IMPACT OF CROP YIELD INSTABILITY

ON THE FARM BUSINESS

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ABSTRACT

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ON THE FARM BUSINESS

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Farm income variability due to unstable production and prices is not new to prairie farmers. Studies have attempted to show what a farmer does when crop losses reduce his income below some minimum level. However, for Manitoba, in particular, there is no objective evidence available as to what a farmer should do if his income is reduced below some minimum level of survival due to crop failure. Many extension workers suggest that a farmer should diversify his business if he has experienced variability in the farm production and prices. Since the Canadian Wheat Board keeps the grain prices reasonably stable, some people argue that the main cause of income variability is weather. Also since diversification involves heavy initial investment, crop insurance is suggested as an income stablizer under weather risks. In many instances, due to rapid technological improvements in agricultural industry, such advice does not furnish the expected income stability on a farm firm. The present investigation was undertaken in the Carman district of Manitoba with a view to finding the answers to the following questions:

(a) What is the maintenance limit on the farm and how does the farmer manage to maintain the farm and the firm expenses under weather risks?

(b) How serious is the crop yield instability in terms of the modern farm business and how vulnerable are farmers to yield or income losses?

(c) If the farm income does not cover the maintenance limit what actions does the farmer take to cover the necessary family living and operating expenses?

More specifically the objectives of the study are to analyse the effects of crop yield instability on the allocation and use of resources within the farm business, to analyse enterprise diversification and crop insurance as alternative means of reducing the impact of crop yield instability on the farm business, and to evaluate which one of the two alternatives courses of action (diversification or crop insurance) will reduce income variance or minimize the probability of loss to give a more stable farm income.

In order to analyse the general nature of risk and uncertainty in Manitoba five major crops (wheat, oats, barley rye and flax) of the province were selected and the measures of variability (mean, variance, standard deviation and coefficient of variation) were used for the period 1921-1963. To analyse the impact of crop yield instability within the province, thirty-five farmers from the Carman District Farm Business Association were selected during 1957-1964 period. For a detailed study of the impact of crop yield instability, two farmers out of thirty-five were selected for the same period. The two case farms were on two different soil types. This facilitated the analysis of crop insurance as an income stabilizer. A comparison of farm incomes on these two farms was made in two extreme years, 1960 and 1961. The 1960 year did not experience any crop losses whereas a severe drought in 1961 drastically reduced the crop yields.

This study reveals three major problems of crop yield instability: (1) Farmers tend to diversify their businesses over a period of time, (2) that a wide income variability due to crop yield instability coupled with other factors exists within the farm firm, and (3) that in a year of crop failure the farmers tend to use cash and grain reserves and accumulate debts in order to maintain the living standard at some minimum level.

However, the farmers do not cease farming due to one or two crop failure years. Neither do they significantly reduce the production expenses in an unfavorable crop year. Rather they try to live within unstable crop yields by diversifying their business, increasing debts and using up savings. Linear programming also showed that the farm income variability due to uncertain crop production and prices can be reduced by diversification of the business.

The farms used in this study are not representative of the whole population of Manitoba farms. In addition, inferences based upon the case study method are not a basis for inductive generalizations. The conclusions of the study offer solutions to the problem of crop yield instability for the farmers included in the sample. The present investigation also recognizes the over all problem of crop yield instability for the farmers in the Carman area of Manitoba.

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INTRODUCTION

General Importance of The Topic

The hazards of the weather are not new to the prairie farmers. The Selkirk Settlers suffered crop losses as a result of drought and frost from the date of settlement (1812).[1] The crop failure of 1820 did not leave even enough grain for seeding the crops and the settlers borrowed seed grain from Wisconsin (U.S.A.). Later, in 1826, they suffered an unexpected disaster of flood and many of them left the thriving agricultural community of the Red River Valley and migrated to the United States. The Red River settlers faced complete starvation during 1867 and 1868 as their crops were completely destroyed by locusts.

Again during the 1880's, the remaining Selkirk Settlers suffered serious crop failures. In 1883 a bad drought followed by an early frost brought about a complete crop failure. Manitoba crops were badly damaged by a wet fall in 1884. The 1885 drought damaged the crops in Saskatchewan and Alberta. From 1886 to 1887 drought was widespread throughout the prairies. The drought and early frosts again wiped out almost all crops in 1889.

This was not the end of difficulties, however. The dry weather during the 1930's was incredibly disastrous for farmers. An extremely dry

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[1]H.G.L. Strange, A Short History of Prairie Agriculture, (Searle Grain Company Limited, Winnipeg, 1954) p. 10.

season during 1933 and another in 1937 reduced prairie crop yields well below the long-run (1930-60) average.[2] While the decade 1940-49 was very satisfactory, in the 1950's farmers experienced some crop losses. Flooding and rust in 1954 considerably reduced wheat yields in Manitoba. An early frost in the autumn of 1959 gave another setback to the farmers in Western Manitoba. The year 1961 saw a repetition of the disastrous droughts of the 1930's. The widespread drought in 1961 came as a shock for a whole new generation of young farmers in Manitoba.[3]

The prairie settlers had attempted to hedge against unstable crop yields as early as in 1868. In that year the settlers attempted to raise some livestock particularly sheep on their farms. The livestock activity was abandoned because of a rapid drop in the price of wool during 1869. In 1893 Mr. Hardy W. Campbell, for the first time successfully grew crops in the dry season.[4] However, not until the turn of the century was major emphasis placed on farming techniques and organization of production, oriented to diversification.

Stress Over Last Half Century On Diversification

In 1888 the Government of Canada established the Dominion Experimental Farms to investigate the possibility of successful farming under

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[2]J.C. Gilson, Instability in Agriculture and Crop Insurance, (paper presented to the Farm Conference Week, University of Manitoba, March 1962) p. 2.

[3]Ibid: p. 1.

[4]J.B. Hedge, Building the Canadian West, (The MacMillan Company, New York, 1936) pp. 326-27.

conditions of dry weather as experienced in the 1880's. The head of the experimental farms at Brandon reported to the Federal Government in 1889 as follows:

> Our season points to only one way in which we can in all years expect to reap something. It is quite within the bounds of probabilities that some other and perhaps more successful method may be found, but at present I submit that fallowing the land is the best preparation to ensure a crop.[5]

The discovery of summer fallow gave some relief from the effects of drought to Prairie agriculture and settlements again started in 1888. But the settlers suffered from setbacks other than drought. The early frosts and hail storms damaged the crops seriously in 1890.

Nothing could be done to prevent hail, but the Dominion Experimental Farms made attempts to develop varieties of cereals, especially wheat, which would stand early frosts. A number of new varieties were produced by Dominion Experimental Farms. An early variety, Marquis, was made available to the farmers in 1910. This variety gave new life to the prairie farmers.

The practice of dry farming or summer fallowing which started in 1888 and the introduction of new rust resistant varieties in 1910, may broadly be termed as diversification. By definition, diversification is the process of distributing resources over the production of a variety of farm products rather than specializing in one or two. In the case of dry farming, a certain portion of farmland is left idle during the summer and different crops are sown on the rest of the farm.

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[5]Strange, op. cit., p. 27.

This idle portion of the farmland preserves more soil nutrients and moisture than the land under crops and this reduces or spreads the risks of drought.

Completion of the Canadian Pacific Railway in 1885 improved the transportation facilities to the Prairies. The ranching industry developed and the livestock was shipped great distances by rail. The settlers raised grain for their personal use and livestock for marketing. Besides livestock raising, the settlers placed more emphasis on wheat production. High yields in normal years and lower costs of production, compared to livestock motivated the decision to concentrate a majority of farm resources in wheat production. Frequent frosts and droughts endangered wheat production and often proved disastrous to specialization in grain. The Interior Department, Ottawa, reported in 1884:

> However profitable the growing of wheat may be in a country so well adopted as the North-West for the production, at very small costs, the population should not be entirely dependent upon that one industry .... I am convinced that mixed farming would, in the end, prove most profitable to the settlers and most advantageous to the country.[6]

In 1896, the Report of the Interior Department, Ottawa, again reported:

> There is abundant evidence throughout the country that settlers have adopted the principle of mixed farming with advantage to themselves and the community at large.[7]

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[6]Sol Sinclair, The Degree of Diversification Present and Potential In Farming In Western Canada, (Unpublished B.S.A. Thesis, University of Saskatchewan, March 1932) p. 10.

[7]*Ibid.*, p. 10

The tendency towards diversification has been growing since 1896. Diversification of the crop enterprise with major emphasis on wheat production has increased tremendously. The number of livestock per farm has also increased since then.

The major factors responsible for this increase in wheat acreage were, (a) the general rise in prices after 1896, (b) the development of summer fallowing as an aid to dry farming, (c) introduction of early maturing varieties of wheat and (d) the rapid expansion of railways.

Studies[8] have shown an increasing trend towards diversification on Manitoba farms. Table 1 reveals this fact.

The relative importance of cash income received from wheat has declined from nearly 43 percent in 1926-1930, to some 29 percent of the total cash income in 1961-1963. The total income from livestock increased from 34 percent to nearly 52 percent during 1926-1963. The most important factor indicated by this table is that the farmers of the province were not as dependent upon crops, particularly wheat, in 1961-1963 as in 1926-1930. Unstable crop production seems to be the important factor responsible for this shift.

W.M. Drummond states:

> As farming becomes more specialized, farmers will be less able to spread their business risks over several enterprises.

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[8] See for example, V.E. Nelson, An Analysis of the Effectiveness of Diversification as a Means of Overcoming the Instability Characteristic of Farm Income in Manitoba, (Unpublished Master's Thesis, Department of Agricultural Economics and Farm Management, University of Manitoba, May 1959). Also D.W. Ware, The Variability of and the Sources of Farm Cash Income, Canada and Provinces, 1926-1960, (Canada Department of Agriculture, Economics Division, March 1963) p. 6.

TABLE I

RELATIVE IMPORTANCE OF FARM ENTERPRISES, FIVE YEAR AVERAGES, MANITOBA, 1926-63
(BASED ON THE PERCENTAGE OF THE TOTAL FARM CASH INCOME)

Source of income	1926-30	1931-35	1936-40	1941-45	1946-50	1951-55	1956-60	1961-63
Wheat	42.5	40.2	42.1	25.7	25.4	19.8	25.6	28.6
Oats	3.7	2.3	2.4	5.8	4.8	4.5	3.7	3.3
Barley	13.7	5.5	7.8	11.7	8.9	11.9	7.5	3.7
Rye	1.6	0.4	0.9	0.6	0.6	0.6	0.8	0.7
Flaxseed	1.5	0.7	0.5	2.3	6.5	4.8	6.4	7.6
Potatoes	0.6	0.8	0.5	0.6	0.2	0.3	0.4	0.3
Vegetables	0.4	1.0	0.8	0.8	0.6	0.9	0.8	0.5
Other crops	1.6	2.4	2.2	2.5	1.6	2.7	2.8	3.4
Total crops	66.1	53.3	57.2	50.0	48.6	45.5	48.0	48.1
Cattle & calves	10.3	12.6	14.5	13.5	18.4	19.7	17.9	20.2
Hogs	6.6	7.8	8.3	13.4	9.9	8.3	8.6	8.7
Sheep & lambs	0.4	0.8	0.8	1.3	1.5	1.2	0.7	0.4
Dairy products	8.7	15.8	11.4	11.6	10.4	11.8	11.6	11.5
Poultry	2.9	3.7	2.5	4.5	3.9	5.1	4.5	4.2
Eggs	3.6	3.7	2.8	2.9	4.5	5.2	5.3	4.9
Other livestock products	1.4	2.3	2.5	2.8	2.8	3.2	2.4	2.0
Total livestock & products	33.9	46.7	42.8	50.0	51.4	54.5	52.0	51.9
Total farm cash income	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Since they will have their business eggs in fewer baskets and since they will have to do a lot more buying they will become less and less able to withstand unfavourable price changes and relationships. They will become increasingly subject to the vagaries of a price economy[9] (and natural hazards).

Ad hoc Programs and Policies to Deal With Incidence of Crop Yield Instability

Farm Assistance Programs: A steady flow of agricultural production is of prime importance for the nation's economic and social progress. The natural calamities leading to unstable agricultural production call for sound policies and programs from time to time. The drought of the 1930's and a widespread crop failure combined with very low prices of farm products necessitated a large scale relief program by the Federal Government. The important depression and drought relief programs were:

(i) The relief and drought assistance programs of the Federal Government during the 1930's covered a broader field in the Prairie Provinces. Agreements were signed by the Federal Government with various Provincial Governments for settling families on the land. These arrangements were made under Relief Acts of 1932, 1934 and 1935, the Unemployment Relief and Assistance Act of 1936 and the Unemployment and Agricultural Assistance Act of 1937. Farmers were also assisted in purchasing seed grain, food, and fodder. The Federal Department of Agriculture took part in the relief programs during drought years in the Prairie Provinces. Since 1936 the Department has given help in the form of[10] (a) feed, fodder and direct relief, (b) purchase and distribution of foodstuffs in drought areas, (c) Land Settlement Assistance, (d) freight on livestock to and from places of feed supply to drought areas and on haying equipment and (e) aid to farmers who suffered poor crop yields.

(ii) Feed fodder and direct relief: The Federal Department of Agriculture bought, shipped and distributed feed and fodder for livestock during

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[9] P. Harsany, Adjustments and Economic Planning in Canadian Agriculture, (Academic Publishing Company, Montreal, 1964) pp. 38-39, words in paranthesis added.

[10] M.R. Cameron and F. Shefrin, Federal Agricultural Assistance Programs, Canada 1900-1951, (Canada Department of Agriculture, Ottawa, April 1962) p. 12.

