AN ECONOMIC AND STATISTICAL EVALUATION

OF

AN ALL-RISK CROP INSURANCE PROGRAM

A Thesis

Presented to

The Faculty of Graduate Studies and Research

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

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June, 1965

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation and gratitude to all those who aided in the preparation of this thesis, as well as the Department of Agricultural Economics and Farm Management which provided the financial assistance that made this study possible.

The author is deeply indebted to Dr. M. H. Yeh, under whose supervision this thesis was written, for his excellent advice and continuous encouragement. Special thanks are due to Dr. J. C. Gilson for his criticism and helpful suggestions. The general guidance given by Dr. Sol Sinclair, Head of the Department, is highly appreciated.

Thanks are also due to Mr. P. H. Ford, Manager of the Manitoba Crop Insurance Corporation, and members of his staff for the assistance in providing some materials used in the study. Mr. H. E. Tolton, Assistant Manager and Director of Research of the Corporation, was most helpful for his suggestions on many practical problems.

Appreciation is due to Mr. Nick Demchuk who friendly corrected mistakes in English; and Mr. Neil Longmuir who helped the calculations for statistical tests.

ABSTRACT

Fluctuation in farm income resulting from variation in crop yield is one of the most significant features in agricultural production. In order to reduce the financial disaster due to crop failure in any particular year, the Government of Canada encourages every province to adopt a crop insurance program through the financial aids authorized by the Federal Crop Insurance Act. Several provinces, including Manitoba, have introduced the crop insurance program on a trial basis. It is expected that successful results of these experiments would introduce this program to the majority of Canadian farmers in a near future.

Along with the introduction of crop insurance program, the following problems arise: (1) what is the possibility of a crop insurance program that could be self-sustaining? (2) to that extent could the fluctuation in total farm income be reduced through the crop insurance program?

The possibility of a self-sustaining crop insurance program mainly relies on its ability to establish a premium-indemnity schedule, acceptable not only to the insurer but also to the farmers. Both the theoretical and practical aspects of the premium rate-making process were critically examined.

Farm records in the Carman area of Manitoba were used to analyze the influence of a crop insurance program on farms by size and by soil type. The historical cash farm income data of Manitoba have provided information on the source of farm income and income variation in that area.

Some conclusions drawn from this study are:

(1) A self-sustaining crop insurance program, defined as one which enables to balance indemnity payments with premium receipts over a period of years, is practically possible.

(2) In order to establish an appropriate premium rate scheme, the yield data should be collected on the basis of those factors such as weather conditions, local topography, soil productivity, land use in recent years, and special farming practices. All these factors might have significant effects on the level as well as the fluctuation of crop production.

(3) There are evidence that farmers on the poor land or on small farms may have difficulty to be covered by the crop insurance program.

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CHAPTER I

INTRODUCTION

Instability is one of the most significant characteristics in agricultural production. A relatively long period of production as well as a great reliance on weather conditions such as rainfall and temperature result in the fluctuation of the yield of each crop and other farm products from year to year. In addition, modern commercialized agriculture suffers from variation in the price of its product. The consequence is well demonstrated by the severe fluctuation of farm income, through changes in production and/or price. However, most farmers prefer to have a relatively stabilized annual farm income. Several important reasons are as follows:

1. Farm family living expenses tend to be relatively constant over a period of years. For a given average farm income, the smaller the annual income fluctuation, the more stable would be the family living expenses.
2. Modern agriculture requires a large investment and continuous adoption of new technology. A stable farm income would encourage farm investment to a level which is close to optimum.
3. Under the assurance of a stable farm income, it would be easier for the farm operator to design

a long run plan for future development in order to make possible fuller utilization of all the resources available on the farm.

4. Agriculture is an integral part of the national economy. A relatively stable farm income would constitute a steady flow of sales and purchases between agricultural and non-agricultural sectors, thus, helping to stabilize the general economy.

There are two causes underlying the farm income instability. One of these is risk, the other is uncertainty. Each has different implications as to the possibility of its stabilization.

Risk is an objective concept. It refers to the outcome of losses in income which can be measured in a probabilistic manner. Two methods are available to find out the probability distribution of losses; namely, a priori knowledge and statistical induction. In contrast, uncertainty is a subjective concept. The occurrence of losses in income involving uncertainty cannot be determined by either a priori knowledge or statistical induction.

In comparison, the dividing line between risk and uncertainty is somewhat ambiguous in the sense that whether the probability density function can be derived from the statistical generalization or not, may depend on available information, statistical technique used, and the degree of

precision required. However, in practice, the distinction is important. The probability density function of the loss in income involving risk, whether estimated by a priori knowledge or statistical induction, provides information regarding the degree and frequency of the risk. This information is essential in establishing a protective device known as insurance. An insurance program is by no means to avoid the occurrence of the risk or the loss of income. It is designed to level off the losses throughout time by paying a fixed amount of premium per unit of time so as to minimize the suffering from the loss at a particular time. The premium rate is calculated in such a way as to equalize the mathematical expectation of the damage caused by the insured risk with respect to a designated coverage level. Within a certain period, the sum of the premium payment is theoretically equal to the expected total losses or indemnity. Therefore, through an insurance program, the part of income instability due to risk can be reduced by the payment of a premium.

Since events involving uncertainty do not enable one to derive a probability density function, it is impossible to estimate a proper premium rate based upon the degree and frequency of its damage. The part of income instability due to uncertainty, therefore, cannot be stabilized by means of insurance.

In general, the variability of crop yield is mainly caused by uncontrollable weather conditions, insects, and plant diseases. These causes are more or less random in nature for a particular year. A crop insurance program might be introduced for the purpose of stabilizing farm income fluctuation, resulting from the variability of crop yield due to these uncontrollable factors. The program could be feasibly sound if it enables one to find out the distribution function of yield risk. More explicitly, the program should be able to set a premium-indemnity schedule mutually acceptable to both the farmer and the insurance agency so that the program could be self-sustaining over a period of years.

THE PROBLEM

For the purpose of stabilizing farm income, a Federal Crop Insurance Act was passed by the Houses of Commons of Canada in 1959. The Act authorizes the Federal Government to subsidize certain cost incurred in the operation of crop insurance in any province and also to provide loans in case of necessity. Through Federal assistance, an insurance program could be established in the place where it is desired.

In response to the Federal Act, the Province of Manitoba set up a test program in four areas in 1960. The

program has been expanded considerably since that time. The experiment is designed to accumulate sound experience so as to enhance the prospect of extending the program to the whole province. The Provinces of Saskatchewan and Prince Edward Island began a similar effort but on a relatively small scale.

At the end of 1964, legislation concerning the adoption of a crop insurance scheme was passed by both the Provinces of Alberta and Nova Scotia.

In adopting a crop insurance program as an instrumental means to reduce income variability, several problems arise, namely:

1. Is it possible to have a self-sustaining program in crop insurance including the administrative expenses?
2. On what basis could an appropriate premium-indemnity schedule be set up?
3. How effective is crop insurance in stabilizing the farm income?

GENERAL HYPOTHESES

Based on the problematic situation in the preceding paragraphs, this study is directed by the following three hypotheses:

1. A sound crop insurance program could be carried out to the extent that the total receipts from

the premium balance the total payment for indemnity over a period of years. It is hardly possible to include the administrative expenses in the premium rate. Furthermore, before the program has accumulated its own reserve, a short-run fluctuation in crop yield may be so heavy and consecutive as to cause a substantial deficit. In this situation government loans are indispensable.

2. The historical yield data compiled on province or district level are not appropriate for estimating the frequency function of the crop damage and thus not suitable to serve as a basis for the calculation of premium rate. More detailed yield data classified by type of farming, soil productivity and weather conditions are necessary.
3. The significance of the crop insurance program, in its efforts to reduce farm income fluctuation, diminishes, because of the facts that (a) the proportion of income from crop has been decreased, and (b) the provided level of protection is too low or the corresponding premium rate is too high in some of the high risk areas.

ASSUMPTIONS

The two basic assumptions of this study are:

1. The program is on a voluntary basis. The farmer may enter into the program on his own wishes.
2. The farmer prefers a stable income over time. In order to reduce income instability due to yield fluctuation, farmers are willing to substitute regular annual premium costs for unpredictable losses each year.

THE PLAN

The rest of the study is organized in the following way:

Chapter II is to review the historical crop insurance program and related activities in North America. The main emphasis attempts to find out a few basic elements which must be included in a sound insurance program. The findings also provide a better understanding towards the difficulties as well as the possibilities of a self-sustaining crop insurance program.

Chapter III is designed to investigate the theoretical background for the calculation of premium rates. The fundamental obstacle to this calculation process arises from insufficient data readily available. One method to estimate the premium rate is to apply normal-curve theory to historical

average yield data on county or district level. The applicability of this method is tested statistically. The unsatisfactory results of the tests lead to further search for the estimation of premium rate in the next chapter.

Chapter IV considers the statistical problems involved in the estimation of an unbiased premium rate. The use of area yield is preferred, but it requires that the area should be delimited according to the crop yield risk. An hypothesized model for the long-run trend and variation in crop yield helps to explain the necessity of adjusting the coverage level over time.

Chapter V deals with the economic effects of the crop insurance program. Two central problems are: (a) to what extent could the individual farmer under a different yield risk situation afford to buy a crop insurance policy? and (b) what are the major effects of a crop insurance program on the stabilization of farm income? Sample data obtained from the Carman area of Manitoba are used in analysing these two problems. Historical cash farm income in Manitoba Province are also analysed in order to discover the source of farm income and income variation in the province.

The last chapter gives the general conclusions of the study and suggests, in particular, further improvements towards a sound crop insurance program and, in general, a more effective stabilization of farm income.

CHAPTER II

HISTORICAL REVIEW OF CROP INSURANCE IN NORTH AMERICA

This chapter deals with the historical development of crop insurance in the North American Continent beginning with the efforts of a few private companies through to government participation.

In the United States, the Federal Crop Insurance Corporation was established in 1939. With 25 years of experience, it provides a good basis for establishing a crop insurance program.

The Canadian approach to the problem is a little different. The Prairie Farm Assistance Act in 1939 put its emphasis on public relief as the basis of need. All three Prairie Provinces are interested in the crop insurance program, but each is aware of the financial responsibility which may result. The Federal Crop Insurance Act of 1959 cleared away some of the hesitation toward the adoption of a crop insurance scheme by the individual province. Under the encouragement of the Federal Act the provinces of Manitoba and Saskatchewan have each carried out an insurance program on a trial basis. Further expansion of the crop insurance device in Canada will largely depend on the results of this experimental program.

THE PIONEERS OF CROP INSURANCE -- PRIVATE COMPANIES

The Realty Revenue Guaranty Company of Minneapolis, Minnesota, offered the first simple form of all-risk crop insurance to the farmers in 1899. The insurance policy was to guarantee a minimum crop income of five dollars per acre for a premium of twenty-five cents per acre. This type of insurance policy attempted to cover both yield and price uncertainties. Little was known about the internal operation of the company, except that the management was very inefficient. The consequence is that the company closed down with heavy losses.

Two independent companies, Bankers of Montana and the National Union of Pittsburg had carried on about the similar insurance policies in the spring wheat sections of Minnesota, North and South Dakota, and Montana in 1917. These policies attempted to insure wheat, flax, rye, oats, barley and spelt against all risks except fire, flood, winterkill and the farmer's own failure in farming practices. The insurance policy was to offer seven dollars per acre in case of a total loss at a premium of seventy cents. Partial failures were paid off by the difference between the value of actual harvesting yields and the value of insured yields. Both companies, however, suffered heavy losses. The failure of business was due to: (a) severe drought in the insured

area; (b) highly concentrated crop risks in a small area; and (c) most of the insurance was underwritten so late in the season that farmers had foreseen the crop losses.

The Hartford Fire Insurance Company made the third attempt at writing all-risk insurance on a national basis, from 1920 to 1923. The policy was to provide a coverage equivalent to the cost of production of the insured crop with a premium rate averaging five percent of the coverage. A drastic price decline happened in 1920 resulting in a heavy loss to the company. Besides, the company also suffered from the variation in the coverage which was based on the inaccurate costs of production as estimated by the applicants. Because of the disadvantage of price fluctuation, the new contract in the second year stipulated that no indemnity would be paid under the following two conditions: (a) if the value of the crop at harvest was equal to the insured coverage or (b) if the crop production was equal to the insured production. This new policy mainly was a 'yield insurance'. It could be much safer on the company's side. The farmers, however, lost their interest in the new policy. Business fell off materially in 1921 and the company ceased operation after 1923.

In 1920 The Hartford Company had the intention of extending its business to the Western Canada. Office representatives were sent out to Regina for the analysis of the

Saskatchewan crop record for the ten preceding years. The result was not satisfactory. Thus the company did not take any action in Canada.

