.88
1971/72	82.67	-	-	5.77	39.37	127.81
1972/73	68.93	-	-	11.32	19.24	99.49
1973/74	126.21	-	18.65	7.77	53.93	206.56
1974/75	98.94	-	73.11	28.86	65.24	262.15
1975/76	87.46	-	64.63	40.43	90.80	283.32

[a]The expected gross receipts from the initial payment were formulated by multiplying the initial payment times the marketings. The producers were unaware of the levels of these variables for the current planning period until 1971 so based their expectations upon price and marketings from the previous time period. Since 1971, when the initial price became known in March, producers have been able to combine the announced initial payment in time period t with the marketings from the previous time period to formulate an expected revenue from the initial payment.

(Footnotes Continued)

Table A.13 (Continued)

[b]The expected gross receipts from the interim payment were calculated by multiplying the interim payment from the previous time period times the marketings from the previous time period.

[c]The expected gross receipts from the final payment were calculated by multiplying the final payment from the time period two years previous times the marketings in that time period. This payment is received by producers in the critical planning period and influences their allocation of hectarage by completing the gross receipts from the production and marketings of wheat from 2 years previous.

[d]The expected gross receipts from the non-Board market were calculated by multiplying the non-Board price from the previous time period times the sales into this market in the previous time period. Revenue generated from this market outlet completes the expected gross receipts for wheat.

[e]The expected revenues were calculated using data from Tables A.11 and A.12.

Table A.14

Sunflower/Rapeseed Model[a]

Year	Area	Precipitation	Expected Revenue[b]	Area t-1
	..hectares..	..millimeters..		..hectares..
1955	8094	52	.741	8094
1956	13354	57	1.017	8094
1957	12140	44	.536	13354
1958	18211	11	.853	12140
1959	12950	103	1.503	18211
1960	11331	46	.761	12950
1961	12343	25	1.073	11331
1962	8296	151	1.507	12343
1963	14973	74	1.193	8296
1964	19425	47	.950	14973
1965	19425	96	.549	19425
1966	17442	41	.836	19425
1967	17806	25	1.139	17442
1968	14973	93	.844	17806
1969	19425	51	.818	14973
1970	26304	86	1.071	19425
1971	62725	33	1.215	26304
1972	76889	33	.975	62725
1973	50585	62	1.073	76889
1974	12140	136	.750	50585
1975	24282	39	1.834	12140

[a]These series of data were used to estimate the coefficients of the variables included in the model comparing sunflower revenue to rapeseed revenue.

[b]This series was calculated by dividing the expected revenue from sunflower marketings (Table A.8) by the expected revenue from rapeseed marketings (Table A.9).

Table A.15

Sunflower/Wheat Model[a]

Year	Area	Precipitation	Expected Revenue[b]	Area t-1
	..hectares..	..millimeters..		..hectares..
1955	8094	52	1.019	8094
1956	13354	57	.949	8094
1957	12140	44	.532	13354
1958	18211	11	.492	12140
1959	12950	103	.731	18211
1960	11331	46	.714	12950
1961	12343	25	.967	11331
1962	8296	151	1.220	12343
1963	14973	74	1.059	8296
1964	19425	47	1.127	14973
1965	19425	96	.652	19425
1966	17442	41	.817	19425
1967	17806	25	.846	17442
1968	14973	93	.572	17806
1969	19425	51	.969	14973
1970	26304	86	1.327	19425
1971	62725	33	.988	26304
1972	76889	33	1.067	62725
1973	50585	62	.716	76889
1974	12140	136	.793	50585
1975	24282	39	1.764	12140

[a]These series of data were used to estimate the coefficients of the variables included in the model comparing sunflower revenue to wheat revenue.

[b]This series was calculated by dividing the expected revenue from sunflower marketings (Table A.8) by the expected revenue from wheat marketings (Table A.13).

Table A.16

Results of the Estimations

Sunflower/Rapeseed Model

1. Hectare = 16931.2 - 211.9 Precipitation + 19004.3 Ratio

	(.903) t-value	(-1.502) t-value	(1.053) t-value

Std. Err. of Eqn.	Durbin-Watson	R^2	F-Value
18740	.51	.13	1.25

2. Hectare = 3996.5 - 148.5 Precipitation + 11189.0 Ratio + .81 Prehectare

	(.359)	(-1.759)	(1.036)	(5.521)

Std. Err. of Eqn.	Durbin-Watson	R^2	F-Value
11114.	1.27	.71	12.54

Sunflower/Wheat Model

1. Hectare = 17105.0 - 183.9 Precipitation + 19061.6 Ratio

	(.923) t-value	(-1.373) t-value	(.983) t-value

Std. Err. of Eqn.	Durbin-Watson	R^2	F-Value
18184.	.52	.13	1.17

2. Hectare = -3519.0 - 145.0 Precipitation + 20158.5 Ratio + .83 Prehectare

	(-.330)	(-1.964)	(1.893)	(6.616)

Std. Err. of Eqn.	Durbin-Watson	R^2	F-Value
10337	1.69	.75	15.28

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