1936 and 1939. The Federal Government also gave direct financial help for purchasing food, fuel, clothing and shelter in the drought stricken areas of Alberta and Saskatchewan because of a general crop failure in 1938. The government gave financial help to farmers for purchasing seed and fertilizer in 1939.

(iii) Purchase and distribution of foodstuffs in drought areas: The drought stricken areas of Alberta and Saskatchewan in 1937 and 1938 were supplied with fruits, vegetables, fish, butter, and cheese by the Federal Department of Agriculture. During the year 1939-40 the Department distributed apples and butter to supplement the diet of people affected by drought in Alberta and Saskatchewan.

(iv) Land resettlement assistance: Under the Unemployment and Agricultural Assistance Act of 1937, the Federal Department of Agriculture made agreements with various provinces to help in resettling the people moved from drought areas. The Federal Government also helped the Provincial Governments by giving loans to ease the burden of indebtedness incurred by farmers under previous relief programs.

(v) The Prairie Farm Assistance Act (P.F.A.A.): The P.F.A.A. was passed on June 3, 1939 to help the farmers of the Prairie Provinces and the Peace River area of British Columbia who suffered low yields because of factors beyond their control. Primarily, the purpose of this Act was to assist the Municipalities and the Provincial Governments of the Prairie Provinces in years of crop failure to deal with relief problems which otherwise would be too great for them to handle by themselves. The farmers who suffered low crop yields in the spring wheat areas of the country were given direct financial help by the Federal Government under this Act. The payment of money to the farmers was done in two ways: (a) emergency year assistance and (b) crop failure assistance. Under either kind of help the individual award was payable only on one-half of the farmer's cultivated acreage-- up to a maximum of 200 acres on a farm with 400 cultivated acres or more. Under crop failure assistance a minimum amount of $200 and a maximum of $500 was payable to each farmer[11]. These two forms of assistance were merged into one by an amendment to the Act in 1947. The P.F.A.A. Act has been amended several times since 1947.

(vi) Aid to Prairie Provinces on Account of Unharvested Crops: When the Prairie farmers were unable to harvest more than half of their field crops due to early and abnormal snow in the autumn of 1959, the Federal Government offered to share equally (up to a specified maximum) with each of the three Prairie Provinces, the cost of emergency assistance to farmers and of specified administrative outlay[12].

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[11] Ibid., p. 13.

[12] M.R. Cameron, Federal Agricultural Assistance Progrmams, Canada, 1945-56, (Economics Division, Marketing Service, Canada Department of Agriculture, Ottawa, March 1963) pp. 271-273.

Under this program each eligible farmer could receive payment of $3.00 per acre, up to a maximum of 200 acres unharvested crops of wheat, oats, barley, rye and flax. The specialized crops such as sugar beets, potatoes, vegetables and sunflowers were also paid $3.00 per acre, up to a maximum of $600.00 per farmer. Nearly $24 million was paid out under the P.F.A.A. in 1959 under this program. At the Provincial level, payments were made by the Manitoba Government to those farmers who were unable to harvest more than half of their 1959 seeded acreage and to those who obtained a wheat yield of less than eight bushels per acre or the equivalent in other crops. Maximum payments were based on [13]: (a) $2.00 per unharvested acre on up to 200 acres if the yield per seeded acre was below a specified range. (b) $20.00 per unharvested acre on up to 20 acres in potatoes, other vegetables and sugarbeets if growers harvested from 30 percent to less than 50 percent of the seeded acreage in these crops. (c) $30.00 per unharvested acre on up to 20 acres of potatoes, other vegetables and sugarbeets if less than 30 percent of the seeded acreage was harvested.

The data in Table II indicate the amount of indemnities paid under P.F.A.A. during 1939-64. The farmers in Manitoba were paid over $29 million under P.F.A.A. for the period 1939-64. The highest amount of P.F.A.A. indemnities was paid out to Manitoba farmers in 1961. As previously mentioned, 1961 was a drought year and a total of approximately $7.5 million was paid out as P.F.A.A. indemnities. For all the Prairie Provinces the total of indemnities paid out under P.F.A.A. has been approximately $339 million.

Under P.F.A.A. a levy of one percent is deducted from the purchase price of all grains sold through the Canadian Wheat Board. Manitoba farmers paid approximately $22 million to the P.F.A.A. fund during 1939-64 (Table III). The farmers in Manitoba collected approximately $29 million at the end of 1964. The P.F.A.A. fund, thus, was in deficit of approximately $7 million at the end of 1964. During 1939-64 all the three Prairie Provinces

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[13] *Ibid.*, pp. 273-274.

TABLE II

PAYMENTS MADE UNDER P.F.A.A. (PRAIRIE PROVINCES) 1939-64*

Year	Manitoba	Saskatchewan	Alberta	Total
1939-41	$ 1,557,039.05	$ 25,188,929.00	$ 5,400,007.65	$ 32,145,975.70
1942	—	—	—	—
1943-47	706,909.97	43,132,350.18	14,650,565.65	58,489,825.80
1948	63,638.75	11,532,255.50	2,544,571.50	14,140,465.75
1949	333,089.00	15,373,732.75	6,343,796.25	22,050,618.00
1950	347,239.00	5,608,926.00	4,314,371.75	10,270,536.75
1951	207,393.00	2,247,920.25	2,171,140.50	4,626,453.75
1952	185,691.75	810,803.50	532,101.75	1,528,597.00
1953	619,863.25	1,143,177.50	1,007,525.25	2,770,566.00
1954	5,259,645.50	21,888,528.50	5,781,922.00	32,930,096.00
1955	2,305,548.50	1,290,677.00	1,304,682.25	4,900,907.75
1956	637,310.00	627,083.00	964,456.00	2,228,849.00
1957	1,720,315.00	9,917,414.50	5,806,718.50	17,444,448.00
1958	1,184,970.50	15,026,425.00	7,002,685.50	23,214,081.00
1959	1,926,838.50	14,424,376.00	5,395,541.00	21,746,755.50
1960	666,508.50	4,559,348.50	5,696,956.50	10,922,813.50
1961	7,420,856.50	36,970,775.35	9,678,947.00	54,070,578.85
1962	815,283.00	6,880,283.50	7,789,507.00	15,485,073.50
1963	3,118,501.50	982,394.50	5,406,547.00	9,507,443.00
Totals	$29,076,641.27	$217,605,400.53	$91,792,043.05	$338,474,084.85

*Source: Report on Activities under the Prairie Farm Assistance Act for the Crop Year 1963-64, p. 7.

TABLE III

SUMMARY 1% LEVY COLLECTED 1939 TO JULY 31, 1964*

Crop Year	Manitoba	Saskatchewan	Alberta	Unallocated	Total Levy
1936-46	$ 3,619,477.07	$ 12,892,615.30	$ 6,205,029.21	$ 2,554.69	$ 22,719,676.27
1946-47	845,631.86	2,703,357.17	1,644,706.41	112.20	5,193,807.64
1947-48	764,744.37	2,727,187.90	1,624,237.42	148.51	5,116,318.20
1948-49	1,122,741.27	3,419,480.86	2,086,088.52	185.87	6,628,496.52
1949-50	1,355,660.07	4,525,628.79	2,515,568.28	197.64	8,397,054.78
1950-51	1,442,138.08	3,890,444.68	2,001,322.58	153.72	7,334,059.06
1951-52	1,331,548.73	5,075,404.05	2,560,006.74	116.72	8,967,076.24
1952-53	1,423,916.39	6,375,831.62	3,074,384.50	179.48	10,874,311.99
1953-54	973,258.03	4,944,452.16	2,069,163.48	158.10	7,987,031.77
1954-55	748,694.05	3,169,787.24	1,614,486.03	152.31	5,533,119.63
1955-56	736,868.80	3,805,410.60	1,697,544.20	77.17	6,239,900.77
1956-57	864,573.57	3,608,339.14	1,732,861.33	88.50	6,205,862.54
1957-58	804,333.23	3,706,548.23	1,603,509.96	83.08	6,114,474.50
1958-59	1,009,011.92	3,803,745.72	1,861,242.56	Nil	6,674,000.20
1959-60	961,496.49	3,671,561.96	1,693,865.53	Nil	6,326,923.98
1960-61	930,501.29	4,246,938.63	1,763,654.49	Nil	6,941,094.41
1961-62	795,916.15	4,055,847.98	1,987,734.44	Nil	6,839,498.57
1962-63	1,213,940.74	5,279,829.33	2,120,654.06	Nil	8,614,424.13
1963-64	1,148,704.13	6,937,953.14	2,649,635.02	Nil	10,736,292.29
TOTALS	$ 22,093,156.24	$ 88,840,364.50	$42,505,694.76	$ 4,207.99	$ 153,443,423.49

*Source: Report on Activities under the Prairie Farm Assistance Act for the crop year 1963-1964, p. 6.

paid approximately $154 million under the one percent levy. The amount of P.F.A.A. indemnities received by these provinces was approximately $339 million. The P.F.A.A. fund was, thus, short by approximately $185 million during the period 1939-64.

History of Demand For Crop Insurance

In Western Canada, the demand for crop-insurance is not recent. In 1920 the Hartford Fire Insurance Company of Connecticut (U.S.A.) investigated for the first time the possibility of crop insurance in Saskatchewan. A year later the Home Insurance Company of New York (U.S.A.) sold four crop insurance policies in Alberta. As a result of the continuous crop failures in the Prairies during 1930-32, and again in 1934, the government of Saskatchewan set up a crop insurance investigation committee in 1935. It strongly recommended the introduction of crop insurance in the Province[14].

In 1936, W.J. Hansen, approximated that 9% of the acreage seeded under wheat was crop failure for the period 1916-35 in Saskatchewan. Hansen studied the feasibility of crop insurance in Saskatchewan and concluded that a 'mutual crop insurance organization, with no capital structure in any case, would be required to make a careful selection of the risk areas....., for certain areas of the Province, at present, relief is the only alternative to insurance for continued crop failure'[15].

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[14]Gilson, Op. cit., p. 13.

[15]Canadian Society of Agricultural Economics 9th Annual Meeting—W.J. Hansen, Economic Aspects of Crop Yield Insurance with Reference to the Province of Saskatchewan, (Agricultural Economics Branch, Canada Department of Agriculture, Ottawa, 1936) p. 8.

After Hansen's study, R.E. Motherwell was appointed in 1944, by the Saskatchewan Reconstruction Council to re-examine the feasibility of crop insurance in the province. In his conclusion he doubted the practicability of crop insurance but was optimistic about its possibility. The Saskatchewan Royal Commission on Agriculture and Rural Life conducted a study in 1956 on crop insurance. One of its main conclusions was than 'an experimental crop insurance program be launched in Saskatchewan as a program complementary to, but separate from, the present P.F.A.A. program' and further 'that reserve requirements for the experimental program be provided by the Federal Government'.[16]

A study[17] made on crop-yield variability in the Prairie Provinces showed that 8 out of 14 districts in the Province of Manitoba had wheat yields below 50% of the average for one or more years during 1921-1956. All nine crop districts in Saskatchewan had wheat yields below 50% of the average during the period of study in one or more years. In one district of Saskatchewan the wheat yield was below 50% of the average for ten years. Thirteen out of seventeen crop districts in Alberta had wheat yields below 50% of the long-term average.

The severity of the crop failures, mainly due to extreme weather risks, was given serious attention in the Province of Manitoba. The government be-

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[16]Gilson, _op. cit._, p. 14.

[17]_Reference Paper on Crop Insurance in Canada_ (Canada Department of Agriculture, January 1963), p. 2.

lieved that only crop insurance programs would help in stabilizing farm income and business activities of the farming communities. The then Premier of Manitoba, John Bracken appointed a Manitoba Crop Insurance Committee on October 18, 1938. In the final report on February 1940 the Interim Committee concluded that:

> Crop insurance would enable farmers to set aside a reserve during years of good crops to provide against emergencies resulting from crop failures or poor crops, and would help to place agriculture on a self-sustaining basis, by ensuring a greater stability of income.
>
> We have arrived at the conclusion that crop insurance is both desirable and practicable for Manitoba, beginning with wheat and later on to include the other main cereal crops grown in the Province[18].

Again in 1954 the Government of Manitoba appointed a Crop Insurance Commission to review the report of Crop Insurance Committee in 1940. The Commission concluded that: (i) under today's farming conditions P.F.A.A. is inadequate, (ii) the financial support of the Federal Government is necessary in implementing the crop insurance program. The Crop Insurance Act was passed by the Federal Government in July, 1959. The following crops are insurable under Federal Government Act: wheat, oats, barley, rye, buckwheat, grain, corn soyabean, potatoes, sugarbeets, tobacco, sunflower seed, rapeseed, apples, pears, peaches, plums, cherries and apricots. This Act enables the Federal Government to enter into agreements with any province in establishing the crop insurance programs and in contributing means (loans etc.) to assist farmers. In 1959 the Government of Manitoba passed complementary legislation for the establishment of the "crop insurance test areas" on the

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[18] Interim Report—Manitoba Crop Insurance Committee, (April 1939) p.2.

basis of crop yield instability. The Government of Saskatchewan also passed a Crop Insurance Act in 1960.

Since 1960 the crop insurance program has been in operation in the Province of Manitoba. Approximately 4,413 farmers participated in the program in 1963 and the indemnities to the farmers amounted to $531,504 during that year. The total number of participants in the crop insurance program has been increasing in Manitoba as shown in Table IV.