From 1920 to 1921, the Home Insurance Company of New York offered a contract similar to that of the Hartford Company. The result was also unsatisfactory. In its second year of operation the company sold crop insurance in the three prairie provinces of Canada. Only 60 policies were sold in south-western Alberta. The company lost $28,000 in one year of operation. This is the only private venture of all-risk crop insurance in Western Canada.

Later on, two Kansas companies (Agricultural Protective Mutual Insurance Company and the Sowers Plan of Insurance) entered into an all-risk crop insurance program in 1931-32 and 1937-38 respectively. Both companies offered a production cost policy with a premium rate ranging from five to thirteen percent of production. Both companies suffered from unexpected drop of wheat price during the period of operation and closed down their business.

In conclusion, the causes of failure for all these private companies could be summarized as follows:

1. A fluctuation in prices of farm products was so drastic and irregular.
2. Actuarial data were entirely insufficient for all these companies.

3. The initial capital was not sufficient. All these companies were forced out of business before a reserve could be accumulated.
4. The levels of premium and coverage were not well classified by the productivity of land. In certain cases, farmers underwrote the policy when the loss of crop was already apparent.
5. Lack of experience as well as inefficient management made the business unsuccessful.

THE EXPERIENCE OF THE FEDERAL CROP INSURANCE COMPANY IN THE UNITED STATES

The Federal Crop Insurance Act was enacted by the U.S. Congress in February, 1938, providing a nation-wide insurance policy on wheat. Accordingly, the Federal Crop Insurance Corporation (F.C.I.C.) was established in 1939 as an agency within the United States Department of Agriculture. The important contents of the Act are:

1. The system is voluntary in nature.
2. Insurance only covers the crop yield.
3. The amount of coverage is no more than the cost of production per acre in a specific area or seventy-five percent of the long-run average yield.
4. The premium rate is of such an amount as to balance the indemnity payment over a period of years.

5. An initial capital stock of one hundred million dollars was supported by the Federal government. The government was also responsible to pay the annual administration expenses up to a maximum of twelve million dollars.

The crop insurance business operated by F.C.I.C. in the first five years from 1939 to 1943 was not successful. The indemnity exceeded the premium every year by a total amount of $36.9 million. In addition, the administrative expenses cost the government another $28.2 million. Losses that were incurred in this period were partly due to droughts in 1939 and 1940, and partly due to the wide-spread winter-kill in 1941. However, part of the loss was attributed to defects in the insurance and also adverse selectivity. For instance, loss adjustment was not efficient, and some insurance was underwritten so late in the season that a crop loss was apparent. As a result of the huge loss in these five years, the U.S. crop insurance program was discontinued in the summer of 1943.

There was no insurance program on the 1944 crop nor on the 1945 winter wheat crop planted in the fall of 1944.

The program was re-instituted by an amendment to the Crop Insurance Act in December,1944. According to the new amendment, insurance was offered on a national basis for wheat, cotton and flax in 1945. Corn and tobacco were also

included on a trial basis. In order to improve the insurance program, some new policies were introduced:

1. Since 1941, an incentive bonus was given to those individuals who bought the insurance for seven consecutive years but did not claim for a single loss.
2. A three-year contract on wheat was introduced in 1943. The purposes were to reduce the possibility of adverse selectivity and to simplify the insurance procedure.
3. An independent loss-adjustment system was established in 1944.
4. The insurance program would be offered to a county with a minimum number of fifty farmers.

The financial results in the period of 1945 to 1947 inclusive showed a significant improvement in wheat, satisfactory experience with flax and tobacco, and little loss on corn. However, heavy losses on cotton were incurred in both 1945 and 1946.

Starting in 1948, the crop insurance program was reduced to an experimental basis. Insurance was available for only 375 counties[1] in 1948, as compared to 2,400 counties in 1947.

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[1]Number of total counties includes duplication when more than one crop is insured in a county.

In addition to the five commodities of wheat, corn, cotton, flax and tobacco, dry edible beans and a multiple crop insurance were also included.

Table I shows that the financial results between two periods of 1939-47 and 1948-63 were significantly different. A decline of loss ratio from 1.48 to 0.94 indicates that the financial program was changed from a deficit position in 1939-47 to a surplus position in 1948-63. It is important to note that the improvement of this financial situation was accompanied by a decrease in the average premium rate (as a percentage of the total level of protection) from 9.4 percent to 6.6 percent.

The indemnities paid for different causes of losses are illustrated in Table II. The loss due to drought and excess moisture accounted for more than one half (53.1 percent) of the total claim. The other main causes of loss were due to insects, hail, freeze, wind and disease.

In 1963, the crop insurance program had been expanded to 2,378 counties. The insurable crops included apple, barley, dry edible bean, cherry, citrus, corn, cotton, flax, grain sorghum, oats, pea, peach, peanut, potato, raisin, rice, soybean, tobacco, tomato, wheat and a combined (or multiple) crop. Total protection reached to nearly half a billion dollars.

Many changes and improvements have been made since

TABLE I

A COMPARISON OF CROP INSURANCE EXPERIENCED BY F.C.I.C. IN TWO DIFFERENT PERIODS, 1939-47 AND 1948-63

Period	Protection (1)	Premium (2)	Indemnity (3)	As % of Protection: Premium (2)/(1)	As % of Protection: Indemnity (3)/(1)	Loss Ratio (3)/(2)
	(Thousand Dollars)					
1939-47	1,564,916	146,848	217,287	9.4	13.9	1.48
1948-63	4,781,116	314,921	295,566	6.6	6.2	0.94
1939-63	6,346,032	461,769	512,853	7.3	8.1	1.11

Source: Federal Crop Insurance Corporation, Annual Report, 1963, (Washington: United States Department of Agriculture, 1964), p.17 and p.33.

TABLE II

CAUSES OF LOSSES IN F.C.I.C.

Causes	Percentage
Drought	39.1
Excess Moisture	14.0
Insects	10.9
Hail	10.2
Freeze	10.0
Wind	5.6
Disease	4.8
All others	5.4
Total	100.0

Source: Federal Crop Insurance Corporation, Annual Report, 1963 (Washington: U.S. Department of Agriculture, 1964), p.9.

1948. The main features of the present F.C.I.C. program could be summarized as follows:

1. Since 1948, a fixed price for each insurable crop was used in converting the premium and indemnity into cash value. The fixed price was established before the planting time. Later on several choices of the amount of insurance per acre for each crop, associated with respective premium rates, were available to the farmer. This amount would serve as a standard in converting the loss of commodity into cash.[2] Used for three years during 1960-62, it proved to be unsatisfactory due to the fact that the farmers were not able to understand it. This method of fixed price was abandoned in 1963. A new method which includes several unit prices for a single commodity is now available to the farmers. The chosen price is used in calculating the value of loss.[3]

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[2]For instance, if an insured has 100 acres of wheat and the guaranteed production is 10 bushels per acre, total coverage is, therefore, 1,000 bushels. Also assume that the total production of this insured turns out to be 700 bushels which is 300 bushels short of the coverage. The percentage of loss is obtained by dividing 300 bushels by 1,000 bushels or 30 percent. In other words loss equivalent is 30 percent of 100 acres or 30 acres. If this insured has chosen 15 dollars of insurance per acre, total indemnity will be 450 dollars.

[3]In the example shown in footnote 2, the loss of production is 300 bushels. If the insured has chosen 2 dollars per bushel his total indemnity will be 600 dollars.

2. The level of insured coverage, or the guaranteed production, is expressed in terms of yields per acre. Two guiding principles for deciding the level of guaranteed production are: (a) seventy-five percent of long-run average production and (b) an average investment in crop production. The latter principle has been emphasized since 1948. This means that there is a more conservative level of insurance. The long-run average yield in a county is usually used as a unit in computing the level of coverage. This level of coverage is then adjusted in accordance with the local variation of productivity within that county. Sub-area yield records, soil maps and other information is used in making such an adjustment. Each sub-area has its own appropriate level of coverage.

3. The premium rate is based on the estimated losses per acre over a representative period of years. Since individual farm records for past twenty or thirty years are seldom available, county average production is used for substitution. The procedure of calculating the premium rate based on county average production by the use of a normal-curve approximation will be discussed in some details in the next chapter. The county premium rate is then adjusted in two ways, namely: (a) actual insurance losses of that county in past years are incorporated into the rate, and (b) the local variation in soil productivity is also con-

sidered in the rate. Furthermore, the premium rate should be set up adequately in order to meet unseen losses and to establish a reasonable reserve throughout the years. The operating expenses are not included in the premium rate. The premium rate so decided is still in physical terms. Later on it is converted into cash by the same fixed price as in the calculation of indemnity in the case of crop losses.

4. The closing date of each crop insurance is established before the usual planting season of each crop in order to avoid the possibility of so called 'adverse selection of risk.' Moreover, a maximum number of contracts, including carryover and new, is restricted to each county in accordance with its past records. In case total contracts reach the assigned maximum number by the closing date, further sales are stopped for a re-check to determine the cause of the increase. Sales may be continued only when the cause of increase is found to be due to the expansion of the crop area rather than adverse selectivity of risk.

5. A continuous contract is used in order to simplify the sales efforts. However, the contract permits cancellation by both parties several months in advance of the closing date.

6. The level of indemnity progresses with the different stages of crop development. This is designed for protecting investment only. For instance, if the complete damage

of a crop makes harvest unnecessary, harvesting expenses are deducted from the indemnity payment. In a case when the crop is seriously damaged early in the planting season, the farmer is expected to replant his crop if it is still practically possible.

7. Insurance covers a loss in quality as well. Generally, the damaged crop is converted into a standard grade. If the resulting amount of production is lower than the coverage, the difference is paid by the corporation as an indemnity.

8. The incentive bonus schedule has been used in encouraging a continuous program over the years. It provides that after 3 years of participation without losses, premium rate is adjusted downward. The discount from the basic rate is 5 percent after 3 years, 10 percent after 4 years, and up to a maximum discount of a 25 percent after 7 years.

Despite all these improvements and sound insurance experience since 1948, the F.C.I.C. still had the problem of low participation. It was estimated in 1957[4] that only twenty percent of eligible farmers in counties where insurance was provided were insured. The percentage of participat-

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[4] Federal Crop Insurance Corporation, A Reappraisal of the Federal Crop Insurance Program, (Washington: U.S. Department of Agriculture, 1958), p.13.

ion with respect to the individual crops varied from thirty-five percent for flax to only ten percent for citrus. There are three main factors which have affected the participation adversely.[5] Firstly, some farmers may find that the cost of crop insurance is too high for them to afford. Secondly, government measures such as Soil Bank program provide some guaranteed income to the farmer and makes the protection of crop insurance less important. Thirdly, since government relief is available in case of severe and wide-spread natural calamity, some farmers tend to rely on public help in the form of a grant or a loan rather than insurance protection.

Several conclusions may be drawn from the F.C.I.C. experience.

1. The risk of crop damage may be severe and wide-spread for several consecutive years. Even a well-established crop insurance company may be involved in heavy losses during some period of its operation. The evidence shows that a huge reserve fund provided by U.S. government helped the F.C.I.C. to get through the first nine difficult years, 1939-48. Otherwise the F.C.I.C. would be forced out of the operation before it had the chance to build up the sound insurance experience. This fact should not be overlooked in introducing a new crop insurance program elsewhere.

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[5] Ibid., pp.2-3.

2. The most significant accomplishment of F.C.I.C. operation evidently shows that the estimated premium rate scheme must be dependent upon a well-classified risk area with the reference to the past experience and variation of soil productivity in local area. However, if some systematic procedure in classifying the crop risk is carried out at the very beginning, it would be much more helpful in estimating the premium rate in the long-run.

3. Those devices such as incentive bonus, continuous contract, and early closing date, are important for the avoidance of the possibility of adverse selectivity.

4. The fact that the United States Congress liquidated the F.C.I.C. in 1944 after a heavy loss in the operation of crop insurance deserves special attention in the planning of a crop insurance program under governmental sponsorship. Only when the program itself is well-organized and progressive, could it expect to receive some financial aid from government. Otherwise, even the most ardent supporter would turn away.

5. The recent financial reports showed that the Corporation could balance the premium receipt over the indemnity payment within a period of 15 years. This evidence certainly indicates that over a period of years a self-sustaining crop insurance program is possible.

THE PRAIRIE FARM ASSISTANCE ACT AND THE CROP INSURANCE PROGRAM IN CANADA

I. Prairie Farm Assistance Act

The Prairie Farm Assistance Act[6] (P.F.A.A.) was enacted in 1939 after a decade of continually low agricultural production in western Canada and world economic recession. The Act was applicable to the spring wheat area including the provinces of Manitoba, Saskatchewan, Alberta and the Peace River District of British Columbia. Its basic purpose was to provide a vehicle for distributing 'relief' payments to farmers on the basis of need.[7]

The wheat yield in an area, usually a township or a block, is used as a single criterion for the relief payment. However, the payment is not restricted to wheat losses nor to the wheat growers. If the average wheat yield of a township (or block) is below certain level, then all farmers within that area are eligible to receive same standard of payment for each acre of cultivated land, no matter what is the actual yield of wheat or other crops on the individual farm.

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[6] Statutes of Canada, An Act to Assist Agriculture in the Prairie Provinces, (3 Geo.VI, Parts I-II, Ottawa: The Queen's Printer and Controller of Stationary) Chapter 50, pp.459-464.

[7] Saskatchewan Royal Commission on Agriculture and Rural Life, Crop Insurance, (Report No. 9, Regina: Queen's Printer, 1956), p.21.

The Act has been amended several times since it was firstly introduced, but the basic principle does not change. As it is provided now, there are four following categories of payment:

1. If the average wheat yield in the area is not more than 3 bushels, the payment shall be 4 dollars per acre.

2. If the average yield of wheat in the area is more than 3 and not more than 5 bushels per acre, the payment shall be 3 dollars per acre.

3. If the average yield of wheat in the area is more than 5 and not more than 8 bushels per acre, the payment shall be 2 dollars per acre.

4. If the average yield of wheat in the area is more than 8 bushels and not more than 12 bushels, the payment shall be ten cents per acre for each cent, or fraction thereof, not exceeding ten, by which the average price is less than eighty cents per bushel.

The aforesaid level of payment applies to a maximum of one-half of the cultivated land of the farmer, or two hundred acres. In other words, the annual maximum payment to an individual farmer is no more than 800 dollars.

The Act was not primarily intended to be a crop insurance program. But it has its insurance aspect as well. A one percent levy was collected on all wheat, oats, barley, rye, flax and rapeseed sold in the public market within the

area. Due to this fact, P.F.A.A. is referred to as an area yield crop insurance or a first step towards a more comprehensive crop insurance program.[8]

The operation of P.F.A.A. from 1939 to July 1963 has showed a deficit of $187,683,745.[9] Besides, a total of $24,362,383 for administrative expenses was paid by government.[10] On average, the cost of P.F.A.A. including deficit and administrative expenses was $8,835,255 annually.

There are many criticisms regarding the application of P.F.A.A.. Generally, the dissatisfaction is due to the following reasons:[11]

1. A one percent levy on all the market value of grain and a single rate of payment fail to recognize those critical factors such as the average yield and yield variability on individual farm. There is a tendency for farmers on good land subsidize those on poor land.

2. A township or a block is too large as an unit area to reflect the yield on the individual farm.

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[8] Ibid.

[9] Canada Department of Agriculture, Report on Activities under the Prairie Farm Assistance Act for the Crop Year 1962-63. (Ottawa: Department of Agriculture), pp.5-6.

[10] Op.cit., Annual Reports from 1939-63.

[11] Manitoba Crop Insurance Commission, Report of the Manitoba Crop Insurance Commission, (Winnipeg: Queen's Printer, 1955), p.12.

3. The payments are relatively too small in terms of the present-day agricultural business.

However, the Act did provide a considerable amount of assistance to those farmers who have been affected by the crop losses, especially to those farmers in the province of Saskatchewan,[12] where natural disasters were relatively more frequent. It is also a better form of assistance than the direct relief payment in the 1930's.[13]

II. Research on Crop Insurance in Prairie Provinces

All three prairie provinces have paid much attention to the feasibility of a crop insurance program. Some of the important studies and proposals are as follows:

(A) The province of Saskatchewan has experienced the heavy crop failures in 1931, 1933 and 1934, when the province average yield was at 8.8, 8.7 and 8.6 bushels respectively. In 1935, the Saskatchewan Crop Insurance Committee was established under the provincial department of agriculture. The preliminary report[14] listed some of the difficul-

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[12] Under P.F.A.A., $216,608,177 or 65.6 percent of the total payment were paid to the farmers in Saskatchewan.

[13] M.E. Andal, "Some Economic Aspects of the Prairie Farm Assistance Act," The Economic Annalist, IVXX, (February, 1954), 15.

[14] Saskatchewan Department of Agriculture, Preliminary Report of the Committee on Crop Insurance, (Regina: Department of Agriculture, 1936).

ties involved in introducing crop insurance into the province. Few major difficulties were lack of individual yield records, high premium rate for the risky areas, moral hazard, and difficulty to attain continuous support from a majority of farmers. On the other hand, it suggested that (a) the crop insurance program could be brought into practice only when a specific number of municipalities supported the program; (b) the premium rate should vary according to the risk zone, but the level of coverage should be fairly uniform within the province.

(B) The Alberta Department of Agriculture also investigated the feasibility of crop insurance in 1935. The report[15] published in 1936 suggested three possible ways to help the farmers in the dry areas of the province, namely: (a) all-risk crop insurance; (b) crop income payment; and (c) farm storage. Due to the difficulties of putting a satisfactory program into operation coupled with the possibility of financial losses, it was concluded that a crop insurance program was not suitable for the province.

(C) W. J. Hansen of the Economics Branch of Canada Department of Agriculture made an intensive study on the crop insurance possibilities for Saskatchewan in 1936. According

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[15] Alberta Department of Agriculture, A Report on the Rehabilitation of the Dry Areas of Alberta and Crop Insurance, (Edmonton: King's Printer, 1936).

to his report issued in 1937,[16] he considered that a voluntary crop insurance could be an alternative to public relief. Using the yield data for the period 1918-35, Hansen discovered that the closest approximation to the cost of insurance on individual farms would be the municipality average yield. Several risk zones (or rate areas) were delineated by grouping the municipal units. Within each risk zone the premium rate was fairly uniform. Furthermore he also suggested that the provided coverage should be no less than 60 percent of a long-run average yield. Otherwise, it would not be able to help farmers to solve their financial hardships.

(D) The suggestion from the Manitoba Crop Insurance Committee[17] indicated that crop insurance was feasible and desirable in Manitoba. Therefore it recommended that if the producers on a minimum of 25 percent of the wheat acreage supported the program, the provincial government should take steps toward a crop insurance scheme on a municipal basis. By using the yield data of 1921-1938, the study showed that coverage and premium rate can be established for each crop

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[16] W. J. Hansen, Economic Aspects of Crop (Yield) Insurance with Reference to the Province of Saskatchewan, (Ottawa: Canada Department of Agriculture, 1937).

[17] Manitoba Economic Survey Board, Crop Insurance in Manitoba, A Report on the Feasibility and Practicability of Crop Insurance in Manitoba, (Winnipeg: King's Printer, 1940).

district in Manitoba. The report recognized the fact that a sound crop insurance might not be able to cover farmers on submarginal land. Nevertheless, it contended that the majority of farmers in the province could afford to pay the cost of insurance.

(E) R. E. Motherwell has prepared a report[18] on crop insurance for Saskatchewan Reconstruction Council in 1944. His study was heavily influenced by the F.C.I.C. operation in the early 1940's. Motherwell concluded his report by saying that "crop insurance for this province (Saskatchewan) is possible but its practicability is doubtful."[19] The difficulties of applying insurance program were: (a) that farmers in high risk areas were unable to pay the required premium for protection; (b) that the provided coverage in most areas was too low to serve the purpose of disaster preventive; (c) that under a voluntary system, there was the problem of continuous participation; and (d) that even compulsory system could not ensure a self-carrying crop insurance for many areas in the prairie provinces.

(F) The Manitoba Crop Insurance Commission was set up in 1954 to review the P.F.A.A. and to evaluate the feasibility of crop insurance. In its report[20] published in 1955,

[18]R. E. Motherwell, A Study of Crop Insurance, (Report of the Saskatchewan Reconstruction Council, Appendix 3, Regina: King's Printer, 1944).

[19]Motherwell, op.cit., p.40. Parenthesis added.

[20]Manitoba Crop Insurance Commission, op.cit.

it fully recognized the income stabilizing function of crop insurance, assuming such a program was practicable. Nevertheless, the insurance experience of F,C.I.C. in nearby areas led the report to conclude that crop insurance in Manitoba could cause enormous losses in any one or a series of years. The report implied the necessity of Federal Government assistance to the program in one way or other, but did not give any detailed consideration to the form or extent of such assistance.

(G) The Saskatchewan Royal Commission on Agriculture and Rural Life made another study[21] on crop insurance in 1956. The report urged the desirability of crop insurance as a system to stabilize the prairie agriculture. Realizing the short-run problems of implementing a crop insurance program and the long-run feasibility of its application, the report made the following two main recommendations:[22]

1. That an experimental crop insurance program be launched in Saskatchewan as a program complementary to, but separate from,the present Prairie Farm Assistance Act Program.
2. That reserve requirements for the experimental program be supported by the Federal Government.

In summary, crop insurance has claimed the continuing

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[21] Saskatchewan Royal Commission on Agriculture and Rural Life, op.cit.

[22] Saskatchewan Royal Commission on Agriculture and Rural Life, op.cit. p.99.

interest of prairie farmers and their provincial governments. The conclusions of the various studies may be different from one to another, but their common findings can be summarized in the following aspects:

1. Crop insurance is a desirable way of reducing farm income fluctuation throughout the years;
2. Lack of individual yield record in the prairie area makes the adoption of crop insurance difficult;
3. The high yield fluctuation in the prairie area may cause heavy losses in a single or a series of years;
4. Crop insurance may not be able to protect farmers on submarginal land;
5. A sound crop insurance program requires farmers' continuous participation; and
6. The financial assistance from Federal Government is necessary for the development of crop insurance scheme in the prairie provinces.

III The Federal Crop Insurance Act

The Government of Canada enacted in July 1959 "An Act to provide for Contributions and Loans to the Provinces in respect of Crop Insurance"[23] (abbreviated as the Federal Crop

[23] Statutes of Canada, An Act to Provide for Contributions and Loans to the Provinces in respect of Crop Insurance, (7-8 Eliz. II, Ottawa: The Queen's Printer and Controller of Stationary, 1959) Vol.1, pp.265-69.

Insurance Act). The Act authorizes the Federal Government to make an agreement with each province which adopts a crop insurance scheme under the provincial government. It includes the following important provisions:

1. The government of Canada is to contribute to the insurance program each year as follows:

> "(a) fifty percent of the expenses incurred by the province in that year in the administration of the insurance scheme; and
> (b) if the province has by the agreement undertaken to pay a share of the premiums, the lesser of
> (i) the amount required to reimburse the province for the share of the premiums paid by it in that year, or
> (ii) twenty percent of the premiums paid in respect of policies of insurance in that year."[24]

2. Total loans made to a province "shall not exceed in any year seventy-five percent of the amount by which the indemnities required to be paid under policies of insurance exceed the aggregate of
(a) the premium receipts for that year,
(b) the reserve for the payment of indemnities, and
(c) two hundred thousand dollars."[25]

3. The amount of insurance to be affected on any crop in any area shall not exceed sixty percent of the long-term average yield of the crop in the area.

4. The premium rate scheme with respect to any policy of crop insurance should be designated in fulfilling the self-sustaining insurance scheme.

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[24] Ibid., s.4. (1).

[25] Ibid., s.4. (2).

5. The Prairie Farm Assistance Act is no longer effective on those cultivated lands where the crop insurance scheme extends.

IV. The Manitoba Crop Insurance Test Program

A. Legislation Background

In response to the Federal Act and as a first approach to a large scale crop insurance program in the province, the Manitoba Legislative Assembly passed the Crop Insurance Test Areas Act[26] in August, 1959. The act authorizes:

1. That the Board and Body of a Crop Insurancy Agency to administer the crop insurance business in Manitoba be established.
2. That the selection of test areas be such that twenty-five percent of the qualified person or persons operating at least twenty-five percent of the land in the area are willing to participate in the program.
3. That the insurable crops be wheat, oats and barley.
4. That the insurance cover such perils as hail, drought, excessive rainfall, flood, frost, wind (including tornado), disease (including rust), and pests.

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[26] Statutes of Manitoba, An Act to Establish Crop Insurance Test Areas in Manitoba (7 Eliz. II, Winnipeg: Queen's Printer, 1959), pp.109-121.

5. That the long-term average yield be thirty-five years.
6. That the price of insured crops be based on the initial price of average grade fixed by the Canadian Wheat Board in the same crop year.
7. That a person is qualified to buy the insurance policy if he is actually engaged in farming in the test areas, including the production of an insurable crop.
8. That the payment of fifty percent of administrative expenses be supported by the provincial treasury.
9. That a working capital up to a total amount of five hundred thousand dollars be available to the agency,
10. That an agreement be made with the Government of Canada in accordance with the Act of the Parliament of Canada enacted for the same purpose.

The Act was amended in May 1960, May 1962 and May 1963 respectively. The main amendments include:

1. Insurable crops are wheat, oats, barley, flax and sugar beets or any combination of two or more of these crops.
2. The established price per bushel of wheat, oats and barley is the initial price set by the Canadian Wheat Board on October 31 of the previous year.