The Red River crop reporting district includes the West Red River and South Central areas in Table IV. The number of participants in the Red River Valley during 1961 was about 85% of the total participants in the province. During 1962, 1963, and 1964, it was about 59%, 54%, and 47% respectively. The Red River crop reporting district includes the farmers belonging to the Carman District Farm Business Association which is the area used for the present study. Though it is difficult to reach a general conclusion on the basis of only four years data, Table IV shows that the number of participants in the Red River Valley decreased by 38% during 1960-64. Perhaps this reduction is due to the relatively high premium cost, in relation to net farm income[19]. However, the number of participants in the province as a whole increased each year. This indicates that unstable crop production forced the farmers to buy crop insurance even though its cost was relatively high in relation to net farm income.

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[19] Y. Wu, An Economic and Statistical Evaluation of All-Risk Crop Insurance Program, (Unpublished Master's Thesis, Department of Agricultural Economics and Farm Management, University of Manitoba, June 1965).

Objectives

Studies[20] have indicated that the extreme drought in 1961 brought the yields of all crops far below the long-run average yields. It is also argued that rainfall for the 1961 crop was lowest in the history of prairie agriculture[21]. The average wheat yield per acre in the prairies was 10.4 bushels in 1961 being the second lowest since 1937 (6.4 bushels). On the basis of these aggregate figures one would infer that farm income in the prairies was also far below the long-run average income. But these aggregate yields or income do not reflect the true picture on individual farms. The argument which has been statistically proved to be true for all may not necessarily be true for one or a few individual farms. Thus, arguing that the 1961 drought reduced crop yields and income in all the prairie farms close to the level of the 1930's, suffers from the fallacy of induction. The 1961 crop yields in the prairies were close to the 1930's, but farm prices differed significantly. However, after studying the impact of the 1961 drought year on individual farms, one may tentatively assume that crop yields on the individual farms also varied with the average yields in the prairies. This is an _a priori_ knowledge or assumption. This study examines the validity of this _a priori_ assumption on the Carman area of Manitoba. How far income

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[20] M.H. Yeh and L.D. Black, _Weather Cycles and Crop Predictions_, (The University of Manitoba, Faculty of Agriculture and Home Economics, Technical Bulletin No. 8, November 1964) p. 10.

[21] G.D.V. Williams, _Prairie Droughts, The Sixties Compared With Thirties_, (Agricultural Institute Review, January-February, 1962, Ottawa) p. 16.

TABLE IV

COMPARATIVE ANALYSIS OF CONTRACTS IN FORCE
FOR THE CROP YEARS ENDED 31ST MARCH 1961 TO 31ST MARCH 1964

	CONTRACTS IN FORCE			
	1960-1	1961-2	1962-3	1963-4
West Red River				
MacDonald	409	387	426	441
Montcalm	283	214	210	211
Morris	337	314	377	431
	1029	915	1013	1083
South Central				
Dufferin	97	119	174	166
Grey	137	131	140	151
Rhineland	436	520	503	555
Roland	106	127	131	155
Stanley	223	235	261	259
Thompson	80	104	130	136
	1079	1236	1339	1422
South West				
Albert	-	69	117	97
Arthur	91	87	97	83
Brenda	132	129	182	141
Cameron	-	40	70	54
Edward	49	51	73	46
Winchester	-	44	127	98
	272	420	666	519
Northern				
Birtle	-	134	165	169
Boulton	72	67	76	71
Ellice	-	45	71	66
Russel	-	68	112	119
Shellmouth	-	101	124	133
Silver Creek	20	53	89	81
	92	468	637	639
North Central				
Assiniboia & Charleswood	-	35	48	50
Cartier	-	163	191	188
Rockwood	-	128	170	150
Rosser	-	83	102	104
St. Francois Xavier	-	61	73	73
Woodlands	-	101	110	100
	-	571	694	665

TABLE IV (continued)

	CONTRACTS IN FORCE			
	1960-1	1961-2	1962-3	1963-4
Outside-Sugarbeets	-	44	64	73
Mid-West				
Clanwilliam	-	-	-	63
Corwallis	-	-	-	74
Daly	-	-	-	69
Elton	-	-	-	110
Harrison	-	-	-	100
Minto	-	-	-	58
Odanah	-	-	-	76
Saskatchewan	-	-	-	103
Whitehead	-	-	-	88
	-	-	-	741
TOTALS:	2472	3654	4413	5142

Source: Manitoba Crop Insurance Corporation, Winnipeg.

decreased in 1961 in comparison to 1960, and what actions farmers took to face the economic distress in 1961, is the main purpose of this study. In other words, the study pinpoints the impact of crop yield instability on the farm business[22].

The term impact in this project is used as a dynamic force which compels the farmer to react to crop yield instability. Farmers' reaction to crop yield instability may be reflected in the diversification of the farm

[22]The term farm income includes all cash receipts by selling farm products, excluding depreciation charges, imputed value of household consumption and family labor. Farm business includes farm income, household consumption, family labor employment and depreciation charges on fixed capital. These two terms are broadly interpreted as net cash income and net farm income respectively. For detailed discussion on net farm income and net cash income, see J.A. Hopkins and Earl O. Heady, Farm Records and Accounting, (4th Edition, Iowa State College Press) pp. 172-176.

business or in buying crop insurance. There is no evidence available for guidance in making this choice. Therefore, main emphasis has been placed on finding out precisely which one of the two will sustain the 'maintenance limit' defined later. When the farm income is not enough to cover the 'maintenance limit' some financial help from outside the farm may be required. This study will thus allow more accuracy in determining credit needs, estimating the loan repayment capacity of the farm business and the desirability of farm income stabilization programs. The study does not intend to examine economically efficient resource allocation between the farm (production firm) and the family. However, various studies have been conducted to see how closely the farms as firms and as household units are related[23].

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[23]See for example, E.O. Heady, W.B. Back and G.A. Peterson, Interdependence Between the Farm Business and the Farm Household With Implication On Economic Efficiency, (Iowa Agriculture Experimental Station Research, Bulletin 398, 1953). Also see G.L. Maddox and E.D. Chastan Jr., Production-Consumption Interrelationships of Alabama Farm Family Business, (Agricultural Experimental Station, Auburn University, Auburn, Alabama, Bulletin 342, February 1963).

CHAPTER II

NATURE AND SCOPE OF THE PROBLEM

General Nature and Extent of Risk and Uncertainty

Crop yields in the prairies are highly uncertain. Rainfall at the proper time is the main factor determining the crop yield[1] and at present is beyond the control of the farmer. In the long-run or in the whole life span of the farmer, good and bad crops may average out resulting in an adequate average income for the farm family. But in the short-run farmers may face serious problems. Even a single year of crop failure may create financial troubles. A poor crop year such as that of 1961 threatens the survival of the farm business as a whole, even if family living levels are drastically reduced.

Uncertainty of grain prices is no longer a very serious problem to the Manitoba farmers. The Canadian Wheat Board operations keep the price level at a reasonably stable level. However, the Manitoba farmers are still confronted with the problem of crop yield variability, over which they have no, or very little, control.

The basic problem in Manitoba in the long-run is one of finding means to reduce or eliminate the unpredictable manner in which low crop yields

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[1] See for example Dominion Bureau of Statistics, 1941. The influence of precipitation and temperature on wheat yields in the Prairie Provinces, 1921-1940. (Quarterly Bulletin Agricultural Station July-September) pp. 167-187. Also M.H. Yeh and L.D. Black, Weather Cycles and Crop Predictions. (The University of Manitoba, Faculty of Agriculture and Home Economics, Technical Bulletin No. 8, November 1964) p. 8.

alternate with high yields. Means should be found to keep the family farms at least above some minimum survival level and to protect them from being insolvent. Possible solutions to these difficulties can be found by analysing the effects of crop yield variability on the farm business. The analysis of the farmers' action in the event of crop failure is necessary for finding practical solutions of the problem consistent with the farmers' attitude towards crop yield variability. Finding means to cope with the instability of crop yield on the farm business, is in fact a matter of learning how to live with unpredictable instability. This instability or uncertainty that the farmer faces is regarded as the farm problem. The nature and magnitude of risk and uncertainty[2] is, theoretically, the same at the farm and firm levels. However, the farmer as farmer and the farmer as entrepreneur react differently to the problems of uncertainty.

Uncertainty may create a problem of survival on the farm by reducing farm income below some minimum level. Under the conditions of uncertainty the farmer's first end is to 'survive on the farm'[3]: When the farmer is sure

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[2]No distinction has been made here, between the words, uncertainty, instability and variability. However, a brief discussion has been developed on the definitions of risk and uncertainty in Chapter III, Definitions and Discussions on Risk and Uncertainty. For the synonymous use of these terms also see C.O. Hardy, Risk and Risk-Bearing, (University of Chicago Press, 1923) pp. 46-55; J.R. Hicks, "The Theory of Uncertainty and Profit", Economica, (Vol. 12, May 1951) pp. 170-189; D. Gale Johnson, Forward Prices for Agriculture, (The University of Chicago Press, 1947) p. 38, note; K.J. Arrow, "Alternative Approaches to the Theory of Choice in Risk-Taking Situations", (Economica, Vol. 19, October 1951) pp. 404-437.

[3]Farm survival may be defined as a farmer's actions of minimizing the probability of an uncertain loss rendering him insolvent, by organizing production, maintaining cash reserves and outside funds (credit and insurance). The level of survival must cover the annual farm costs and the household consumption expenditure. The word "survival" used in this chapter has been

of his survival on the farm, his second end is to maximize profit. Schickele describes it this way: "Any 'gambling' after survival of the farm and home is reasonably well assured (in the farmer's mind), must be regarded as a means for serving the end of income maximization"[4].

Income in agriculture varies more than in any other industry. Price affects both farm as well as industry's income. But the former is subject to high variability since farm production largely depends on weather conditions. The degree of certainty of farm production or income desired by the farmer depends upon price and weather conditions[5]. However, an uncertain outcome may be avoided by a sacrifice of certainty equivalent[6].

Nature and Extent of Crop Yield Instability in Manitoba

To study the nature of yield variability five crops (wheat, oats, barley, flax, rye) which are the main grain crops of the province were considered and the degree or extent of their yield variability measured. The variance[7],

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borrowed from Dr. R. Schickele's article "Livestock as Income Stabilizer", North Dakota Agricultural Experimental Station Bi-monthly Bulletin, Vol. XII, No. 6, July-August 1950, pp. 198-203. In the next chapter the author has developed the concept of the 'maintenance limit' parallel to the "survival limit", and thus the two terms will be used synonymously throughout the whole inquiry.

[4]R. Schickele, "Farmer's Adaptations to Income Uncertainty", Journal of Farm Economics, (August, 1950) p. 362.

[5]J.A. Boan, "A Study of Farmers' Reaction to Uncertainty Prices Expectations", Journal of Farm Economics, (Vol. 37, February 1955) p. 95.

[6]O.H. Brownlee and W. Gainer, "Farmers' Price Anticipations and the Role of Uncertainty in Farm Planning", Journal of Farm Economics, (Vol. 31, May 1949) pp. 266-275.

[7]Variance is defined as the expected value of the variant squared minus the square of the variant's expected value. Sample variance (S^2) is an unbiased estimate of the population variance (σ^2). σ^2 is expressed as $\sigma^2 = E\,[X-E(X)]^2$ where X is the variant and n is the number of observations in the sample. Standard deviation (S) is the square root of the sample variance and coeffic-

standard deviation, coefficient of variation and mean are used as measures of crop yield instability. The crop yield variability has also been measured for each crop district in the province. The variability of crop production in a single crop district is greater than for the province because fluctuations tend to be averaged out as fourteen crop districts are aggregated together into a single statistic.

For the province as a whole, the variability of oats, and barley yields is greater than for any of the other three major crops under study. The mean, variance and the standard deviation for flax are lowest followed in order by rye, wheat, barley, and oats. The analysis of the data in Table V would suggest that those farmers who are in a good capital position to withstand great risks and are interested in the level of income alone would select flax. The examination of the coefficients of variation shows, flax is the second lowest whereas barley and oats have the greatest relative variability of yields. This can be interpreted by saying that of the five major cash crops studied, the degree of yield instability is greatest for barley followed by oats, wheat, flax, and rye. Barley production involves greater yield risks than oats or any other crops because it is more susceptible to plant diseases. Farmers may be indifferent to growing wheat, oats or barley; the final choice might then be determined by the crop which gives the greatest net income.

Examination of crop yield variability according to the crop districts (Appendix I) shows that during 1921-63 the crop yield statistics in the Morden

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ient of variation (c.v.) is calculated as $c.v. = S(100)/\bar{X}$ where $\bar{X}$ is the sample mean.

TABLE V

CROP YIELD VARIABILITY, MANITOBA 1921-63*

Crop	Mean Yield	Average Mean Square Deviation (Variance)	Root Mean Square Deviation or Standard Deviation	Coefficient of Variation %
Wheat	18.6	22.7	4.8	25.6
Oats	31.4	79.5	8.9	28.4
Barley	24.5	64.8	8.1	32.8
Flax	8.8	3.6	1.9	21.5
Rye	16.0	8.2	2.9	17.9

* Bushels per acre.

district[8] except for barley and oats were fairly close to the provincial yield statistics. Reasons for greater crop yield variability of barley and oats in Morden district are the same as those for the province as a whole, that is, barley yield is relatively more susceptible to plant diseases than are wheat, oats, flax and rye. Farmers in this district should have no preference between wheat and oats which have coefficients of variation of 25.9% and 24.3% respectively. The final choice therefore is based on selection of those crops which give the greatest net income. The same reasoning holds true for the crop yield variability in the crop districts of Neepawa and Russell[9].