3. The established price per bushel of flax is 90% of its average price during the ten crop years immediately preceding the insurance period.
4. The established price per hundred weight of sugar beets is its average price during the years from 1940 to the crop year immediately preceding the insurance period.
5. After the test area has been established, the agency shall not continue to provide insurance in the test area unless the minimum requirements for establishing the test area is satisfied in the subsequent year.
6. In case the quality of the insured crop is affected by the designated perils, the agency will pay the amount by which the resulting value of the insured crop is short of the total coverage.
7. The Provincial Treasury may advance to the agency to use the working capital up to two million dollars.
8. "The Manitoba Crop Insurance Corporation" is to be used instead of "The Crop Insurance Agency."

B. <u>The Insurance Experience of Manitoba Crop Insurance Corporation</u>

The Manitoba Crop Insurance Corporation (M.C.I.C.) was established in 1960. In the first year it was applied to four test areas covering 19 rural municipalities. An upward trend

of participation in crop insurance program is shown in Table III. In 1963-64 a total of 5,142 policies were sold to the farmers in these test areas, representing a participation of 50 percent.

TABLE III

A TREND OF PARTICIPATION IN MANTIBA CROP INSURANCE TESTING PROGRAM, 1960-64

Crop Year	No.of Total Contracts	Estimated participation as % of farms in the area
1960-61	2,472	38.1
1961-62	3,654	39.9
1962-63	4,413	48.2
1963-64	5,142	50.3

Source: "Report of the Manitoba Crop Insurance Corporation", Annual Report of the Department of Agriculture and Conservation for the Year Ended March 31st, 1964, (Winnipeg: Department of Agriculture and Conservation, 1964), p.202.

The operation[27] of M.C.I.C. has benefitted from the experience of F.C.I.C. In a few year period, the Corporation has successfully adopted several significant policies such as continuous contract, discount for good experience, combined adjustment plan,[28] choice of dollar coverage of 75 percent or

[27]"Report of the Manitoba Crop Insurance Corporation", Annual Report of the Department of Agriculture and Conservation for the Year Ended March 31st,1964 (Winnipeg: Department of Agriculture and Conservation,1964), pp.181-212.

[28]A combined adjustment plan pays indemnity only when the (cont'd)

100 percent, etc. Progress also has been made on the calculation of premium rate and coverage. In 1960, due to the limitation of data available, both the premium rate and coverage level were calculated on the basis of a township. This practice soon arose the complaint from the farmers, since, for instance, the sand ridges were being insured for the same coverage level and premium rate as the finely textured clays. Since 1961, soil productivity has been used as a criterion in determining the premium and coverage for each type of soil zone. In order to have a better estimate of premium rate, the Corporation also performs an annual yield survey of the insureds and delineation of areas with respect to crop yield risk.

Heavy crop losses due to drought were experienced in 1961. More than one million dollars were lost in that single year. In the rest of the three relatively normal years, two of them were on the favorable side and the other in the deficit. Table IV summarizes the insurance experience of M.C.I.C. in its first four years of operation.

Besides the premium paid by the farmers, the Corporation had received an amount equivalent to 25 percent of that premium[29] from the Federal Government. The total administrative expenses, including field operation, research and general office,

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[28] total value of the insured crops is less than the total coverage of these crops.

[29] Or put it in another way, the Federal Government pays 20 percent of the total premium.

TABLE IV

SUMMARY OF INSURANCE EXPERIENCE OF

M.C.I.C., 1960-64

Crop Year	Protection (1)	Premium* (2)	Indemnity (3)	As % of Protection Premium (2)/(1)	As % of Protection Coverage (3)/(1)	Loss Ratio (3)/(2)
1960-61	$4,071,748	$255,487	$ 87,082	6.3	2.1	0.34
1961-62	6,687,277	434,783	1,586,406	6.5	23.7	3.65
1962-63	9,637,614	684,249	531,504	7.1	5.6	0.78
1963-64	12,222,226	816,901	1,242,165	6.7	10.2	1.52
Total	32,618,865	2,191,420	3,447,157	6.7	10.6	1.57

Source: Report of the Manitoba Crop Insurance Corporation, Ibid., 1960-64 Reports.

* Premium charged to the insureds.

were equally shared by the Federal and the Provincial government. The total administrative expenses were $1,387,795 in the four year period, or an average of $346,949 annually.

In summary, a few private crop insurance companies had tried to apply the ordinary insurance to agriculture in the early 1920's, without success. Findings from various studies in the prairie area showed that crop insurance was desirable but its practicability was doubtful, at least from the standpoint of a single provincial government.

Realizing the responsibility of public relief, the P.F.A.A. was adopted by the Federal Government in 1939. The operation of the Act was simple and systematic with a very low administrative cost as compared to a crop insurance program. However, the proportion of deficit to total expenditure under P.F.A.A. was much higher than the crop insurance. Table V provides the financial results for the comparison of government expenditure between P.F.A.A. and F.C.I.C. indicating the nature of the two different approaches to the problem of farm income stabilization.

A feasible and practical crop insurance program could be formulated if such a program would be financially supported by both the Federal and Local Governments. In general, the Manitoba crop insurance program in 1960, was a conservative start but it could be a warranted measure. Although the M.C.I.C. financial statement was still in deficit, over a

TABLE V

COMPARISON OF GOVERNMENT EXPENDITURE ON

P.F.A.A. and F.C.I.C., 1939-1963

Agency	Total	Administrative Expenses	Deficit
		(thousand dollars)	
P.F.A.A.	C.N. $212,046	24,362	187,684
F.C.I.C.	U.S. $189,192	138,098	51,094

Source: The P.F.A.A. data were obtained from Reports on Activities under the Prairie Farm Assistance Act, 1939-63, (Ottawa: Department of Agriculture), while the F.C.I.C. data from Annual Reports on Federal Crop Insurance Corporation, 1939-63, (Washington: U.S. Department of Agriculture).

period of years it may become increasingly more self-supporting, as F.C.I.C. experience has shown.

CHAPTER III

PRINCIPLES OF PREMIUM RATE-MAKING AND ITS APPROXIMATION

The most critical problem encountered in the adoption of a crop insurance program lies on the calculation of the premium rate. The review in the preceding chapter showed that an inappropriate premium rate is the main source of failure of a crop insurance scheme, either due to over-payment of indemnity or loss of the participants. As a matter of fact, disagreement on the feasibility of the crop insurance arises mainly from the difficulties in deriving an appropriate premium rate. Once this problem has been reasonably solved, there would be a smaller obstacle for the provinces in Canada to introduce crop insurance as a means of stabilizing farm income. This chapter examines the theoretical and practical aspect of premium rate-making. The empirical truth of the approximation formula which applies normal-curve theory to the area average yield data for the estimation of premium rates is statistically tested.

THE ESSENCE OF PREMIUM RATE-MAKING

Theoretically, a unit premium rate, P, for the insurance of a certain crop consists of three components; namely, the pure premium rate, administration cost and normal profits.

The pure premium rate per acre, p, varies directly with

the degree of risk in the insured crop yield. For each particular acre of land, loss costs occur when the actual yield falls below the provided level of protection or coverage. If the coverage is designated by C and the yield less than C by y_i, then the theoretical pure premium rate is equal to the mathematical expectation of loss cost, $(C-y_i)$, or

$$(1) \qquad p = E(C-y_i) = \sum_i f(y_i)(C-y_i) \qquad 0 \leq y_i < C.$$

Equation (1) shows the value of the pure premium rate if the frequency function, $f(y_i)$, is known. It also indicates that the level of pure premium rate, p, is influenced by two factors; namely, the level of coverage per acre, C, and the frequency function of acre yield below the coverage, $f(y_i)$. In a high risk area, low yield is usually associated with a high frequency, thus requiring a higher pure premium rate with respect to the same amount of coverage. On the other hand, a pure premium rate will be increased for the same risk of crop yield if the provided level of coverage is shifted upwards.

The level of coverage is usually designated by the insurance company or government policy. Therefore, the statistical problem of obtaining the pure premium rate depends on how to estimate the frequency function, $f(y_i)$.

Administration cost, K, refers to those expenses which do not vary directly with the total amount of land covered by insurance in a short period. Expenses such as salaries,

rent, promotion cost, have to be paid no matter how many farmers buy insurance for the current year. Only in the longer period, when the business continues to expand or contract, will the amount spent for administration change. Since the total amount of administration cost is fixed each year, its unit cost per acre of insured crop, c_f, varies inversely with total acreage of insured land, N, covered in the insurance, i.e.,

$$c_f = K/N .$$

The normal profit, N_p, is a lump sum of money profit which is just enough to attract the enterpreneur who remains in the business of crop insurance in the long-run. The unit normal profit, n_p, also varies inversely with the size of the insurance business; or

$$n_p = N_p/N$$

Therefore, the premium rate, P, which the insurer has to charge against the insured should be the sum of these three items, or

$$P = p + c_f + n_p \tag{2}$$

Since all-risk crop insurance program is now operated under government sponsorship on the North American Continent, the requirement for normal profit is not applicable. The government also agrees to bear a part of the pure premium and total amount of administration cost. The actual premium rate,

adopted by the crop insurance agencies in Canada and United States is substantially lower than the rate expressed by equation (2).

THE PROBLEM OF DATA AVAILABLE AND THE NECESSITY FOR ADJUSTMENT OVER TIME

As it was mentioned in the previous paragraph, the pure premium rate, p, can be calculated if the frequency function, $f(y_i)$, is available. Generally the estimation of $f(y_i)$ may be approximated by two possibilities; one is a priori and the other is empirical. An a priori frequency function for low yield, y_i, is almost impossible to establish because of the fact that the crop yield fluctuates not only from district to district but also from year to year. Therefore, its derivation has to depend on statistical generalizations using empirical yield data.

If in the past M years, yield records for a particular acre of land are available, the estimated pure premium rate per acre or average annual loss cost for that piece of land may be approximated by

$$(3) \qquad \hat{p} = (1/M) \sum_{i=1}^{m} (C-y_i) \qquad 0 \leq y_i < C, \; m \leq M.$$

Where y_i refers to those acre yields less than the coverage, C, and m is number of years of those acre yield below the coverage out of the M years.

The pure premium rate so estimated could balance the

premium receipts with the indemnity provided that insurance is offered at the beginning of M years and the insured continued his participation throughout the period. Nevertheless this is not the actual situation in applying the premium rate. The premium rate so estimated is to apply for the present insurance policy with the requirement that it would balance the premium-indemnity schedule in some specified future period. Since the yield in the next M years could not possibly be the same as it was in the last M years, the estimated $\hat{p}$ needs adjustment before it can satisfy the requirement of balance in future period. Again historical yield data are not generally available on individual farm level. Estimation of the pure premium rate by formula (3) is, therefore, limited in scope.

The search for the frequency function, $f(y_i)$, now shifts towards the following two aspects:

1. Some statistical methods should be developed so that the pure premium rate could be approximated by using those yield data which are generally available or at least easy to collect.
2. Using these past yield data, some adjustments may have to be made in the estimation of the pure premium rate before it could be applicable to the present or future.

THE USE OF NORMAL-CURVE THEORY IN THE ESTIMATION OF THE PURE PREMIUM RATE[1]

I. Description of the Method

In North America the historical average yield data for the past thirty to forty years are generally available at the county or crop reporting district level. One method to estimate the pure premium rate is to use this average area yield. This method assumes that for each year the acre yield within a county or district is normally distributed with the mean equal to the annual area average and that the variance is constant and proportional to the long-run average, $\bar{Y}$. In other words, for a particular year t the probability density function of the acre yield within a county or crop district, Y_{ti}, is expressed in the following form:

$$(4) \quad f_t(Y_{ti}) = \left[1/(\sqrt{2\pi}\,\sigma)\right] \exp\left[-\tfrac{1}{2}(Y_{ti}-\bar{Y}_t)^2/\sigma^2\right], \quad 0 \leq Y_{ti}.$$

Where Y_t is the average yield for year t, σ is the constant standard deviation and equal to $k\bar{Y}$ where k a positive value between 0 and 1, and $\bar{Y}$ is the long-run average yield.

For the year t, the total loss cost of the area with respect to coverage level, C, could be estimated by

$$(5) \quad \hat{L}_t = \int_0^C f_t(Y_{ti})(C-\bar{Y}_t)\,dY_{ti}$$

Given the total number of acres in a particular area as N_t, then the pure premium rate for a particular t-th year,

[1] R.R. Botts and J.N. Boles, "Use of Normal-curve Theory in Crop Insurance Rate-making," Journal of Farm Economics, XL (August, 1958), 733-740.

$\hat{p}'_t$, is equal to the average loss cost per acre, i.e.,

$$(6) \qquad \hat{p}'_t = L_t/N_t = (1/N_t)\int_0^C f_t(Y_{ti})(C-\bar{Y}_t)dY_{ti}.$$

As a matter of fact both equation (5) and (6) are general forms used for the estimation of pure premium rate by using area yield. Their validity does not depend on the form of distribution, $f(Y_{ti})$. However, only when this form of distribution is specified can a premium rate be estimated with respect to each level of coverage, C.

In the present case, the form of yield distribution, $f_t(Y_{ti})$ is assumed to be normally distributed as shown in equation (4). Therefore, equation (6) can be reduced to the following form[2]:

$$(7) \qquad \hat{p}'_t = A_t(C-\bar{Y}_t) + d_t\,\sigma.$$

Where t specifies a particular year; A_t is the proportion of the total acres with yield less than coverage, C; $\bar{Y}_t$ is the average of acre yields; d_t is the ordinate of normal distribution at point C; σ is the standard deviation of the yields and assumed to be proportional to the long-run area-average yield.

Since in equation (7) the value of $\bar{Y}_t$ and σ are derived from the historical yield data, the level of C is pre-determined; A_t and d_t are given by a theoretical distribution table, and the estimated pure premium rate for the t-th year, $\hat{p}'_t$ is

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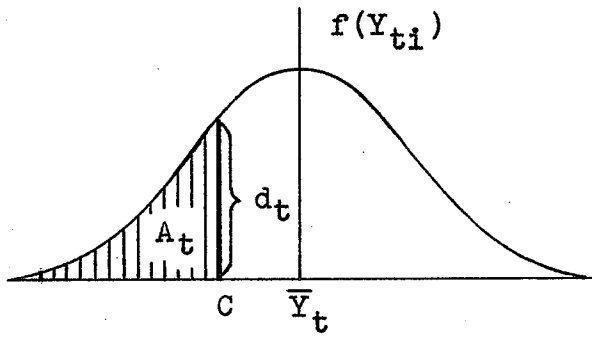
[2]For the details of mathematical proof see Botts and Boles, ibid.

uniquely determined.

FIGURE 1

THEORETICAL NORMAL-CURVE OF ACRE YIELDS



Because the crop yield fluctuates from year to year, this requires that the estimation of a pure premium rate be based on average acre yields over a period of n years. This estimated average pure premium rate can be simply derived in the following form:[3]

$$(8) \qquad \hat{p}' = (1/n)\left(\sum_{t=1}^{n} p_t'\right)$$

II. <u>The Validity of Normal-curve Approach</u>

The merit of the normal curve approach lies on its convenience for application. It only requires historical yield data on a county or crop-reporting district level. This type of information is generally available over a period of years.

[3]The validity of equation (8) does not depend on the normal-curve assumption.

Only two parameters, namely, the level of coverage, and the magnitude of a constant standard deviation, δ , expressed as a proportion of the long run average yield, need to be decided. A pure premium rate, thus, can be estimated for each county or district by applying equations (7) and (8).

However, the applicability of the normal-curve approach solely depends on two critical assumptions. Firstly, that each of the annual acre yields within an area must be normally distributed. Secondly, that the standard deviation of each distribution is constant throughout the years. The second assumption of a constant standard deviation is relatively less important as compared with the first normal-curve assumption of annual acre yields within an area. If the first assumption is not fulfilled, then the second assumption is no longer relevent. Hence a test of normality concerning actual yield data for a particular year and area is the first step that must be taken in order to examine the empirical truth of this method.

III. Statistical Tests of Normality

Several statistical methods are available to test the normality of the actual yield data; namely, the Chi-square test, Kolmogorov-Smirnov test, and tests of skewness and kurtosis. The first two tests are designed to compare the actual sample distribution with the theoretical normal distribution. The

null hypothesis of normal distribution is accepted if the discrepency between the two is within a certain range which varies directly with the size of a sample and the level of significance. In a test of skewness and kurtosis, a distribution is normal if the coefficient of skewness, $\sqrt{\beta}_1$, equals 0, and coefficient of kurtosis, β_2, equals 3. Any departure of sample statistic, $\sqrt{b}_1$, from $\sqrt{\beta}_1 = 0$ is an indication of skewness while the departure of b_2 from $\beta_2 = 3$ indicates kurtosis. The tests of skewness and kurtosis, therefore, are designed to compare $\sqrt{b}_1$ with $\sqrt{\beta}_1$ and b_2 with β_2, both being under the same level of significance. The critical values of both the 5 percent and 1 percent probability level for $\sqrt{\beta}_1$ and β_2 are available in the theoretical tables[4]. The normality assumption is accepted if both $\sqrt{b}_1$ and b_2 fall within the range provided by its respective tables. The test of skewness and kurtosis provides not only a test of normality but also gives information about the actual shape of the distribution. Therefore, it is preferred in the present context.

The data used in testing normality were based on the spring wheat sown on the summer-fallow land, of those farmers who bought crop insurance policies, for the crop years 1961-62 to 1963-64 inclusive, in six rural municipalities,[5] in the

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[4] R.C. Geary and E.S. Pearson, Tests of Normality, (Biometrika; London: University College Press, Cambridge, 1938), pp.7-8.

[5] It includes Rhineland, Roland, Thompson, Stanley, Gray and Dufferin.

TABLE VI

TESTS OF NORMALITY FOR THE YIELD OF WHEAT SOWN ON SUMMERFALLOW LAND IN SOUTHERN MANITOBA#

Crop Year	Soil productivity rating	No. of acres	$\sqrt{b_1}$	b_2
1961-62	90	1,783	2.45*	2.25*
	80	6,988	.18*	3.06
	70	25,619	.42*	3.15*
	60	6,998	.91*	4.81*
	60+	5,870	1.12*	6.68*
	50	2,704	.19*	2.39*
	40	2,089	.12*	2.31*
	30	299	.08	1.75*
1962-63	90	2,018	-.23*	4.00*
	80	11,898	-.49*	4.00*
	70	32,086	-.02	2.35*
	60	12,111	-.31*	3.91*
	60+	5,494	-.44*	2.39*
	50	3,303	.08*	3.50*
	30	1,170	-.54*	2.35*
1963-64	90	2,365	.28*	8.80*
	80	9,130	.08*	2.86*
	70	9,907	.27*	2.96
	70+	23,393	.65*	1.69*
	60	8,785	-.11*	2.57*
	60+	5,666	.75*	3.65*
	50	2,834	.64*	2.84*
	40	1,414	.36*	3.48*
	30	333	-.42*	2.55*

The term * = 5% level of significance indicating that the assumption of normality was not accepted.

province of Manitoba. These data are part of the crop yield information collected by the Manitoba Crop Insurance Corporation through the annual yield survey of its insureds. The questionnaire, in its present form, classifies the production of each crop by soil group, the type of land use in the preceding year, and the application of fertilizer. The frequency distribution of the wheat yield used for the test is listed in Appendix I.

Table VI shows the results of the statistical tests. None of the annual yield distributions within the area surveyed was normally distributed. Fifteen out of twenty-four distributions were skewed to the right, while seven skewed to the left. Only two distributions showed no signs of skewness, but they did show the sign of kurtosis. Besides, the results showed that twelve distributions appeared to have low peakness while another ten tended to high peakness. Two distributions showed no sign of peakness at all but indicated skewness to the right.

Because of the existence of a significant difference between the actual yield distribution and the hypothesized normal distribution, the use of the normal-curve approximation to this area would result in a biased estimation. The pure premium rate will be under-estimated if the actual yield distribution is skewed to the right, and be over-estimated if the actual distribution is skewed to the left. And the biasness will be increased if the actual yield distribution is more

concentrated than otherwise.

IV. Test of Homogeneity of Variance

A test for homogeneous variance is necessarily required after the hypothesis of normality for the actual yield data was accepted. The method used to test the homogeneous variance was proposed by M. S. Bartlett.[6] It indicates that the null hypothesis for the equal population variance, δ_t^2, for the yield data in different years, would be accepted if the calculated Chi-square value, χ_o^2, is less than the theoretical value, $\chi^2_{(1-\alpha)}$, at the level of significance, α. The test criterion for the acceptance of the null hypothesis can be expressed in the following form:

(9) $\chi_o^2 < \chi^2_{(1-\alpha)}$ with degrees of freedom = k-1.

Where: $\chi_o^2 = \log_e 10 \left[(\log_{10} S^2) \sum_{t=1}^{k} (n_t-1) - \sum_{t=1}^{k} (n_t-1) \log_{10} S_t^2 \right]$;

$S^2 = \sum_{t=1}^{k} (n_t S_t^2) / \sum_{t=1}^{k} (n_t-1)$;

α is level of significance;

S_t^2 is the sample variance;

n_t is the sample size in the calculation of S_t^2;

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[6] M.S. Bartlett, "Some Examples of Statistical Methods of Research in Agriculture and Applied Biology", Journal of Royal Statistics (Supplement), No.4, (1937), 137.

K is the total number of sample variances;

$\chi^2_{(1-\alpha)}$ is theoretical Chi-square value with d.f. equal to k-1 and level of significance at α.

Equation (9) shows that Bartlett's testing method is under an a priori condition of normal population. However the preceding empirical results showed that none of the annual yield data within the area was normally distributed. Hence, the test for homogeneous variance becomes less necessary after the normal assumption has been rejected.

CHAPTER IV

FURTHER STATISTICAL CONSIDERATIONS ON PREMIUM RATE-MAKING

The empirical test of normality from the actual yield data was not accepted in the previous chapter. This fact gives rise to the following three questions:

1. For what reason should the normal-curve approach not be applied generally to the yield within a county or district?
2. What kind of arrangement has to be made with respect to the collection of yield data in order to apply the normal-curve formula in the estimation of pure premium rate?
3. If the normal-curve theory is not applicable at all, is it still possible to have a reasonable estimation of premium rate or not?

On the other hand, so long as the present premium rate is estimated by using past yield data, it is necessary to examine the discrepancy between the past and present yield risk. In a number of years several factors such as technological improvement in farming technique and innovation in mechanization, along with better management have played an important role in the improvement of crop production. It is also possible that the existence of insects, plant diseases and soil erosion may have unfavorable effects on the long-run

crop production. Each of these situations will have different implications to the size of crop loss cost and thus affects the pure premium rate or coverage level. The adjustment of the premium rate or the coverage level, therefore, varies with the nature and the extent of changes in land productivity over time.

THE CONDITION OF A NORMAL DISTRIBUTION

The normal distribution is applicable to many events, varying from the distribution of height and weight of the people within the same age group to the random error terms.

The underlying cause for the rejection of the normality assumption in the previous chapter may be the lack of homogeneity in the condition of crop production within the area. The boundary of a crop reporting district is not associated with the factors influencing the crop yield. Therefore, even though the soil productivity of the land within the district is the same, local variation of other factors may be so great as to render production in sub-areas significantly different from each other. If this is the situation, then the delimitation of the crop risk area, based on some natural or artificial criteria may form a region satisfying the condition for a normal distribution.

The following factors will have the most important effects on the level of crop production:

1. Weather conditions: Temperature, rainfall and the

length of the growing season constitute the main natural environment for crop production. A weather map will provide the most required information.

2. Topography: Local variation in topography is associated with changes in temperature, wind velocity, and soil moisture. It is also related to the vulnerability of crop damage caused by extreme weather conditions, such as excess rainfall and drought.

3. Soil productivity: The soil productivity is determined by its chemical composition, contents of organic matters and water containing capacity. In the long-run, soil productivity is a composite product of the weather conditions, topography and land use in the past.

4. Land use in recent years: Continuous planting of the same type of crops depletes soil nutrition, in the sense that it competes for same kind of minerals and organic matters in the soil. Crops such as legumes are complementary to small grain production, since the former fixes nitrogen from the air and thus provides nutrition to the latter. The common practice of summer-fallow also provides favorable effects on the yield in the succeeding years.

5. Application of chemical fertilizer: Land productivity for the current crop production can be improved by using chemical fertilizer before or during the planting season. The extent to which such an improvement will happen also

depends on the type and level of fertilizer which has been applied.

The first three factors provided the basis for the delineation of the boundary of a homogeneous production area. Within the area, the differentiation of production may also be due to different land use during the previous year or variation in the level of current fertilizer application. Thus, these two factors constitute the additional evidence for the classification of yield risk. In other words, only that crop land which is located within the crop risk area and which has the same fertilizer treatment and the same land use in the previous year could be considered as a statistically homogeneous group. The yield distribution from the land belonging to such a homogeneous group might have a better possibility of being normally distributed. Of course, there is no a priori necessity that it should follow the normal distribution. Whether it is or not, still depends on empirical evidence. Only when the yield data from a particular crop risk area has been accepted as a normal distribution, could the normal-curve approach be used for the estimation of the pure premium rate.

In practice, it is necessary to collect at least five years of sample yield data from each crop risk area. These data help to examine the boundary of the area and also to test the hypothesis of normality. For the time being, the

loss cost estimated from the sample yields of the risk area will serve as the basis for the adjustment if the existing premium rate is calculated from the data on a district level. As time passes, the accumulation of historical yield data from the risk area will provide information for an unbiased estimation of the pure premium rate.

It should be noted that by using the sample data from the risk area for the calculation of the pure premium rate, no assumption has been made with regards to the size of the standard deviation. Their magnitudes are those calculated from sample yields. Nevertheless, when more information is available one may find some relationship between the level of production and the size of the standard deviation. If this is the case, the importance of the continuous collection of sample yields decreases. In other words the estimation can be carried out by using the average yield of the risk area.