[8]The crop reporting districts Morden or Red River Valley includes the farmers belonging to the Carman District Farm Business Association (C.D.F.B.A.).

[9]The crop districts of Neepawa and Russell include the farmers belonging to the Western Manitoba Farm Business Association (W.M.F.B.A.). C.D.F.B.A. and W.M.F.B.A. are voluntary associations of the farmers. The purpose of these associations is to co-operate with the Department of Agricultural Economics,

Implications and Impact of Crop Yield Instability on the Farm Business

Management of the farm involves many complicated decisions based on the expectations of future events. Most of these anticipations have various degrees of risks in the planning process. Some of the following studies reveal implications of crop yield instability on the farm business:

(1) Farm Unit Dispersion[10]

A study on farm unit dispersion by Jensen and Nash in the north-eastern Montana area for the year 1942-56 showed that:

> For those years in which growing conditions were quite unfavourable over the whole area, yield variability was less than in other years .... The range of probable yield is reduced for the dispersed farm operator. To some extent this permits some improvement from the standpoint of predictable yields, allowing for more accuracy in determing credit, needs and an improved ability to estimate the loan repayment capacity of the farm business[11].

Another study on dispersion and yield variability in the Montana area revealed that wheat yield variability and field dispersion are inversely related. In general the study concluded[12]:

University of Manitoba, Winnipeg, in farm management research. The source of data used in this study are the C.D.F.B.A. A brief discussion has been developed regarding the reasons for selecting data from farm business records in Chapter IV. C.D.F.B.A. was organized in the Spring of 1957 and the W.M.F.B.A. in 1962.

[10]Dispersion is defined as a procedure to reduce yield variability, when a farmer scatters his farm land holdings (through exchange, purchases or rentals) over some area so that the several tracts of land in his farm will not be contiguous.

[11]Farm Unit Dispersion, (Montana Agricultural Experiment Station, Montana State College, Bozeman, Technical Bulletin 575, April 1963) pp. 1-19.

[12]Don Bostwick, Studies in Yield Variability (Montana Agricultural Experiment Station, Bulletin 574, January 1963) pp. 1-47.

(i) Field dispersion appears to be a means appropriate to reduce the uncertainty of dryland wheat yields and therefore, the income uncertainty of farmers.

(ii) Dispersion is an insurance device with direct costs and indirect benefits. Costs would be the fuel and time consumed by the farmer in moving any added distances between dispersed fields. Benefits would be reduced yield-income uncertainty, making possible a more rational long-term planning of the business.

(iii) Field dispersion, as a device for reducing the effect of hail for an individual farmer, might substitute for hail insurance. However, dispersion would not directly affect hail insurance rates for a given locality, but it would affect farmers participation in hail insurance programs.

(2) <u>Crop Insurance</u>

Another implication of crop yield instability is the lack of security in the farmer's mind. This sense of insecurity directs the farmer to insure crops. Thair shows that the more vulnerable farmers have a tendency to subscribe to crop insurance in greater number than the farmers having more capital assets since the former is more financially insecure than the latter. Professor Thair argued:

> It is apparent that the high-risk area farmers of Burke County look on such a scheme with more favour than the low risk Eddy County farmers. Over half (53.8%) the Burke County farmers were willing to pay a premium of 10 percent compared to just over one third (36.2%) in Eddy County ....

Thair concluded that:

> .... farmers are sensitive to the dangers of bankruptcy and take deliberate steps to provide security. Some of these practices, such as summerfallow, may increase income as well as provide some security, while others, such as keeping unproductive reserves, may provide security but reduce income and retard progress[13].

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[13] P.J. Thair, <u>Meeting the Impact of Crop-Yield Risks in Great Plains Farming</u>, (Agricultural Experiment Station, Fargo, North Dakota, Bulletin 392, June 1954) pp. 5-34.

Another study by Barber in Kansas revealed that:

> .... The net income deficits that are experienced without insurance are appreciably reduced by wheat crop insurance and entirely avoided by multiple crop insurance[14].

Barber like Thair also suggested that greater yield stability could be obtained by more extensive summerfallowing and the adoption of other moisture-conserving practices.

(3) Farmers' Hedge on Recommendations

Crop yield instability considerably affects the farmers' production decisions. A study on fertilizer practices in North Central Manitoba, by Professors Gilson and Hedlin revealed that the farmers used fertilizer at levels somewhat below that recommended for different crops. The authors report that:

> An attempt was made to determine why the farmers who never used fertilizer were hesitant to use a practice which was highly recommended for the area. Many reasons were given by these farmers. One farmer, for example, indicated that fertilizer was too expensive, another indicated that the return from investment in cattle tended to be higher than the return from a corresponding investment in fertilizer, several indicated that risks such as flooding, poor crop prospects, etc., tended to discourage the use of fertilizer[15].

In addition to the above, crop yield uncertainty also affects the farmers' decision to borrow money either to fulfill the requirements of recommendations or investment elsewhere. This fact has also been reported

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[14]E.L. Barber, Meeting Weather Risks in Kansas Wheat Farming, (Kansas Agricultural Experiment Station, Manhattan, Report No. 44, September 1950) pp. 1-30.

[15]J.C. Gilson and R.A. Hedlin, Fertilizer Practices in North Central Manitoba, (Department of Agricultural Economics and Farm Management, University of Manitoba, Winnipeg, Memo No. 1, January 1963) pp. 5-10.

by Gilson and Hedlin. They state that:

> The farmers were also asked under what conditions they would borrow for the purchase of fertilizer. Twenty-six (out of 45) indicated that they would borrow to purchase the amount ordinarily purchased when cash was available. Six indicated that the amount borrowed would depend on moisture and crop prospects. There were many other circumstances under which the farmers indicated that they would borrow. Perhaps the most important limiting factor appeared to be that of risk and uncertainty due to weather, grain marketing and for other reasons.

In another paper Dr. Gilson claims that farmers are hesitant to follow fertilizer recommendations due to fear of risks involved in crop production. He states:

> A group of farmers in Manitoba were very apprehensive when soil tests indicated that they should apply anywhere from two to three times more fertilizer on their 1962 crops than they had normally been using. They did not dispute the fertilizer recommendations based on the soil tests but they were fearful of the risks involved. They were fearful because the widespread drought of 1961 had drastically reduced their yields, notwithstanding the large investment they had in recommended crop and land use practices[16].

Dr. Gilson further argues that 'the availability of capital and risk (crop yield instability) appear to be the two most important deterrents to expanded fertilizer use'.

The farmers hedge on fertilizer use is not only restricted in the province of Manitoba, it is spread all over the country. Dr. Harsany puts it this way:

> Unfortunately, however, the consumption of chemical fertilizers in Canada is exceedingly low .... It is quite important to note that in the Prairie Provinces, where the plant nutrients replacement should

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[16] J.C. Gilson, Economic Aspect of Fertilizer Use at the Individual Farm Level. Paper presented to the Canadian Fertilizer Association Convention, Murray Bay, Quebec, August 29, 1964. (Department of Agricultural Economics and Farm Management, University of Manitoba, Winnipeg.)

be the most important, the fertilizer consumption is almost negligibly low; only 0.36 percent of the total Canadian consumption[17].

Among the economic reasons for not using chemical fertilizers, risk of dry weather and unstable crop yields are important.

(4) Losses Suffered

Crop yield instability brings many losses and uncertainties to the farm business. It reduces farm income drastically and threatens the survival of the farm family. The losses suffered by the farm business due to crop yield uncertainty may be broadly classified as follows:

(i) If the farm income is uncertain (either due to yield or price instability), the farmer cannot plan his farming operations efficiently. He is not able to determine the kind and amount of resources that should be used to produce his crops. His long-run plans about the soil and water conservation practices are also uncertain and thus he is unable to make these practices profitable. Unimproved soil and conservation practices, do not bring maximum crop production and income. Low level of the farm income checks the growth of the farming enterprise. Uncertain crop yields on the farm thus form a vicious circle reducing income gradually and continuously.

(ii) The second effect of uncertain income is that the farmer is not completely able to meet family living expenses. These family expenses are the same from one year to the next[18]. Thus if annual income is unstable, many expenditures which allow a desirable level of living must be foregone in years of low income.

Crop yield fluctuations are not only dangerous to the individual farmer but they are also detrimental to the community welfare. Schickele found that

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[17] P. Harsany, Adjustments and Economic Planning in Canadian Agriculture, (Academic Publishing Co., Montreal, 1964) p. 39.

[18] See for example, Rainer Schickele, "Farm Business Survival Under Extreme Weather Risks", (Journal of Farm Economics, Proceeding Number, Vol. 31, November 1949) pp. 931-943.

about one third of all North Dakota farmers lost their farms through foreclosure during the 1930's mainly because of low crop yields[19].

(5) Investment Decisions

Systematic production and investment decisions increase the efficiency of farm production. Perfect foresight helps the farmer in making perfect decisions and using farm resources for greater profit. The inefficient use of resources due to imperfect knowledge in farming affects both, the individual farmer and society. Heady and others declare that:

> Inefficient use of resources will continue in agriculture so long as decisions must be made in a highly uncertain environment, the farmer sacrifices in terms of profit while the consuming society sacrifices by realizing fewer goods and services than could be produced from the quantity of resources employed in agriculture and the economy generally[20].

Farmers generally assume that the future will be similar to the past. Past experience is most important in decisions of farmers for fertilizer purchase. Heady and others in a study on investment decisions have shown that given the short-run framework (over 3 years) almost two-thirds of the total farmers interviewed, stated that investment decisions in machinery and building were primarily dictated by needs[21].

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[19] Ibid.

[20] E.O. Heady, E.W. Kehrberg, and E.H. Jebe, Economic Instability and Choices Involving Income and Risk in Primary or Crop Production, (Agricultural Experiment Station, Iowa State College, Ames, Iowa, Research Bulletin 404, January 1954) p. 619.

[21] E.O. Heady, R.J. Hildreth and G.W. Dean, Uncertainty, Expectations and Investment Decisions for a Sample of Central Iowa Farmers, (Iowa Agricultural Experiment Station, Ames, Iowa, Research Bulletin 447, January 1957) p. 999.

Heady and others also found that:

> .... as the interest rate goes above the common rates, it is this group (farmers with lower equity and less capital) which appear unresponsive to changes in the interest rate.

Relatively high interest rates fixed by the monetary authorities are probably irrelevant for many low capital farmers. They have many investment opportunities in which the expected return is extremely high. Low interest rates do not seem to induce high capital farmers to borrow more money. Borrowing by these farmers is probably influenced more by internal capital rationing because of risk aversion than by the level of interest rates[22].

Thus, internal capital rationing reflects the risk aversion attitude of the farmer. However, a farmer with a strong equity position can withstand losses for a few years and recover them in other years. He can 'take greater chances' than a farmer who has a smaller equity ratio and who is liable to go bankrupt following one major crop failure. A farmer with a smaller equity, therefore, plans his farm production and investment more conservatively. He follows a plan for his main enterprise which assures him a minimum income level each year. However, he may use a few resources in a risky enterprise since he has little to lose and 'if everything goes well' may make a substantial profit.

(6) Miscellaneous Adjustments

In addition to the above implications of crop yield instability for the farm business, there are various other farming adjustments made by the farmers during growth years or unfavourable crop years. A study by Skrabanek,

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[22]Heady, Hildreth and Dean, *Ibid.*, pp. 1005-1006.

Banks and Bowles[23] summarises the following farming adjustments made during the drought years of 1950-58 in Texas County:

(a) Decline in the number of farms.

(b) Percentage increase in the number of older farmers.

(c) Increase in the size of farm.

(d) Increase in the livestock sales[24].

(e) Changes in the land use pattern.

(f) Decline in the acres of crop harvested.

Thus, the farm business as a whole, as one can easily envisage, is replete with the problems of crop yield instability. The nature of these problems ranges from being theoretical on one side to methodological and empirical on the other. The field is not purely economic in nature, it involves, as well sociological and psychological attitudes of individual farmers.

The problem of crop yield variability is one of the long-run as well as the short-run. The problem is one of finding means to reduce the unpredictable manner in which low crop yields alternate with high yields. However, the present investigation concentrates on short-run problems, that is, one or two crop years.

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[23] R.L. Skrabanek, Vera J. Banks and Gladys K. Bowles, Farmers Adjustments to Drouth In a Texas County, (Texas Agricultural Experiment Station, College Station, Texas, Bulletin B. 1005, January 1964) pp. 3-28.

[24] See for example, Roger H. Willsie, Why Farmers Sold Out In Central Nebraska In 1956-57, (University of Nebraska College of Agriculture, Linclon, Nebraska, The Agriculture Experiment Station, Research Bulletin SB 445) pp. 8-9.

The problematic situation, as described above indicates the following questions where empirical research should be undertaken:

1. What is the 'maintenance limit' on the farm and how does the farmer manage to maintain the farm and the firm expenses under extreme weather risks?
2. How vulnerable are farmers to the extreme weather risks?
3. If the farm income does not cover the maintenance limit what actions does the farmer take to achieve the 'maintenance limit'?

Research on crop yield instability can, therefore, be very helpful for public policy formulation. It can be used to devise the most suitable measure to be adopted in the event of crop losses in years when the farm income is below certain specified 'maintenance levels'. It can facilitate the comparison of the role of crop insurance and diversification in stabilizing farm income in the event of crop failure. It can also tell the nature of adjustments to be adopted by the farmer in maintaining a level of farm income which will cover at least farm and family expenses.