THE NORMALITY REQUIREMENT IS NOT INDISPENSABLE

Since there is no guarantee that the yield distribution of a risk area has to be normal, what will happen to the estimation procedure if it follows some other form of distribution?

The answer to this question is as follows:

Firstly, equation (6) in the last chapter has shown that the determination of the pure premium rate does not depend on the assumption of a normal distribution. The frequency function in the equation can be any type.

Secondly, it does cause trouble in the delineation of the risk area if the yield in the area is not normally distributed. Since in this situation, there will be some confusion with regard to the fact that the non-normal distribution of the yield within the risk area is due to errors involved in the delineation of the boundary or in the intrinsic nature of the yield distribution. More efforts may be required before the area boundary can be set down and the fact of a non-normal distribution be accepted.

Thirdly, if the yield distribution of the same risk area changes from year to year, then no simplified procedure can be used for the estimation of the pure premium rate. In other words, it relies heavily on the continuing collection of sample yield data over time.

A HYPOTHESIZED MODEL OF SECULAR GROWTH AND THE VARIATION OF CROP YIELD OVER TIME

The pure premium rate estimated from the past historical yield data can be used as a device to balance the insurance program in the future period only when there is no significant difference in production level between the two periods. Some

adjustment is necessary if there is a divergence in the future period.

In a modern society agricultural productivity tends to increase over time through technological improvement and capital intensification. The tendency for general productivity to decline over time is quite uncommon. Nevertheless, in case of upward or downward trends the reason for adjustment is the same, despite the fact that each goes to the opposite direction. However, in the following analysis, the consideration is mainly for an upward yield trend.

Equation (10) shows an hypothesized model for the secular growth and variation of crop yield for a particular acre within a crop risk area.

$$(10) \quad Y_{ti} = R_t + T_t + W_t + e_{ti} \qquad (t; 1,2,\ldots n;\ i: 1,\ldots N)$$

Where: Y_{ti} is the yield of acre i in year t;

R_t is the average resource input per acre in the area for year t;

T_t is the average technological standard in the area for year t;

W_t is the average weather effects on the production in the area in year t;

e_{ti} is a random residual which measures the deviation of the individual yield from the average yield of the area. It assumes a

positive value if the yield of the particular land is higher than the area average, and negative, otherwise.

In addition, the following assumptions have been made with respect to equation (10);

1. The joint effect of changes in inputs, R_t and technological standard, T_t, on the yield, Y_{ti}, is assumed to be a linear increasing function of the time t, i.e.,

$$\hat{Y}_{ti} = Y_o + bt. \tag{11}$$

2. The weather effects have a cyclical nature with a fixed period of m years,[1] i.e., the weather effect on year t, W_t, is the same as in year t+m, W_{t+m}, or

$$W_t = W_{t+m}. \tag{12}$$

3. The residual e_{ti} has a distribution $g(e_{ti})$, not necessarily normal, for each year t. In case e_{ti} is normally distributed for each year t, the annual average value, $\bar{e}_t=0$. In case of a non-normal distribution, $\bar{e}_t$ is not equal to 0, but due to the fact that e_{ti} has the same form of distribution the $\bar{e}_t$ values are equal for different years, i.e.,;

$$\bar{e}_t = \bar{e}_{t+j}. \qquad \text{for all } j = 0,1,2,\ldots n. \tag{13}$$

[1] For the analysis of cyclical weather effect see M.H. Yeh and L.D. Black, Weather Cycles and Crop Prediction, (Technical Bulletin No.8; Winnipeg: Department of Agricultural Economics, University of Manitoba, 1964.)

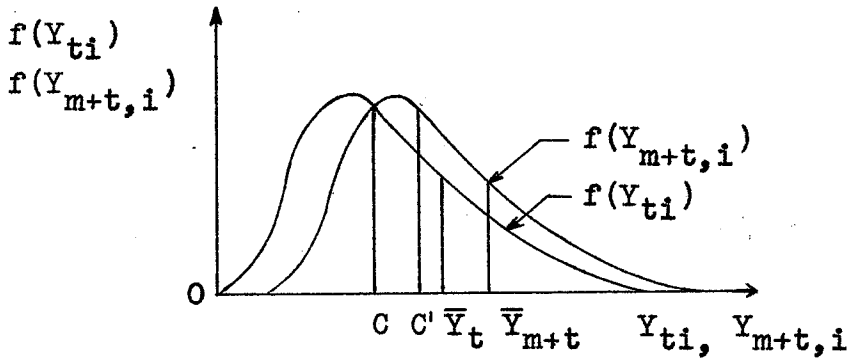
Based on equations (11) to (13), Table VII shows both the hypothesized historical yield on the particular land and the average yield of the area during a period of 2m years.

ADJUSTMENT OF THE PREMIUM RATE OR COVERAGE LEVEL OVER TIME

Assume that the historical yield data of the first m years as shown in Table VII are available. If these data are now used to calculate the pure premium rate, what are the necessary adjustments on this rate or level of coverage so that they can be applied to the next m years which have a known up-ward trend in crop production.

FIGURE 2

YIELD DISTRIBUTION IN YEAR t AND YEAR m+t



The distributions[2] of yield in year t and year m+t are shown in Figure 2. No assumption has been made concerning

[2] If the two variables, X_1 and X_2 have the functional relationship of $X_1=X_2+C$, where C is a constant, then $\bar{X}_1=\bar{X}_2+C$, and $V(X_1)=V(X_2)$. Thus $f(X_1)$ shifts to the right of $f(X_2)$ by distance C.

TABLE VII

HYPOTHESIZED CROP YIELD DURING A PERIOD OF 2m YEARS

Year	Yield (Y_{ti})	Average ($\overline{Y}_t=(1/N)\sum Y_{ti}$)
1	$Y_{1i} = Y_o + b + W_1 + e_{1i}$	$\overline{Y}_1$
2	$Y_{2i} = Y_o + 2b + W_2 + e_{2i}$	$\overline{Y}_2$
.	.....	.....
.	.....	.....
t	$Y_{ti} = Y_o + tb + W_t + e_{ti}$	$\overline{Y}_t$
.	.....	.....
.	.....	.....
m	$Y_m = Y_o + mb + W_m + e_{mi}$	$\overline{Y}_m$
		$Y_1=(1/m)\sum_{t=1}^{m} \overline{Y}_t$
m+1	$Y_{m+1}=Y_o+(m+1)b+W_{m+1}+e_{m+1}$	$\overline{Y}_{m+1}=\overline{Y}_1+mb$
m+2	$Y_{m+2}=Y_o+(m+2)b+W_{m+2}+e_{m+2}$	$\overline{Y}_{m+2}=\overline{Y}_2+mb$
.	.....	.....
.	.....	.....
m+t	$Y_{m+t}=Y_o+(m+t)b + W_{m+t}+e_{m+t}$	$\overline{Y}_{m+t}=\overline{Y}_t+mb$
.	.....	.....
.	.....	.....
2m	$Y_{2m}=Y_o + 2mb + W_{2m}+e_{2m}$	$\overline{Y}_{2m}=\overline{Y}_m+mb$
		$Y_2=(\frac{1}{m})\sum_{t=1}^{m} \overline{Y}_{m+t}$
		$= Y_1+mb$

the forms of the probability density function, $f(Y_{ti})$ and $f(Y_{m+t,i})$. Nevertheless, the three assumptions in the model have stipulated that these functions must belong to the same type of a probability density function, the second function, $f(Y_{m+t,i})$, moved to the right with respect to the first function, $f(Y_{ti})$, by the distance mb.

The total loss cost for the area in year t, $\hat{L}_t$, with respect to coverage level, C, can be calculated by applying equation (5), i.e.,

$$(14) \quad \hat{L}_t = \int_0^C f(Y_{ti})(C-\bar{Y}_t)dY_{ti}.$$

According to equation (6) the estimated pure premium rate or average loss cost based on year t will be

$$(15) \quad \hat{p}_t = \hat{L}_t/N.$$

Since Figure 2 has shown that at year m+t the probability function $f(Y_{m+t,i})$ shifts to the right, the loss cost in that year with respect to the same coverage C is decreased. In other words, the premium rate based on t-th year, $\hat{p}_t$, is overestimated if it is applied to (m+t)-th year. Therefore, the average pure premium rate estimated by yield data in the past m years, i.e.,

$$(16) \quad \hat{p} = (1/m)\sum_{t=1}^{m} p_t$$

is also overestimated if it is applied to the future m years.

The adjustment problem can be approached from three different ways, but each has a different implication.

One way of adjustment is to fix the amount of protection, C, and to reduce the size of $\hat{p}$ which is estimated by using yield data in the first m years. The actual amount of reduction depends on the yield distribution, and can be specified only when the form of the distribution is first ascertained.

The second way of adjustment is more realistic than the first one. It suggests that one should fix the pure premium rate at the estimated level, but adjust the coverage value C in the next period. Equation (6) and Figure 2 show that if the coverage, C, is raised to C' by the distance mb, the new loss cost, $\hat{L}'_{m+t}$ with respect to coverage C' in year m+t will equal the loss cost, $\hat{L}_t$, with respect to yield data in year t and coverage level, C, i.e.,:

$$(17) \qquad \hat{L}'_{m+t} = \int_0^{C+mb} f(Y_{m+t,i}) \left[(C+mb)-(\bar{Y}_t+mb) \right] dY_{ti}$$

$$= \int_0^{C} f(Y_{ti})(C-\bar{Y}_t)dY_{ti} = \hat{L}_t.$$

Equation (17) leads to the following two equations indicating the relation between the premium rates in the two periods:

(18) $\hat{p}'_{m+t} = (1/N)\hat{L}'_{m+t} = (1/N)\hat{L}_t = \hat{p}_t$, and

(19) $\hat{p}' = (1/m)\sum_{t=1}^{m}\hat{p}'_{m+t} = (1/m)\sum_{t=1}^{m}\hat{p}_t = \hat{p}$.

Thus the same rate $\hat{p}$, estimated from the past m years' yield data can be used for the next m years, with coverage level raised by mb where m is number of years in each period and b is a coefficient of yield trend. This method of adjustment satisfies the general principle of crop insurance which emphasized the relationship between level of coverage and the long-run average yield. The fact that the physical premium rate does not change with time makes the premium cost for insurance decrease in terms of growing income from the crop.

For the purpose of illustration as to how to apply this second method of adjustment, an example is given as follows:

Research[3] has shown that wheat yield data from 1916-60 in Dauphin area, Manitoba, had a linear trend of Y=15.470 + 0.149t and weather cycles with 2, 6, 9 and 22 year periods. For the present purpose, the cycle of 22 years is chosen. Therefore, at the end of 1960, 22 years of yield data from 1936-60 inclusive, are used to calculate the pure premium

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[3] Yeh and Black, ibid., pp.20-28.

rate, $\hat{p}$, with respect to the coverage level C[4]. If this $\hat{p}$ is to be adopted for the next 22 years, from 1961-82 inclusive, following the second adjustment method the coverage level in the second period should be C+(22)(0.149) or (C+3.278) bushels.

The third way of adjustment is to use the concept of moving average. This method estimates the current premium rate, $\hat{p}''_{m+t}$, and coverage level, C'', by using the yield data in m immediately preceding years, i.e.,

$$(20) \quad \hat{p}''_t = (1/m)\sum_{j=t}^{m+t-1} \hat{P}_j$$

Where $\hat{p}_j = \int_0^{C''} f(Y_{ji})(C-\overline{Y}_j)dY_{ji}$, $C''=k\overline{Y}$, and $\overline{Y} = (1/m)\sum_{j=1}^{m+t-1} \overline{Y}_j$.

As the time passes to year (m+t+1), the yield data at the beginning of the m years, t, is dropped and the new yield in year (m+t) is added. In doing so, this method actually adjusts both the premium rate and the level of coverage from year to year. The premium rate necessarily changes because the yield risk in the beginning of the period is not the same as compared with the yield risk in the end. The coverage level also changes with the long-run average yield.

The use of the moving average has the merit of simplicity. However, discrepancy between past and present situations is not fully removed by the adjustment. For each year both premium rate and coverage have a lag of m years. But it is

[4] This protection level, C, is usually 75 percent or 60 percent of the average yield from 1939-60 in the present example.

certainly better than the case if both of them are estimated by using only the yield data in the first period from 1 to m years and then applying them to the second period from m to 2m years without adjustment.

Several concluding points can be drawn as follows:

1. The yields of the land within a county or district lack the conditions of belonging to the same statistical population. Efforts are necessary in delineating a crop risk area on such criteria as weather conditions, local topography, soil productivity, land use in recent years and application of fertilizer. It is believed that the yield from the land exposed to the same risk can be classified as a statistically homogeneous group. The possibility that yields from the same risk area would have a normal distribution is also substantially increased.

2. The basic principle of pure premium rate-making is not solely dependent on the assumption of normal distribution. It can be of any type, although the existence of a normal distribution simplifies the estimation process.