The present study pertains to the Carman district of Manitoba for the period 1957-64. But to study the impact of crop yield instability on the farm business, 1960 and 1961 crop years were selected. A severe drought occurred in 1961 and the year of 1960 was free from weather hazards. The net incomes obtained from various crop and livestock enterprises during 1961 were compared with the 1960 incomes. Thus, in analysing the impact of variable crop yields, the 1960 year was taken as the basis of comparison. The study has been confined to the micro level. However, it has important implications at the macro level as well. The macro level relationships have been indicated at pertinent places.

CHAPTER III

THE THEORETICAL BACKGROUND

Definitions and Discussions on Risk and Uncertainty

The static theory of the firm gives no consideration as to time or date, changes in technology, preferences, assets distribution and the institutional framework since they are assumed constant. The firm operates with perfect knowledge of the future and prices of the farm products are assumed to be known with certainty. Once these unrealistic assumptions are dropped, marginal cost and marginal revenue are not necessarily equal and the profits of the firm becomes risky or uncertain. Under imperfect knowledge of the future, the entrepreneur will face the problems of error in decisions and planning. The decisions about the allocation of farm or firm resources are based on only an estimated future and thus decision-making takes place in an environment of uncertainty.

Many economists like Hicks, Hardy, D. Gale Johnson and Arrow do not make a distinction between the terms risk and uncertainty. Farmers also use these two terms synonymously and for them any event leading to losses is a risk. However, a distinction can be made between these two concepts and each has different implications for the allocation and use of farm resources. It was Knight's[1] contention that 'changes as such can not upset the competitive adjustment if the law of change is known and an unpredictable change will similarly be ineffective if the chance of its occurrence can be measured

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[1]F.H. Knight: Risk, Uncertainty and Profit, (Houghton Mifflin Co., New York, 1957) Chapter II.

in any way'.

Risk

Risk can be defined as an outcome which can be measured empirically or in a quantitative manner. Webster's dictionary defines risk as the possibility of loss or danger. The year-to-year crop yield variability on a single farm associated with weather fluctuations may be classed as risk if: (a) climate is highly stable, (b) small random variations occur from year-to-year, and (c) the complete range of yield outcomes is repeated frequently enough that the farmer operator can establish the mean or model outcome and the range (variance) of outcomes[2].

In considering the theory of production under non-static conditions, Tintner claims that production process involves time and thus is based on anticipations. He also regards these anticipations as single valued or merely probable, and describes risk as follows: "If the probability distribution of the expectations is considered to be known with certainty (probability one), we will talk of subjective risk"[3].

Hart like Tintner defines risk in the following terms: "Risk is taken to denote the holding of anticipations which are not 'single valued', but constitute a probability distribution having known parameters"[4].

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[2]E.O. Heady, Economics of Agricultural Production and Resource Use, (Prentice-Hall, Inc., Englewood, N.J., 1961) p. 441.

[3]G. Tintner, "A Contribution to the Nonstatic Theory of Production", Studies in Mathematical Economics and Econometrics, (The University of Chicago Press, Chicago, 1942) p. 92.

[4]A.G. Hart, Studies in Mathematical Economics and Econometrics, op. cit., p. 110.

Though any future event whose outcome is not certain involves either risk or uncertainty, the anticipated outcome takes the form of a probability distribution of possible outcomes. Where the parameters of this probability distribution are known, the situation is one of risk. The term risk is often used to denote the variability of yield, price or other outcomes which are predictable in an empirical manner. Thus, measures of dispersion (mean, standard deviation, etc.) can be applied and extent and nature of risk can be predicted empirically.

Luce and Raiffa define risk as:

> We shall say that we are in the realm of decision-making under risk if each action leads to one of a set of possible specific outcomes (the words, prospect, stimulus, alternative, etc. are also used), each outcome occurring with a known probability[5].

Thus, Luce and Raiffa also agree with Tintner and Hart in the concept of risk. Professor Knight describes risk in the following words: "The word 'risk' is ordinarily used in a loose way to refer to any sort of uncertainty viewed from the standpoint of the unfavourable contingency .... We speak of the 'risk' of a loss"[6].

Also according to Knight, in case of 'objective' risk, the distribution of the outcome in a group of instances is known (either through calculation *a priori* or from statistics of past experience). Tintner, on the other hand, states that 'subjective' risk can be described by assuming that the individual has perfect knowledge of the technical and technological

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[5]R.D. Luce and H. Raiffa, *Games and Decisions*, (New York, John Wiley and Sons Inc., 1957) p. 13.

[6]Knight, *op. cit.*, p. 233.

conditions of production[7].

Pure risk involves accurate knowlege of future events, and can be incorporated into the firm's cost schedule. Risk can also be included in the cost schedule of the farm business where the number of cases is not large enough for making prediction of loss on the single farm. "The probability of loss of a barn through fire often is in the nature of 'uncertainty' for a single farm, since the probability that a barn on a particular farm will or will not burn cannot be predicted with an empirical probability of 1.0"[8]. But the insurance companies who have policies on a great number of barns, can establish the probability of losses over the complete number of farms. Thus, for an individual farmer, the probability of an outcome is uncertainty, but for insurance firms it is risk and the farmer can transform his uncertainty into risk by paying risk premium which becomes a part of the cost of production.

The Encyclopaedia of the Social Sciences defines risk in the following terms:

> It is a commonplace that life in its aspect of action involves a liability to error. This liability, interpreted to include the occurrence of results entirely unforeseen as well as those imperfectly allowed for, is ordinarily expressed by the remark, that men take risks. The sources or kinds of error are numerous and difficult to classify. Sense perception itself is presumably more or less inaccurate nor does the individual know accurately his ends. But the more important errors arise from the fact that virtually all

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[7] G. Tintner, "The Theory of Production Under Nonstatic Conditions", (The Journal of Political Economy, Vol. L, October 1942, No. 5) p. 647.

[8] Heady, Ibid., p. 442.

behaviour look to the future and from the notorious difficulty and uncertainty of prediction. This has a particular bearing on economic theory, because the generalizations of theory relate to the conduct which completely achieves an intended aim ....

In a highly changeable or "dynamic" society the most unpredictable element in the situation, or the greatest risk, has to do with price changes rather than with the physical results of production. In some industries, agriculture above all, the unpredictability of the course of nature introduces serious technological risks. Such risks, however, tend to cancel out in the course of time or can be largely eliminated by some form of insurance. Risks of price changes arise from three main sources, changes in attitudes of consumers, changes in the supply of the commodity in consequence of the behaviour of "other" producers, and a miscellaneous, practically unlimited list of contingencies in other industries, which may act through either the tastes or the incomes of consumers. All such risks tend to increase in importance, some very rapidly, with the economic advancement of the society. Risk is a phenomena of change, and progress, which is cumulative change, makes economic society more subject to capricious fluctuations. Technological advance is inherently unpredictable, since anticipating a particular invention would mean making the invention itself, and programs alone, in so far as it follows a regular trend, does not create risk ....

Economic risks or contingencies impinge on the producer in an enterprise economy in consequence of the characteristic fact that entrepreneurs competitively undertake, first, to produce goods in anticipation of demand rather than upon order and, secondly to pay the labourers and property owners, who supply productive resources at fixed rates regardless of either the amount or the value of the product—although in practice there are many exceptions to both these conditions .... If production were carried out only on orders from responsible consumers, the risk of change of wants and the resultant loss in readapting production would naturally fall on the consumers themselves .... Natural contingencies will always cause loss to someone, although the "risks" to the individual may be reduced by grouping under the principle of insurance, and new inventions will in any system destroy much individual productive capacity .... Operation of an entire economic society as a single unit would also serve to eliminate risks in the ultimate degree possible through cancellation or reduction to uniformity through the law of large numbers[9].

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[9]F.H. Knight, The Encyclopaedia of the Social Sciences, (Vol. 13, July 1934) pp. 392-394.

Johnson[10] states risk as a phenomena which denotes the attitudes of entrepreneurs towards the gains or losses of income and capital values which arise from favourable or unfavourable possible contingencies. He also defines "risk aversion" as an attitude of distaste or dislike for an activity in which large losses are frequent and large gains are also possible. "Risk neutrality" in Johnson's world is an indifferent attitude of individual for the mixture of pleasant or unpleasant occurrences.

The major risks affecting agriculture has been classified in detail by Ray[11] and are produced in Figure 1.

Uncertainty

In contrast to risk, the probability of an event occuring cannot be predicted in an empirical manner for uncertainty and thus the parameters of the probability distribution (the mean, variance, etc.) cannot be determined. Therefore, the nature of uncertainty is purely 'subjective' and the future outcome can only be 'anticipated' by the individual. To Professor Knight the term 'uncertainty' refers to the unfavourable outcome and in case of uncertainty it is impossible to form a group of instances, since the situation dealt with is in a high degree unique[12]. Luce and Raiffa define uncertainty as a set of possible specific

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[10] D.G. Johnson, Forward Prices for Agriculture, (The University of Chicago Press, Chicago, Illinois, 1947) vide footnote p. 38.

[11] P.K. Ray, Principles and Practices of Agricultural Insurance, (Bookland Private Limited, 1 Sankar Ghosh Lane, Calcutta, India, 1958) p. 22.

[12] Knight, Ibid., p. 233.

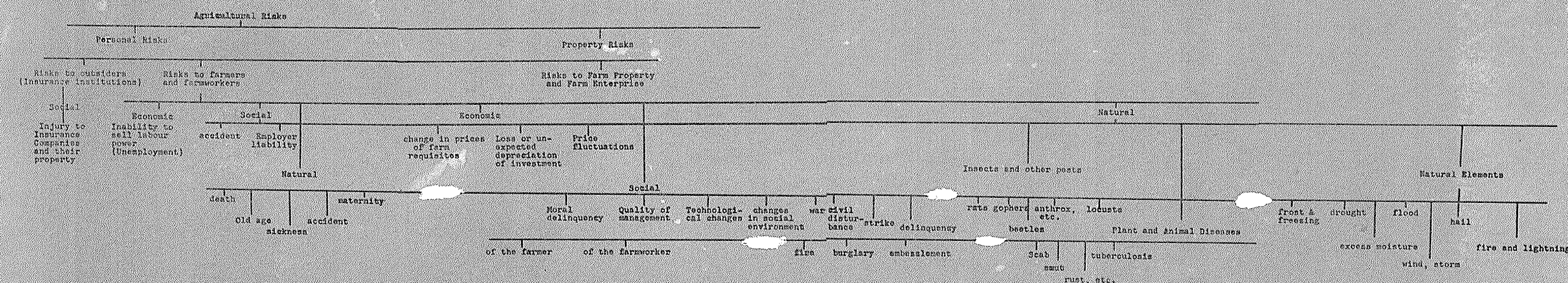

FIGURE 1

AGRICULTURAL RISKS

outcomes, where the probabilities of these outcomes are completely unknown or are not even meaningful[13]. According to Hart "uncertainty" is taken to denote the holding of anticipations under which the parameters of the probability distribution are themselves not single valued[14]. Like Knight, Tintner also defines "subjective uncertainty" as follows:

> If the probability distribution of the anticipations is not itself known definitely but only anticipated again with a certain likelihood, we will talk about subjective uncertainty[15].

Coase[16] while discussing the nature of the firm claims that the firm would not emerge without the existence of uncertainty. Professor Knight starts with a system without uncertainty:

> acting as individuals under absolute freedom but without collusion men are supposed to have organized economic life, with the primary and secondary division of labour, the use of capital etc. developed to the point familiar in present day America .... With uncertainty entirely absent, every individual being in possession of perfect knowledge of the situation there would be no occasion for anything of the nature of responsible management or control of productive activity. Even marketing transactions in any realistic sense would not be found. The flow of raw materials and productive services to the consumer would be entirely automatic.

Professor Knight continues:

> with the introduction of uncertainty the fact of ignorance

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13 Luce and Raiffa, _op. cit._, p. 13.

14 Hart, _op. cit._, p. 110.

15 G. Tintner, _A Contribution to the Nonstatic Theory of Production_, _op. cit._, p. 92.

16 See for example R.H. Coase, "The Nature of the Firm", _Economica_, (November 1937, Vol. 6, No. 16) pp. 386-405.

> and the necessity of acting upon opinion rather than knowledge—into this Eden-like situation, its character is entirely changed ....with uncertainty present doing things, the actual execution of activity, becomes in a real sense a secondary part of life, the primary problem or function is deciding what to do and how to do it.

This fact of uncertainty brings about the two most important characteristics of social organization.

> In the first place, goods are produced for a market, on the basis of entirely impersonal prediction of wants, not for the satisfaction of the wants of the producers themselves. The producer takes the responsibility of forecasting the consumers' wants. In the second place, the work of forecasting and at the same time a large part of the technological direction and control of production are still further concentrated upon a very narrow class of the producers, and we meet with a new economic functionary, the entrepreneur.... When uncertainty is present and the task of deciding what to do and how to do it takes the ascendancy over that of execution the enternal organization of the productive groups is no longer a matter of indifference or a mechanical detail. Centralization of this deciding and controlling function is imperative, a process of "cephalization" is inevitable.

The most fundamental change is:

> The system under which the confident and venturesome assume the risk or insure the doubtful and timid by guaranteeing to the latter a specified income in return for an assignment of the actual results....with human nature as we know it would be impracticable or very unusual for one man to guarantee to another a definite result of the latter's action without being given power to direct his work. And on the other hand the second party would not place himself under the direction of the first without such a guarantee.... The result of this manifold specialization of function is the enterprise and wage system of industry. Its existance in the world is the direct result of the fact of uncertainty.[17]

These quotations give the essence of Professor Knight's theory. The presence of uncertainty means that people have to forecast future wants. This creates a special class of people who direct the activities of others and to whom people give guaranteed wages in the form of the insurance premiums.

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[17]Knight, Ibid., vide pp. 399-400.

Barber[18] and Boucher[19] have used the terms risk and uncertainty synonymously. However, to Knight risk refers to variability which is measurable in a quantitative manner, and, uncertainty refers to the outcome whose probability cannot be established in an empirical sense.

Boulding also makes a distinction between risk and uncertainty quite similar to that of Knight. He states:

> Risk is insurable, uncertainty not. Risk, that is to say can be expressed in terms of a given probability, in uncertainty not only the value of our assets is in doubt, but we cannot even state the probability of the various possible values. This distinction arises because some events, although uncertain in themselves, are members of large family or universe of like events .... It is the existence of a universe of like cases which makes insurance possible....[20]

While defining uncertainty as a game of chance Marschak[21] assumes that an individual knows the probabilities of future events. The preference or aversion to uncertainty, reflects the preference for "insecurity feeling". Thus, Marschak's concept of uncertainty is similar to Knight's concept of insurable risk and insurable uncertainty.

Johnson argues that:

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[18] E.L. Barber, "Production Risks of the Individual Farmer, With Particular Reference to Weather Risks", (Agricultural Finance Review, Vol. 10, November 1947) pp. 47-54.

[19] G.P. Boucher, "Risk and Uncertainty in Agricultural Entrepreneurship", (The Economic Analist, Vol. 18, No. 4, November 1948).

[20] K.E. Boulding, A Reconstruction of Economics, (John Wiley and Sons, Inc., New York, 1950) p. 133.

[21] J. Marschak, "Money and the Theory of Assets", (Econometrica, Vol. 6, October 1938) pp. 320-321.

> The term "uncertainty" is used in a very broad sense to include all circumstances in which decisions must be made without perfect knowledge of significant future events. Significant events are all occurrence which if foreseen perfectly would have influenced the particular decision. Uncertainty will exist if expectations of future prices, yields, or capital allowances are not single valued i.e., if some range of results is considered possible by the entrepreneur.[22]

In conclusion the term uncertainty refers to future outcomes where the probability distribution parameters cannot be determined empirically. The entrepreneur can anticipate the future but there is no way of assembling enough homogeneous observations to predict the relevant probability distribution. While subjective probabilities may be assigned to these anticipations, no method exists by which actual numerical values may be assigned.[23] Unlike risk, uncertainty cannot be reduced to a cost and, thus, is not insurable. Broadly the term uncertainty can be used to include all circumstances in which decisions are to be made under imperfect knowledge about future outcomes.

In the light of the above discussion on the terms risk and uncertainty crop yield instability or variability as used in this study may be classed as both risk as well as uncertainty. Under imperfect knowledge about the future outcome, instability is an uncertainty to the farmer. But the outcome which is an uncertainty to the farmer, may be risk to the insurance institution if it can predict aggregate outcome with some certainty. From the farmer's point of view, instability is a measure of the tendency for

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[22]Johnson, Ibid., p. 38.

[23]Heady, op. cit., p. 443.

yields to fall close to, or far from, the average. Different measures of instability or variability like standard deviation and coefficient of variation are useful to a farmer who is interested in knowing not only his average yield, but how often his yields have been above or below this level.

The Theory and The Economic Model Used

Valid criteria for the efficient resource use can be expounded in three types of relationships (factor-product, factor-factor, and product-product) in the sphere of production with the help of the theory of the firm. The present study is explicitly concerned with the product-product relationship, since the other two types of relationships are implicit in the model used.

(i) Inefficient Resource Use in the Factor-Product Relationship:

The concept of inefficiency of resource use can be understood by graphic representation of a single input-output relationship. This is shown in Figure 2. The classical production function considers ranges of increasing, decreasing, and negative marginal returns. This is based on the Law of Variable Proportions.[24] The total product curve shows the three stages of production, increasing, decreasing and negative marginal returns. Any level of resource use falling in the first and third stages is irrational, whereas the resource use in the second stage is rational. In the first stage it is always possible to obtain more product, say wheat, from the same amount of the variable input, fertilizer, by rearranging the combination of fixed and

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[24] See for details: P.A. Samuelson, Economics an Introductory Analysis, (McGraw-Hill Book Co., Toronto, 1961) p. 26; J.M. Cassels, "On the Law of Variable Proportions", Reprinted in Readings in the Theory of Income Distribution, (The Blakiston Co., Philadelphia, 1946) pp. 103-118, and J. Robinson, The Economics of Imperfect Competition, (MacMillan & Co., London, 1961) in the appendix p. 330.

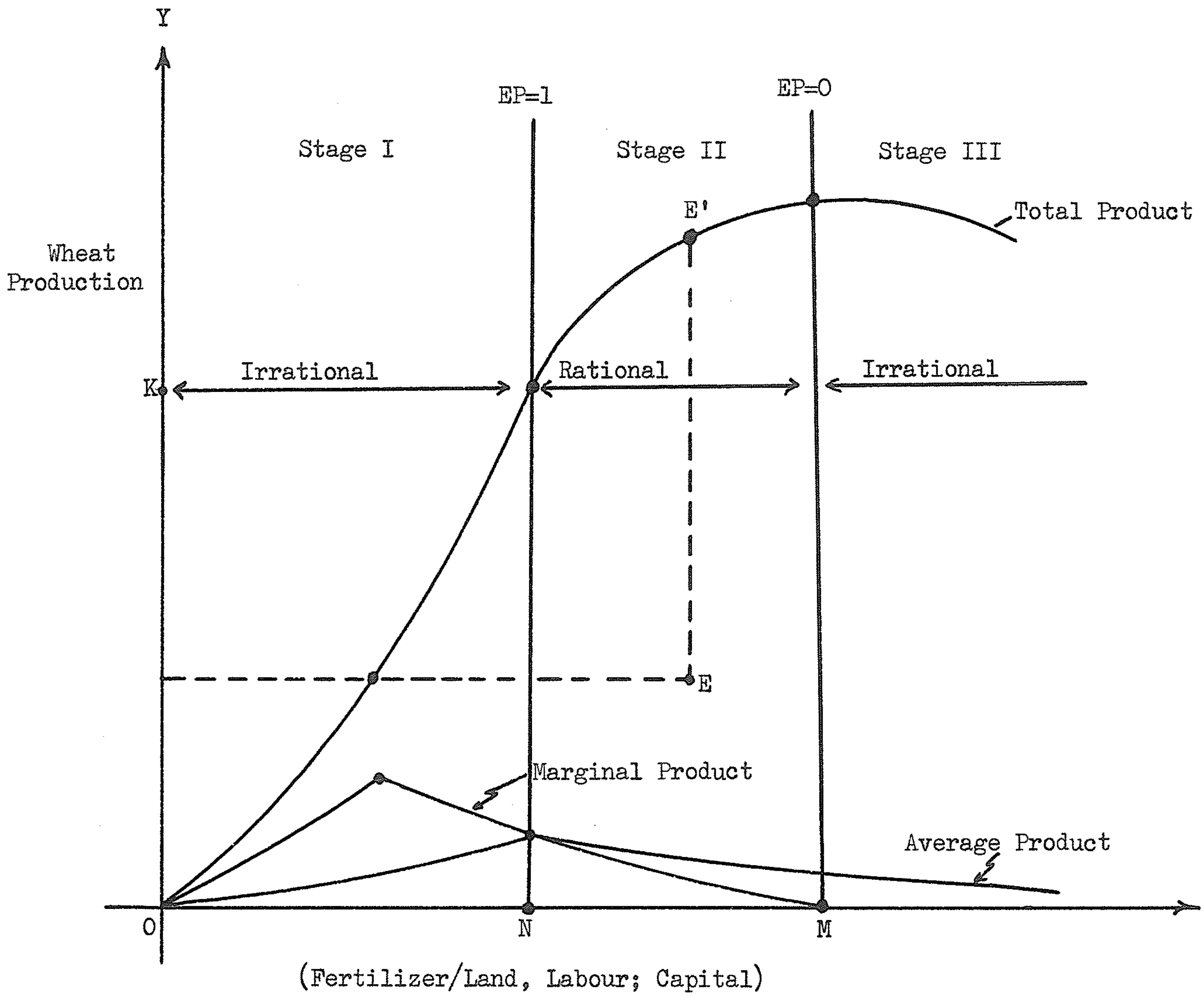

FIGURE 2

STAGES OF PRODUCTION AND RATIONAL RESOURCE USE variable factors. In stage three, it is always possible to withdraw the fertilizer from use in order to get increased total wheat production.

In the case of irrational production, knowledge of price relationships is not necessary. The use of the farm resources is inefficient when they can be recombined to give more product from the same resource or the same product with fewer resources. In addition to the technically inefficient production within the first and third stages, there is another type of irrational or technically inefficient production. Some farmers may follow an inefficient technique of production, if they persist in using an old technique, though their neighbours have adopted a technique which can produce more with the same resource use. This type of inefficient production is represented by such points as E along a production function for that technique in Figure 2.

Heady lists the following reasons of the continuance of technically inefficient agricultural production.[25]

(a) Discontinuous use of fixed resource inputs such as tractors, machines, etc.

(b) Unavailability or unsubstitutability of the desired resources.

(c) Lack or sufficient knowledge about using resources.

(d) Uncertainty of production and prices, and capital rationing.

In Manitoba and particularly in the Carman district, the last two seem to be the main reasons for technical inefficiency.[26] In dealing with

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[25]Heady, op. cit., pp. 90-96.

[26]J.C. Gilson and M.H. Yeh, Productivity of Farm Resources in the Carman Area of Manitoba, (Tech. Bull. No. 1, September, 1959, Faculty of

the problems of uncertainty, due allowance should be made for an uncertainty discount while arriving at a conclusion of increasing farm income which would assume that farmers have perfect knowledge and follow agriculture techniques that are technically efficient.

(ii) Ineefficient Resource Use in the Factor-Factor Relationship

In the factor-factor relationship, the irrational ranges of production are those where a greater physical output can be obtained by the given amount of resources or lesser resources can be used for producing a certain amount of product. This can be graphically shown in Figure 3.

Irrational resource combinations are those segments of the product contour I Q, which are other than the segment a b. In the segment a b, land and labor are technically competitive to each other. The state of the general economy of the region and the social values are very closely connected with the problem of technical inefficiency in the factor-factor relationship in agriculture. In Manitoba, opportunities for off-farm employment are adequate for the farm families, but farm workers may not like to find employment outside the farm on account of low wages or their liking for farm work. This emotional attachment of the farm worker to the land may result in surplus labor in farms[27] and technical inefficiency.

Agriculture and Home Economics, University of Manitoba); M.H. Yeh and L.D. Black, Weather Cycles and Crop Predictions, (Tech. Bull. No. 8, November 1964, Faculty of Agriculture and Home Economics, University of Manitoba).

[27] L. Auer, Productivity of Resources on Farms in the Newdale-Hamiota Area of Manitoba (Unpublished Master's thesis, April 1959, Faculty of Graduate Studies and Research, University of Manitoba). Also see; L.K. Li, A Market for Hired and Family Labor in Canadian Agriculture (Unpublished Master's thesis, August 1965, Faculty of Graduate Studies and Research, University of Manitoba).

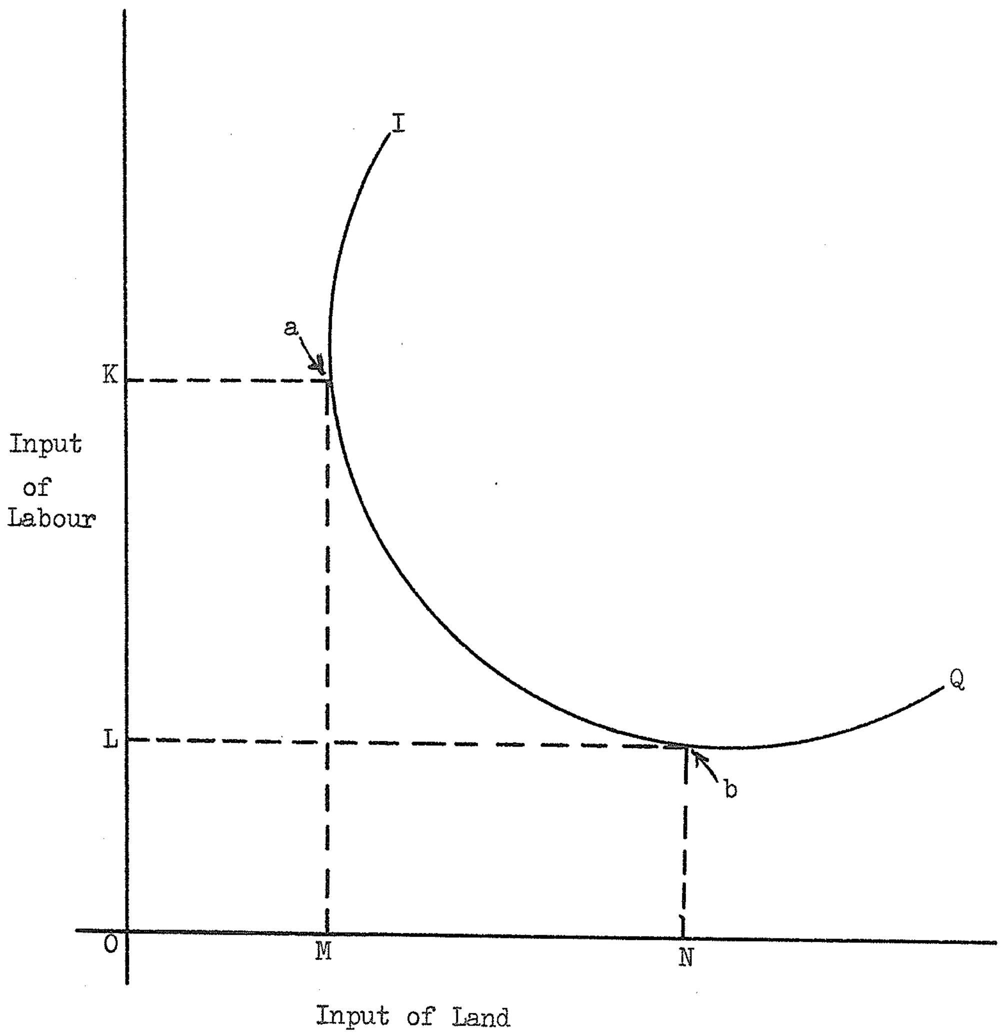

FIGURE 3

AREAS OF IRRATIONAL RESOURCE COMBINATION

(iii) Inefficient Resource Use in the Product-Product Relationship

Irrational areas of resource use also exist under product-product relationships. This is shown in Figure 4. The irrational area of the production possibility curve is that portion which has a positive slope. This is the complementary range and is shown by a b and c d segments of the opportunity curve a d. Under the complementary relationships, it is always possible to rearrange the given resources to increase the output of both products.