3. Growth and variation of yield in the future may be assumed to have two main features: the coefficient of linear upward trend, b, and cyclical weather effects, W, with fixed period, m. In calculating the pure premium rate on the basis of past historical yield data the cyclical variation is averaged out if the choice of the number of years

coincides with the period of the cycle, m. The pure premium rate so estimated on the data from past m years and given level of coverage, C, can be adopted for the future period as a device to balance the premium-indemnity schedule simply by raising the protection level by an amount mb.

CHAPTER V

ECONOMIC EFFECTS OF A CROP INSURANCE PROGRAM ON FARM INCOME STABILITY

From the economic point of view, the significance of a crop insurance program is measured by its ability to reduce the fluctuation in farm income. The physical insurance coverage generally is 60 percent of the long-run average yield which is then converted into money form by using a fixed price. The money coverage expressed as a percentage of the current average income from the insured crop indicates the effectiveness of the insurance scheme in the stabilization of income from that insured crop. Total farm income consists of crop income and income from other sources. A stability in crop income will be meaningfully applicable if the total farm income is mainly attained from crop production and the remaining portion of farm income does not fluctuate.

A higher level of coverage is desired for a function of protecting the farm income from falling to a lower level. However, the higher the coverage the greater will be the premium rate. A high premium rate, in turn, may discourage farmers from joining the program. The relationship between total premium payment and total net farm income provides some indication with regards to the farmer's ability to pay for the insurance policy.

In this chapter, the farm record data in the Carman area of Manitoba, were used to analyze the magnitude of premium cost, level of coverage, and their relation to farm income. The source of farm income and the income variation were examined by using the historical cash farm income in the province of Manitoba. These findings may provide some information for the further improvement of the crop insurance program as a means of stabilizing farm income.

A COMPARISON OF PREMIUM COST AND COVERAGE LEVEL WITH FARM INCOME IN THE CARMAN AREA

The Carman district farm business reports[1] from 1961 to 1963 provide the basic information for analyzing the premium cost, level of coverage and their relations with respect to farm income. This information includes net farm income, cultivated acres for wheat, oats, barley and flax, as well as the total value of production from these four crops. Farm size is divided into three groups: small, medium and large. The definition for size was changed in the 1963 report[2]. However, for the present purpose, it will not affect the basic analysis. Farms are classified according to the soil types. The relationship between these soil types and the standard soil productivity index in Manitoba is presented

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[1] J. P. Hudson, Annual Report of Carman District Farm Business Association, (Winnipeg: The Department of Agricultural Economics, The University of Manitoba, 1961-63).

[2] Ibid., Annual Report, 1963, p.3.

as follows:

Soil type	Average soil productivity rating
Good to excellent soils--light clays and loams	90
Good soils--heavy clays	70
Fair to good soils-sandy loams	40

Assume that all these farms have been covered with a crop insurance policy for wheat, oats, barley and flax[3]. The total premium cost and total coverage for each size and soil type can be calculated for the Carman area by using the premium rate and level of coverage established by the Manitoba Crop Insurance Corporation.[4] Appendix II lists all the results calculated from the farm records and insurance policy. The three-year average is presented in the following analysis.

Table VIII shows the significance of crop insurance in maintaining the minimum level of farm income in the Carman area. In this area, the farmers also receive income from livestock, poultry and crops other than the insured crops.

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[3] The Manitoba Crop Insurance Corporation also offers insurance for beets. Since the method to decide premium rate and coverage level for beets is related to the individual farm's average yield in recent years, thus beets are not included in the present analysis.

[4] The premium rate and coverage level for the combined adjustment program in the south central test area is used for the analysis.

TABLE VIII

TOTAL INSURANCE PROTECTION AS A PERCENTAGE OF THE TOTAL VALUE OF FARM PRODUCTION IN CARMAN AREA, MANITOBA, (1961-63 AVERAGE)

Average soil productivity rating	Farm Size			
	Small	Medium	Large	Group Average
90	31.1	27.9	19.3	25.6
70	39.1	44.6	31.6	38.7
40	17.5	16.8	15.4	15.9

Hence, the general level of income protected by the insurance program might not be quite satisfactory. This is especially true for the protection to the farms on the poor land. Less than twenty percent of the average farm income derived from the poor land was actually protected by the crop insurance program. The situation is better off for farms in the high and middle class land areas where over twenty-five percent to forty-five percent of the farm income was protected through insurance. The same table also shows that the relatively high protection was available to the farmers on small-sized farms as compared with those farmers on the medium and large-sized farms.

The total insurance protection expressed as a percentage of the total value of insured crops measures the adequacy of the money coverage with respect to the corresponding income

from these insured crops. Table IX shows that the level of protection varies with different types of soil. On the middle

TABLE IX

TOTAL INSURANCE PROTECTION AS A PERCENTAGE OF THE TOTAL VALUE OF INSURED CROPS IN CARMAN AREA, MANITOBA, (1961-63 AVERAGE)

Average soil productivity rating	Farm Size			
	Small	Medium	Large	Group Average
90	46.6	47.6	47.8	48.2
70	54.6	52.4	53.9	53.9
40	36.4	36.7	33.9	35.9

class soil, farmers had the highest level of production receiving about 54 percent of the three-year average income from the insured crops when none of the insured crops were harvested. The percentage dropped to 48 percent for those farmers on the high-class land and to 36 percent for those on the poor land. If the present insurance program attempts to provide a coverage equivalent to 60 percent of the current crop income, the existing money coverage may be underestimated for the high and low classes of soil productivity and may be moderate to the middle class.

The total premium cost as a percentage of the total value of insured crops provides a measurement of the whole scheme of premium rate. Table X states that this percentage

was homogeneous with respect to farm size which had the same soil type but was different from one soil type to another. Furthermore, Table X denotes that the ratio of the premium cost to the total value of insured crops was relatively low, on poor land, as compared with those on the other two classes of land.

TABLE X

TOTAL PREMIUM PAYMENT AS A PERCENTAGE OF THE TOTAL VALUE OF INSURED CROPS IN CARMAN AREA, MANITOBA, (1961-63 AVERAGE)

Average soil productivity rating	Farm Size			
	Small	Medium	Large	Group Average
90	2.4	2.5	2.5	2.5
70	3.0	2.9	3.0	3.0
40	2.2	2.2	2.1	2.1

The total amount of premium paid for crop insurance is dependent on the total acreage of the insured crop or crops. Therefore the absolute amount of premium is relatively unimportant. The farmer's financial ability to buy the crop insurance policy is related to the ratio between the premium cost and the net farm income. Table XI concludes that:

1. The percentage of the premium cost to the net farm income was relatively high on the small-sized farms as compared with that on the other two sizes of farms.

2. The percentage of the premium rate to the net farm income was relatively low on the poor land as compared with that on the other types of soil productivity.

TABLE XI

TOTAL PREMIUM PAYMENT AS A PERCENTAGE OF THE NET FARM INCOME IN CARMAN AREA, MANITOBA (1961-63 AVERAGE)

Average soil productivity rating	Farm Size			
	Small	Medium	Large	Group Average
90	5.5	4.0	3.0	4.2
70	10.2	7.8	8.5	9.5
40	7.4	2.9	3.2	3.4

These two findings are consistent with the results as shown in Table X indicating that the same premium rate was charged on the homogeneous type of soil productivity. The small-sized farms, which have structural disadvantages in production, would find themselves in a higher proportion of premium cost to their small net income. On the other hand allowance for the land of low productivity reduces the premium rate on this land, due to an insufficient level of coverage as shown by Table IX.

THE LEVEL OF PHYSICAL COVERAGE AND THE FIXED INSURANCE PRICE

The findings in the previous analysis may give the impression that the current money coverage applies to the area could be underestimated. The money coverage actually is the product of the physical coverage by the fixed insurance price. Thus the possibility as well as the effects of raising money coverage could be examined by analyzing these two components, (i.e., the level of physical coverage and the fixed insurance price). The basic relationship between premium rate and level of coverage with respect to the same yield risk was presented in Chapter III. Generally, an increase in the level of coverage may always result in an increase in the premium rate. The actual increase in premium rate may depend on the relative magnitude of coverage in terms of the average yield and the form of yield distribution.

For the purposes of illustration, the yield distribution is assumed to be normal. Thus the normal-curve formula can be used for calculating the premium rate corresponding to the different levels of coverage. Also, the standard deviation is assumed to be 40 percent of the average yield, $\bar{Y}$. Table XII shows the magnitude of pure premium rate with respect to each level of coverage, both were expressed as a percentage in terms of the average yield. If the level of coverage is 40 percent of the average yield, the pure premium

TABLE XII

THEORETICAL RELATIONSHIP BETWEEN THE LEVEL OF COVERAGE AND PREMIUM RATE*

Coverage as a percentage of average yield	Premium rate as a percentage of average yield	Increase in premium rate as a percentage of average yield
40	1.17	
		0.85
50	2.02	
		1.31
60	3.33	
		1.91
70	5.24	
		2.67
80	7.91	
		3.54
90	11.45	
		4.51
100	15.96	
		5.49
110	21.45	
		6.46
120	27.91	
		7.33
130	35.24	
		8.09
140	43.33	
		8.69
150	52.02	
		9.15
160	61.17	

* These results were calculated by using the normal-curve formula, $p=A(C-\bar{Y}) + d\sigma$, with $\sigma=0.4\ \bar{Y}$.

rate is only 1.17 percent of that average yield. The increment of premium rate is 0.85 percent when the level of coverage is raised from 40 to 50 percent. A constant increase in the level of coverage is accompanied by an increase in the premium rate at an increasing rate. As the provided coverage rises to 160 percent of the average yield, the premium rate becomes 61 percent of the average yield. The increment of premium rate becomes 9.15 percent when the level of coverage is raised from 150 percent to 160 percent. These results suggest that a higher level of coverage would not necessarily provide a favorable insurance policy to the farmers.

Another possibility of adjusting the money coverage could be achieved through a change in the fixed insurance price. The same fixed price is used for the conversion of the premium rate and coverage, from the physical terms, into money forms. Therefore, a proportional increase in the fixed insurance price may result in a proportional increase in money coverage and money premium. These results show that an upward adjustment in the fixed insurance price offers a better solution than an increase in the physical level of coverage. However, if the fixed insurance price is higher than the market farm price, the farmer would have difficulty in paying his premium bill, since the ratio of premium cost to net farm income is unfavorable to him.

Table XIII shows the relation between the fixed insurance

price and the market farm price in the period from 1961 to 1963. For the crop of wheat, oats and barley, the prices used by the Manitoba Insurance Corporation to the area were about two thirds of the market prices. The insurance price for flax was closer to the market farm price; however, the two prices were about identical if a three year average was taken into consideration.

TABLE XIII

FIXED INSURANCE PRICES* AS A PERCENTAGE OF ACTUAL FARM PRICES#

Crop Year	Wheat	Oats	Barley	Flax
1961-62	66.8	73.0	71.4	85.4
1962-63	70.0	78.0	75.0	103.0
1963-64	74.0	76.7	81.5	113.2
Average	70.1	75.4	75.8	100.9

* The fixed insurance prices used in this table were applied to south central test area of Manitoba Crop Insurance Corporation.

\# Annual farm price for the province of Manitoba.

Therefore, the way to set a proper money coverage should depend on how to determine an appropriate physical coverage and the fixed price. The coverage of 60 percent of long-run average yield may not be adequate if an upward yield trend prevails. In such a case this coverage should

be raised to the level which would have a more realistic relation with the current production level. On the other hand, it would be better to bring the fixed insurance price as close to the market farm price as possible.

SOURCE OF FARM INCOME AND THE INCOME VARIATION IN MANITOBA

The effectiveness of a crop insurance program in reducing farm income fluctuation is largely dependent on the proportion of crop income to the total farm income. The stability in crop income would bring the stability into total farm income only when the former is the main source of both the total farm income and income variations.

The cash crop income expressed as a percentage of the total cash farm income measures the relative importance of crop income. In the province of Manitoba, this percentage was decreased from 74 percent in 1926 to 54 percent in 1963. On average, the current cash crop income constitutes only a little more than one-half of the total cash farm income. Therefore, even though the current crop insurance program could manage to protect 60 percent of the cash income from crop, but it actually can protect only about 30 percent of the total cash farm income. This evidence suggests that the current crop insurance program may not be sufficient to reduce the fluctuation of total cash farm income.

The source of variation in total farm income can be examined by analyzing its variance composition. Dividing the total cash income, I, into cash crop income, I_c, and cash farm income other than crop, I_o, the year-to-year variation in the total cash income, S_I^2, can be split into the variation of its components by the following equation:

$$(21) \quad S_I^2 = S_c^2 + S_o^2 + 2r_{co}S_cS_o .$$

Where S_c^2 and S_o^2 are the variances of cash crop income and other cash farm income respectively; r_{co} is the correlation coefficient between cash crop income and other cash farm income.