Irrational resource use can also arise under competitive or supplementary product relationships. This again refers to the selection of techniques which do not show product combinations on the boundary of the production opportunity curve. Any technique which uses the same quantity of resources but produces the product combination which falls within the area bound by the production opportunity curve is an inefficient technique of production. The difference between the optimum income obtained by reorganizing product combinations to maximize profits with the available resource supplies, and the actual income obtained by the farmers will show the inefficiency of the product combinations used by the farmers.

Economic Efficiency and Firm-Household Relationship

Having decided upon the technical efficiency, the economic efficiency may now be considered. Economic efficiency is denoted when resources are used in a manner to maximize the particular objective or end quantity which is relevant to the economic unit under consideration.[28] While the techniques

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[28] Heady, *Ibid.*, p. 98.

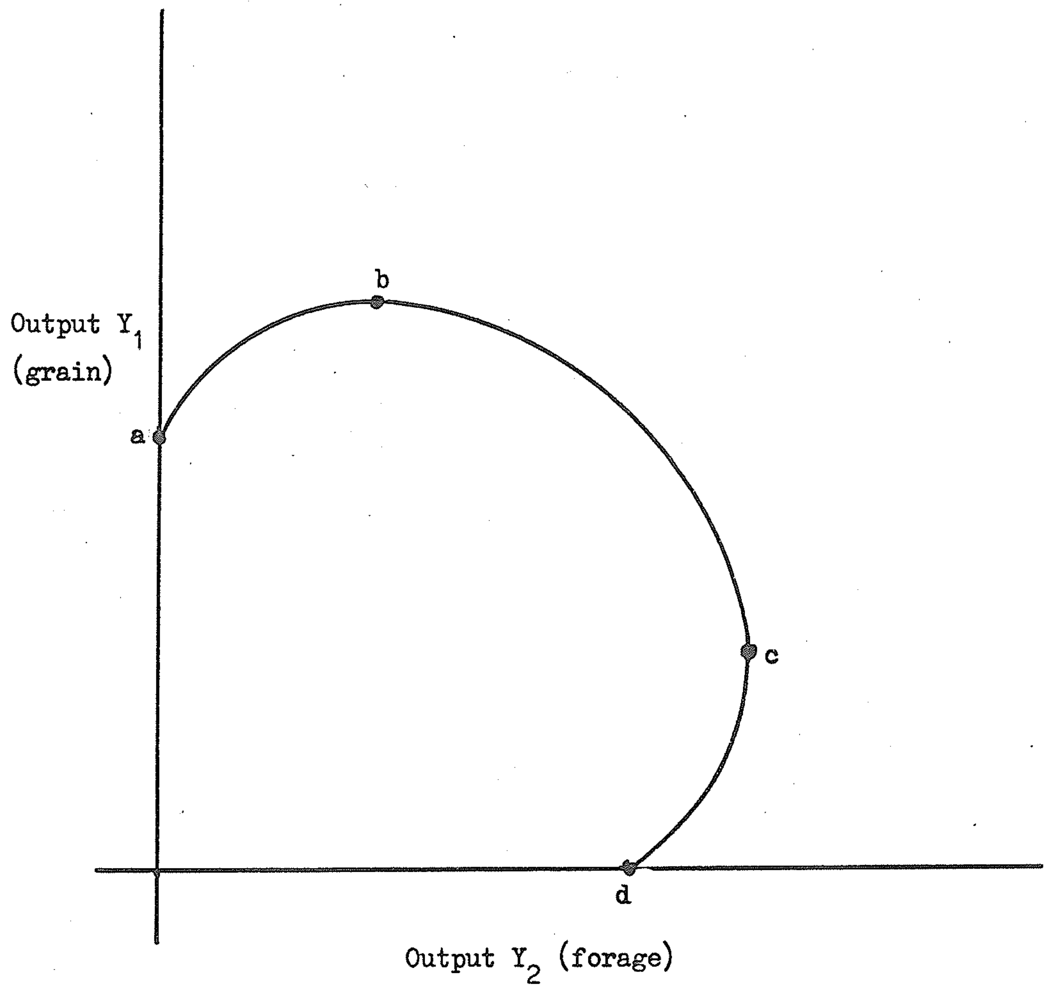

FIGURE 4

COMPLEMENTARY-COMPETITIVE PRODUCTION POSSIBILITIES used in this study consider a farm to be a pure firm, there are important difficulties in treating farms as economic phenomena with such simple characteristics as simple classical theory supposes. They include a joint relationship between the farm business and the family household. The farm family is a combination of a production and consumption unit. For the study of the behavioural aspect of such farm families, the economic models imposing only profit maximizing criteria as the objective, cannot adequately serve. Such farm families may have as their objective the maximization of satisfaction levels or utility which cannot be the nature of the institutions specified by profit realization alone. The attainment of the 'maintenance limit', discussed later, may be a minor but essential objective of the farm families who are faced with farm production uncertainty. The resource use pattern is then guided by this objective. The resource use pattern which seems irrational or inefficient from the point of view of economic efficiency may be quite 'rational'.

Uncertainty and Dynamic Planning of the Farm Firm

In the dynamic planning of the firm, uncertainty of prices and production is a frequent phenomena.[29] To meet these uncertainties, A.G. Hart argues that the business planning preserves the flexibility of prices, production and cost.[30] The flexibility of cost of production in the planning of the farm

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[29] A degree of uncertainty and a need for flexibility exist in the short-run, of course. The point is that uncertainty is magnified many times in the long-run and the needs for flexibility are adjusted to this uncertainty. The given short-run plant either is or is not flexible in varying degree.

[30] Anticipations, Uncertainty and Dynamic Planning (Studies in Business Administration, Vol II, No. 1, The University of Chicago Press, Chicago, 1940),

business is more important than the farm prices. The farmer can control only cost since the farm prices and output are beyond his control. When the farmer changes cost of production in the dynamic planning of his business and is faced with the uncertainty of prices and production, two opinions are commonly held: (a) that devices for meeting uncertainty lower profit expectations, the farmer must be concerned about the higher moments of the profit distribution and (b) that to find a theoretical role for the higher moments of estimate distributions we must suppose the farmer to be concerned about the higher moments of the profit distribution.

Current economic analysis of economic behaviour relies heavily on decisions made by rational units customarily assumed to be seeking perfectly optimal situations.[31] Two criteria are well known—profit maximization and utility maximization.[32] According to these criteria, appropriate types of action are indicated by stating marginal inequalities or by drawing marginal curves[33] which, if satisfied, yield an optimum. But the standard qualifica-

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and "Risk, Uncertainty and the Unprofitability of Compounding Probabilities", Studies in Mathematical Economics and Econometrics, (University of Chicago Press, Chicago, 1942) pp. 110-118.

[31] See for example, J. Robinson, Economics of Imperfect Competition, (MacMillan & Co. Ltd., London, 1964) p. 6, for a strong statement of the necessity of such optimal behaviour. Standard textbooks expound essentially the same idea. See also S. Carlson, A Study on the Pure Theory of Production (P.S. King & Son Ltd., London, 1939), P.A. Samuelson, Foundations of Economic Analysis (Harvard University Press, Cambridge, 1948) and R.H. Leftwich, The Price System and Resource Allocation (Holt, Rinehart & Winston, Toronto, 1964).

[32] Only profit maximization is discussed here, although everything said is applicable equally to utility maximization by consumers.

[33] See pp. 46-51.

tion usually added is that nobody is able really to optimize his situation according to these diagrams and concepts because of uncertainty about the position.[34] Nevertheless, interpretations and predictions of the decisions of individuals are made in terms of these diagrams, since it is alleged that individuals use these concepts implicitly, if not explicitly.

This methodology has been attacked more severly by G. Tintner.[35] He denies that profit maximization even makes any sense where there is uncertainty. Uncertainty arises from at least two sources: imperfect foresight and human inability to solve complex problems containing a host of variables even when an optimum is definable. Under uncertainty, by definition, each action that may be chosen is identified with a distribution of potential outcomes, not with a unique outcome. Also each possible action has a distribution of potential outcomes, only one of which will materialize if the action is taken, and that one outcome cannot be foreseen. Essentially, the task is converted into making a decision (selecting an action) whose potential outcome distribution is preferable, that is, choosing the action with the optimum distribution, since there is no such thing as a maximizing distribution.[36]

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[34]See pp. 39-45.

[35]"The Theory of Choice Under Subjective Risk and Uncertainty", Econometrica, (Vol. 9, 1941) pp. 298-304, "The Pure Theory of Production Under Technological Risk and Uncertainty", Ibid., pp. 305-311, and "A Contribution to the Nonstatic Theory of Production", Studies in Mathematical Economics and Econometrics, Ibid., pp. 92-109.

[36]A.A. Alchian, "Uncertainty, Evolution, and Economic Theory", (The Journal of Political Economy, No. 3, June 1950) p. 212.

In brief the profit maximization assumption of the classical theory does not hold true where there is uncertainty of prices or production. However, the profit maximization assumption may be used in a theoretical model dealing with uncertainty and dynamic planning of the farm firm. In this model—a realized outcome which is the largest that could have been realized from the available actions—is perfectly consistent with the profit maximization—a criterion for selecting among alternative lines of action, the potential outcomes of which are describable only as distributions and not as unique amounts.

A mathematical treatment can be given to the theoretical model which deals with price and output uncertainty or with the cost flexibility. This model does not assume profit maximization as the sole aim of the farmer but makes use of this assumption in the dynamic planning of the farm.

Suppose the farmer is planning to produce a commodity Q, to be sold in two intervals of time by the end of period t_2. He plans to use an input X, applied immediately and an input Y, to be applied at an intermediate date t_1. Assume that prices of these inputs are certain and they both can be made unity by adopting suitable units. The price of output is uncertain: at t_0 the farmer recognizes n possible prices, $P_1, P_2, P_3, - - - -, P_n$, with likelihoods, of $K_1, K_2, K_3, - - - -, K_n$ respectively. He expects that before date t_1 some one of these prices (he does not know which) will become certain. Input and output are bound together by a production function $Q = \phi(X,Y)$.

To begin with, assume that on the basis of a priori knowledge the farmer expects a poor crop year which makes it necessary to contract in advance use of both the inputs. In this case if the price is P_j, the profit, will be, $\pi_j = P_j \cdot \phi(X,Y) - X - Y$ since P_x and P_y equal one by assumption. If the farmer wishes to maximize his expectation of profit, we have,

$$E(\pi) = \sum_{j=1}^{j=n} K_j \left[P_j \cdot \phi(X,Y) - P_x X - P_y Y\right] \quad (1)$$

$$= \sum_{j=1}^{j=n} (K_j P_j)\, \phi(X,Y) - P_x X - P_y Y = \text{maximum}.$$

If we call the price expectation, $\Sigma K_j P_j$, $E(P)$, the farmer should behave as though a price of $E(P)$ were certain. The solution is found by setting the partial derivatives equal to zero. That is by using the profit maximization principle. Then,

$$E(\pi) = \sum_{j=1}^{j=n} (K_j P_j)\, \phi(X,Y) - X - Y$$

$$\frac{\partial\, [E(\pi)]}{\partial X} = \sum_{j=1}^{j=n} K_j P_j \cdot \frac{\partial \phi(X,Y)}{\partial X} - \frac{\partial X}{\partial X} = 0$$

$$= \sum_{j=1}^{j=n} K_j P_j \cdot \frac{\partial \phi(X,Y)}{\partial X} = 1$$

$$\text{Similarly} \quad \sum_{j=1}^{j=n} K_j P_j \cdot \frac{\partial \phi(X,Y)}{\partial Y} = 1 \quad (2)$$

Equations (2) will yield optimum solutions for the inputs X and Y; and given X, Y, Q and E(P) the profit expectations is determined.