Dividing equation (21) by S_c^2 on both sides, gives

$$(22) \quad S_I^2/S_c^2 = 1 + (S_o^2 + 2r_{co}S_cS_o)/S_c^2 .$$

The second term in this equation could be expressed as S_{oc}, i.e.,

$$S_{oc} = (S_o^2 + 2r_{co}S_cS_o)/S_c^2 .$$

This term, S_{oc}, can be used to measure the variation in total cash farm income, relative to cash crop income, due to the addition of other cash farm income.

The series of other cash farm income will serve as a stabilization factor in the total cash farm income if the following condition is satisfied:

(23) $-1 \leq S_{oc} < 0.$

The other cash farm income will serve as a de-stabilization factor in total cash farm income if

(24) $S_{oc} > 0.$

Finally, the other cash farm income will have a neutral effect on the variation in total cash farm income if

(25) $S_{oc} = 0.$

The existence of other farm income will not contribute to the variation in total farm income only when equation (23) or equation (25) is satisfied. In this case, the crop insurance program will be an adequate device to reduce fluctuation in total cash farm income. If the condition of $S_{oc} > 0$ prevails, the fluctuation in total cash farm income is partly due to variation in other cash farm income, thus reduce the adequacy of the crop insurance program.

The historical cash real farm income in Manitoba from 1926 to 1963 was used to test the source of variation in total cash farm income. The relevent statistics are as follows:

$S_I^2 = (30,777,000)^2,$

$S_c^2 = (17,258,000)^2,$

$S_o^2 = (14,199,000)^2,$

$r_{co} = 0.697.$

Therefore: $S_{oc} = (S_o^2 + 2r_{co}S_cS_r)/S_c^2 = 1.82 > 0$.

The result of $S_{oc} = 1.82$ indicate that the addition of other cash farm income would increase the variation in total cash farm income.

Again, $S_I^2/S_c^2 = 1 + S_{oc} = 1+1.82 = 2.82$.

This result indicates that the variation in other cash farm income might contribute to the variation of the total farm cash income by 182 percent of the variation in cash income from crops.

The results may suggest that a combined insurance program including crop and livestock might be necessary in Manitoba in order to reduce the fluctuation in total cash farm income.

CHAPTER VI

CONCLUSION AND SUGGESTIONS

The findings of this study are generally consistent with the hypotheses presented in the first Chapter.

The first hypothesis was supported by (a) the past and current empirical experience of crop insurance operation, and (b) the deductive examination of the principle of premium rate-making process.

The insurance experience was mainly provided by the United States Federal Crop Insurance Corporation in a period of 25 years of operation. This showed that the insurance program was able to balance the premium receipts with indemnity payments in the period of 1948-63. The following facts are responsible for its sound crop insurance program:

1. Some administrative programs have been developed for the purpose of offering a practical crop insurance to the farmers. These programs include an efficient loss adjustment work, encouragement to the good insurance experience of the insureds, and a deterrent to speculation within the insurance program.
2. Through past insurance experience and local adjustment to the risk of crop production, the Corporation has proved its ability to estimate an unbiased premium rate.

3. The reserve funds supported by the government in the period of 1939-47 helped the Corporation to get over the first nine difficult years.

A deductive examination of the premium rate-making principle shows that there is no theoretical difficulty in deriving a premium rate for the insurance of crop yield. However, the main obstacle would be the shortage of the historical yield data on the farm level. An area average yield could be used as a substitute for the yield data on the farm level but such an area must be carefully delineated. Bias may result in applying the estimated premium rate, based on the past yield record, to the present or future period. The discrepancy could be eliminated by appropriate adjustment of the level of coverage or premium rate in accordance with the long-run trend in crop yield.

Administrative costs including those expenses for the collection of crop yield data are relatively high as compared with the pure premium rate. This situation indicates that the farmers are able to participate in the insurance program only if the premium rate charged against them does not include the administrative costs.

The second hypothesis was supported by statistical reasoning. The average yield data on a county or district level do not necessarily belong to the same statistical population. Even though the area yield data come from the same

statistical population it would be still impossible to have an a priori basis to assume any specific type of distribution for the area yield data. Therefore, before a normal distribution of the area yields is assumed, a statistical verification concerning the distribution would be necessarily required. Yields of a particular crop in an area will formulate a statistical population and might have the same distribution from year-to-year only when the crop yields in the area are exposed to the same risk. Factors such as weather, topography, recent land use and special farming practice could be used as a basis for delineating such a crop risk area. Several years of yield data collected in connection with these factors, may be required for the determination of a risk area.

The third hypothesis was tested by empirical data. Total cash crop income in Manitoba was a little more than one-half of the total cash income. Again, crop cash income was not the sole source of fluctuation in total cash farm income. These facts indicate that crop insurance can stabilize only 50 percent of the total cash farm income. The evidence derived from the Carman area showed that the effectiveness of the crop insurance program was relatively limited on those farms within a high risk area as well as those with a small size. Farmers in a high risk area may be reluctant to buy a crop insurance policy in the studied area because the provided coverage is not sufficient. On the other hand, the relatively high

premium cost, in terms of the net farm income, on the small farms may render their participation in an insurance program more difficult.

The following suggestions may be drawn from this study:

1. Crop insurance is a feasible method of helping the majority of farmers who have an unstable farm income in the Canadian Prairies. A sound program will require the continuous support from farmers throughout the good as well as the poor years.
2. A crop insurance program could be self-sustaining over time if a set of yield data are duly collected from a well delineated risk area. In the long-run, the existence of the crop risk area will also be a benefit to other programs such as crop reporting and prediction, land value assessment, and soil conservation.
3. The premium rate and coverage level adopted by the crop insurance program should have taken into consideration the long-run trend of crop yield. The pattern of cyclical variation and up-ward trend in crop production may provide valuable information for the adjustment of the coverage level and premium rate over time. Research projects relating to the effects of weather and technological improvement on the trend of different crop yield would

help to establish a more realistic insurance program for crops.

4. A combined crop-livestock insurance program should be encouraged in order to provide farmers with a fuller measure of protection.

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APPENDIX I

FREQUENCY DISTRIBUTIONS OF WHEAT YIELD SOWN ON SUMMER FALLOW LAND IN SOUTHERN MANITOBA*

*Area includes Dufferin, Thompson, Stanley, Roland and Rhineland.

TABLE I. 1

FREQUENCY DISTRIBUTIONS OF WHEAT, 1961-62

(Number of Acres)

Soil Productivity Rating	Yield in Bushels								
	0 - 4	5 - 9	10-14	15-19	20-24	25-29	30-34	35-39	40 and over
90	-	-	136	513	437	407	240	50	-
80	206	354	1,224	1,936	1,711	921	365	261	10
70	1,108	4,147	8,774	6,020	3,961	1,163	356	90	-
60	518	1,959	2,182	1,394	802	23	-	120	-
60^{+}	334	1,321	2,315	1,245	512	66	27	-	50
50	271	685	490	422	766	30	15	25	-
40	168	791	551	383	195	-	-	-	-
30	68	95	68	68	-	-	-	-	-

TABLE I. 2

FREQUENCY DISTRIBUTIONS OF WHEAT, 1962-63

(Number of Acres)

Soil Productivity Rating	Yield in Bushels								
	0 - 4	5 - 9	10-14	15-19	20-24	25-29	30-34	35-39	40 and over
90	-	60	-	75	160	163	880	385	295
80	54	305	357	646	1,247	2,895	4,113	1,237	1,044
70	983	3,595	3,793	3,500	5,491	5,046	5,828	2,532	1,318
60	40	115	342	534	2,942	3,021	3,865	793	459
60^{+}	120	488	357	832	1,051	787	1,599	180	80
50	23	83	119	377	1,081	659	592	197	177
40	-	111	25	156	183	217	205	273	-

TABLE I. 3

FREQUENCY DISTRIBUTIONS OF WHEAT, 1963-64

(Number of Acres)

Soil Productivity Rating	Yield in Bushels								
	0 - 4	5 - 9	10-14	15-19	20-24	25-29	30-34	35-39	40 and over
90	30	630	240	1,005	355	60	20	25	-
80	443	1,193	946	2,524	2,078	1,170	596	75	105
70	15	691	1,725	2,319	2,599	1,459	849	112	138
70^{+}	6,172	9,095	2,856	2,365	1,384	643	648	140	90
60	40	445	1,078	1,414	2,514	1,554	1,490	165	85
60^{+}	1,113	1,599	1,747	710	386	34	77	-	-
50	-	361	602	676	539	227	286	70	73
40	20	181	203	335	492	119	32	-	32
30	-	-	30	140	158	5	-	-	-

APPENDIX II

SOME STATISTICS CONCERNING THE FARMS IN CARMAN AREA, MANITOBA

TABLE II.1

FARMS ON GOOD TO EXCELLENT SOIL

(AVERAGE SOIL PRODUCTIVITY INDEX: 90)

(Dollars)

Size	Crop Year	Net Farm Income	Value of Total Farm Production	Value of Total Crop Production	Value of Total Insured Crops	Value of Total Insurance Protection	Total Premium Cost
Small	1961-62	1,874	8,516	6,264	4,747	2,494	133
	1962-63	4,015	11,822	9,638	8,837	3,452	177
	1963-64	2,444	8,130	5,723	5,434	2,920	148
	Average	2,778	9,489	7,208	6,339	2,955	153
Medium	1961-62	1,277	11,325	8,289	4,826	2,599	140
	1962-63	6,545	16,969	14,189	11,958	4,819	247
	1963-64	8,030	15,561	12,647	8,997	4,859	248
	Average	5,284	14,618	11,708	8,594	4,092	212
Large	1961-62	3,204	22,112	15,953	10,234	5,497	296
	1962-63	10,579	30,203	23,432	14,097	5,571	288
	1963-64	13,644	30,130	22,319	9,037	4,882	246
	Average	9,142	27,482	20,508	11,123	5,317	277
Group Average	1961-62	2,164	13,768	10,013	6,568	3,509	188
	1962-63	6,123	17,244	13,879	10,782	4,262	220
	1963-64	7,611	19,274	15,189	9,250	5,079	257
	Average	5,299	16,762	13,027	8,867	4,283	222

TABLE II.2

FARMS ON GOOD SOIL

(AVERAGE SOIL PRODUCTIVITY INDEX: 70)

(Dollars)

Size	Crop Year	Net Farm Income	Value of Total Farm Production	Value of Total Crop Production	Value of Total Insured Crops	Value of Total Insurance Protection	Total Premium Cost
Small	1961-62	1,293	8,840	5,423	4,502	3,250	178
	1962-63	1,460	10,447	9,275	9,239	4,003	230
	1963-64	3,648	10,496	7,970	7,624	4,407	242
	Average	2,134	9,928	7,556	7,119	3,887	217
Medium	1961-62	3,318	9,709	7,793	6,346	4,594	252
	1962-63	5,576	16,086	14,836	14,771	5,979	340
	1963-64	3,486	12,745	12,015	11,724	6,628	371
	Average	4,127	12,847	11,548	10,947	5,734	321
Large	1961-62	2,263	14,977	9,601	7,527	5,512	304
	1962-63	4,156	19,018	15,422	12,468	4,818	272
	1963-64	4,393	18,132	13,860	10,526	6,128	345
	Average	3,603	17,376	12,961	10,174	5,486	307
Group Average	1961-62	2,242	12,451	8,233	6,578	4,782	263
	1962-63	3,953	15,135	13,296	12,584	5,091	289
	1963-64	3,134	13,544	12,053	10,386	6,044	337
	Average	3,110	13,710	11,194	9,849	5,306	296

TABLE II. 3

FARMS ON FAIR TO GOOD SOIL

(AVERAGE SOIL PRODUCTIVITY INDEX: 40)

(Dollars)

Size	Crop Year	Net Farm Income	Value of Total Farm Production	Value of Total Crop Production	Value of Total Insured Crops	Value of Total Insurance Protection	Total Premium Cost
Small	1961-62	637	8,841	5,423	2,424	1,173	66
	1962-63	2,208	8,382	5,272	4,569	1,247	78
	1963-64	596	7,015	5,417	4,668	1,821	111
	Average	1,147	8,079	5,370	3,887	1,414	85
Medium	1961-62	1,898	9,709	7,793	3,704	1,761	99
	1962-63	4,526	11,940	7,227	7,050	1,967	123
	1963-64	5,986	14,301	8,753	5,729	2,318	141
	Average	4,136	11,983	7,924	5,494	2,015	122
Large	1961-62	4,778	14,977	9,601	5,630	2,655	150
	1962-63	6,469	21,843	14,382	10,735	2,664	167
	1963-64	7,378	26,452	22,261	12,364	4,439	273
	Average	6,208	21,091	15,412	9,576	3,253	197
Group Average	1961-62	2,875	12,451	8,233	4,294	2,036	115
	1962-63	4,767	15,317	9,828	8,406	2,178	130
	1963-64	4,803	17,031	9,974	7,179	2,931	179
	Average	4,148	14,933	9,330	6,626	2,382	141