Suppose now that the farmer wants to postpone his decision on the input $\bar{Y}$ until the price of Q has been ascertained. He may fix input X provisionally at a level X_m. He may still, however, vary input Y and output Q. Now for a price P_j, his profit expectation is,

$$\pi_{m,j} = P_j \cdot \phi(X_m, Y) - X_m - Y$$

This may be influenced by his choice of Y; therefore, if he wants the highest expectation (given the price, his initial decision on X, and the production function), he will set

$$\pi_{m,j} = P_j \cdot \phi(X_m, Y) - X_m - Y = \text{maximum} \qquad (3)$$

From this, by differentiation, and setting the partial derivatives equal to zero,

$$P_j \; (\partial\phi/\partial Y) = 1 \qquad (4)$$

This gives a solution for the optimum value of Y, which may be designated as Y*, making Y* explicit, we get,

$$Y^* = \gamma(P_j, P_y) \qquad (5)$$

Having determined Y*, we have by implication determined both the optimum output (Q*) and the corresponding profit (π^*). Both these magnitudes will be increasing functions of P_j and X_m at a constant rate. For a given X_m, we may sum over all possible prices, which gives us,

$$E_m(\pi) = \sum_{j=1}^{j=n} K_j \pi^*_{m,j} = \sum_{j=1}^{j=n} K_j Q^* (P_j, X_m) - X_m - \sum_{j=1}^{j=n} K_j \; Y^* \qquad (6)$$

If the maximum expectation is desired, X_m should be so chosen as to maximize this expression. Setting the partial derivative of E_m (π) with respect to X_m equal to zero, we get,

$$\sum_{j=1}^{j=n} K_j \; (\partial Q^*/\partial X_m) - 1 - \sum_{j=1}^{j=n} K_j \; (\partial Y^*/\partial X) = 0 \qquad (7)$$

Solving this equation will yield an optimum value for X_m, which will depend on the dispersion as well as the expectation value of the price distribution.

The fact that higher moments of the price distribution will enter into the expectation of profits under flexibility is plain in the light of the determination of Q*. Obviously, given X_m, the optimum values Y* and Q* must be positively correlated with price. This implies that the function determining Q* must contain a term or terms involving the price with both coefficient and exponent of the same sign. If both coefficient and exponent are positive then when Q* is multiplied by the price in obtaining the profit expectation the resulting expression will contain some power of P with an exponent greater than unity.

Finally, we may consider the effects of substituting probability distributions with expectation values of P_1, P_2, P_3,- - - -, P_n for the supposed certain price estimates anticipated for t_1. So long as it is impossible to postpone decision on the input Y beyond t_1, there is no effect on the optimum policy either under simultaneous or under successive determination. Furthermore, the expectation of profits under either system of planning will be unaffected. But the variance both of prices and of profits will be increased under both methods, and in the same proportion. Accordingly the fact that estimates are not single valued that is, are uncertain at the date of final decision will affect planning only if a subsidiary goal (the maintenance level of the net farm income) of planning is to hold down the profit dispersion.

The dynamic planning of the firm may also be discussed in terms of the firm's continuing growth over a period of time. Many factors are involved in the growth of the firm. Of these some are exogenous, making themselves felt through increased net income. Others depend on managerial ability while still others affect growth directly by increasing productive capacity. The main factors affecting the firm's growth are:

I <u>Technological Development</u>:

(a) technological innovations such as the introduction of hybrid seed and chemical insecticides.

(b) manager's technical ability to combine resources for production.

(c) manager's experience with the business.

(d) development of managerial and labor skill through education and extension.

(e) introduction of newer and better technology through capital investment.

II <u>Capital Accumulation due to</u>:

(a) increased net income and savings.

(b) ability to secure external debt capital which generally depends on the amount of equity capital possessed by the firm.

There are many legal, political, sociological and other institutional factors that impose restrictions on factor availability and combination to agriculture at large. However, the growth of any farm firm has been and is to-day dependent on its access to technology and its ability to engage in capital accumulation in this institutional context.

In consequence growth in the individual farm can be seen in the changes in net income which are functions of capital on the one hand and time on the other. However, the firm's growth may be affected by some exogenous variables such as weather. Figure 5 considers the firm's growth under three possible situations. In Figure 5a, Y_t traces the increases in net income resulting from capital growth when the weather and other conditions in every time period are realized. This path of the firm's growth may, however, be affected by extremely poor crop years and their resulting low incomes and by very good years when the realized crops give incomes that are above the average expectation. Thus, the probability level for variance around the average level of Y_t is represented by such extremely good and poor crop results. These can be shown as an upper limit Y_{tu} and a lower limit Y_{tl} which might be considered as confidence limits to the path over which growth of the farm business can proceed.

In Figure 5 savings (S_t) are defined as net income (Y_t) minus the necessary living expenses (C_t). In Figure 5a and 5c savings are ploughed back into the firm in the form of investment and net income grows, but in Figure 5b the firm's growth is affected by low realized income due to the bad weather or other unexpected causes and the dissavings that follow from maintaining the consumption level based on the higher expected income.

In Figure 5a, K_0, K_1, K_2 and K_3 represent capital at time periods t_0 to t_3 respectively and it is assumed that:

(1) at every time period t, the net farm income covers the necessary family living expenses.

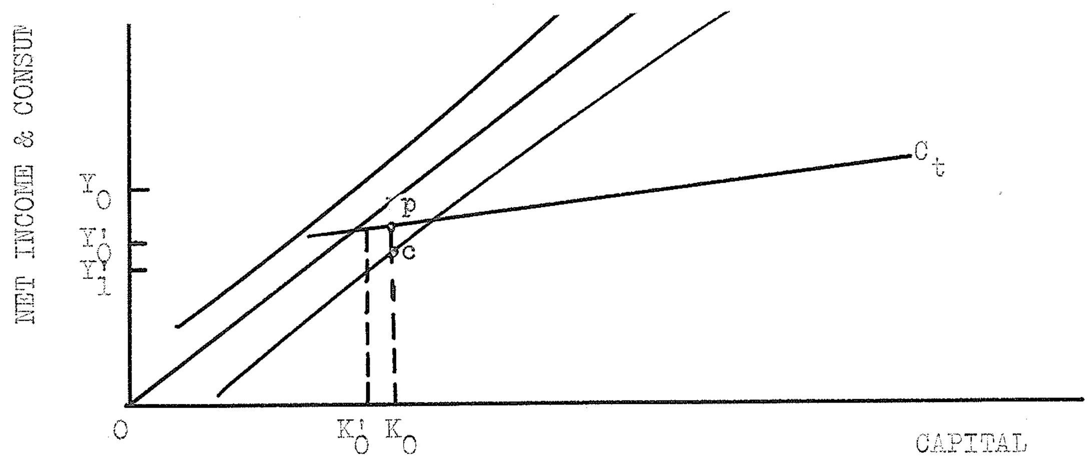
(2) all the net income left over as savings after satisfying the family needs in every time period is used as capital investment in the successive period, that is, $Y_t = f(K_t)$ and $Y_t = C_t + S_t$ and $S_t = Y_t - C_t = I_{t+1} = \Delta K_t$, where, I = investment and ΔK_t = change in capital K at time period t.

(3) while the change in savings between successive time periods can be $\frac{ds}{dt} \gtrless 0$, it must be positive to realize a growing Y_t.

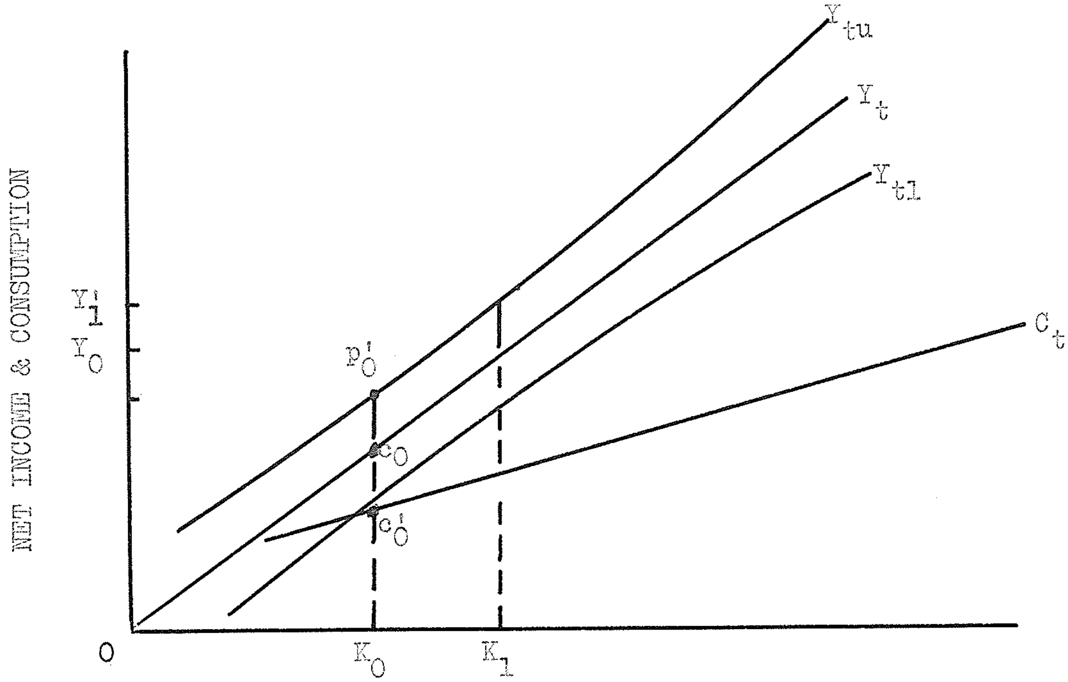
Figure 5a shows the firm's growth when crop yields in every time period turn out to be expected. If the necessary family expenses require c_0K_0 amount of net income in period t_0 when capital OK_0 is the amount of capital invested, the net income saved equals c_0p_0 ($=K_0p_0 - c_0K_0$). This saving when added in period t_1 to the initial stock of capital OK_0 gives a capital stock of OK_1 which is associated with income Y_1. However, should the firm be in a position of investing only OK' capital the net income is Y'. In this case the whole of the income is consumed and nothing is left as savings. Staying at this point means stagnation. For the net income to grow between periods realized savings must be positive. If these are savings in two successive time periods, then those in period t_1 are necessarily greater than savings in period t_0 because it was the savings of period t_0 that helped generate a larger net income in period t_1. If this process continues, the net income saved in every period will be invested in the firm and added to the accumulated investment from previous periods. This growth of net income will continue so long as physical and purchased inputs are available to take up the increments of savings.

In Figure 5b a poor crop year may give net income Y_0' when there is a capital stock of level OK_0 which had been expected to generate Y_0 income. Assuming the family expenses are as shown on the consumption schedule, then this will require dissavings equal to cp which means operating in the next time period on a smaller capital base. Further failures of realized incomes to reach the level of expected income could so decimate capital as to put the farm out of business. Attaining expected income levels on the other hand would permit the realization of capital accumulation and growing incomes.

Figure 5c shows the consequences when realized incomes are above expected yields in one period as a result of exceptional weather conditions for example. If the farmer had invested OK_0 capital in period t_0 and maintained the level of consumption associated with the income Y_0



(b) NET INCOME AS A FUNCTION OF CAPITAL
(Realized Income Less than the Expected)



(c) NET INCOME AS A FUNCTION OF CAPITAL
(Realized Income Greater than Expected)

FIGURE 5: NET INCOME AS A FUNCTION OF CAPITAL
(Realized and Expected Incomes)

expected from that level of capital, he will find himself with savings equal to $c_0' p_0'$ in period t_0 which is $c_0 p_0'$ more than was expected. These savings will be invested in period t_1 along with OK_0, the amount of capital available. Thus, investment OK_1 generates income OY_1' in time period t_1.

In the above models the implicit conditions for a net income to grow over time are that savings and return to capital investment in every time period be greater than zero. In other words, the production should be carried on within the first and second stages of the production function.* Thus, assuming that the farmer wants savings in any time period which will permit greater income to the farm business after satisfying the family living expenses in time period t, allocation of resources within the first and second stages of the production function would accumulate capital over a period of time. As the stock of capital accumulates by this process its increasing magnitude offers a cushion that may absorb weather risks more readily in successive time periods.

The growth of net income over time on a farm may not necessarily be represented by smooth curves (Figure 5). In a real world situation a farmer cannot select a flexible plant at the beginning of the year, nor does he necessarily realize a regularly increasing Y_t over time, because among other things he cannot predict changes in weather. As a result he will not be found to be operating in the exact manner a particular simple theoretical model suggests. Rather as shown in Figure 5 his capital - income - time relationship may show variance as he reacts to external

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*See p. 46.

effects and his own expectations. No matter what income level is actually realized he has to meet fixed costs on the farm and family expenses since the firm's survival requires the maintenance of the family.[37] In the long-run production costs and household expenses of the farm must be covered by farm income if it is to survive. Unless it has an income in excess of the "maintenance limit" growth of the firm will not be possible. The following section is devoted to defining the "maintenance limit".

The Maintenance Limit

In Figure 6, curve CC' is the consumption schedule. The 'break-even' point B shows the level of net income at which farm family or families just break even. At break-even point consumption expenditure is exactly equal to net income, the family is borrowing nothing and on balance saving nothing. To the right of the point B, the curve CC' lies below the 45° line and indicates net savings. If the family has ON dollars of net income in one year, it consumes NE dollars and saves EE' amount of its net income. To the left of the break-even point B, the 45° line shows the amount of dissaving by the family. The excess of consumption over income is family's "net dissaving" and is measured by the vertical distance between the 45° line and CC' curve and equals to AA' dollars.

The "propensity-to-save schedule" can easily be derived from the consumption schedule of Figure 6. The saving schedule is simply the distance between the 45° line and the propensity-to-consume schedule. The saving

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[37] See for an example R. Schickele, "Farmers Adaptations to Income Uncertainty", (Journal of Farm Economics, Vol. XXXII, No. 3, August 1950) pp. 356-374.

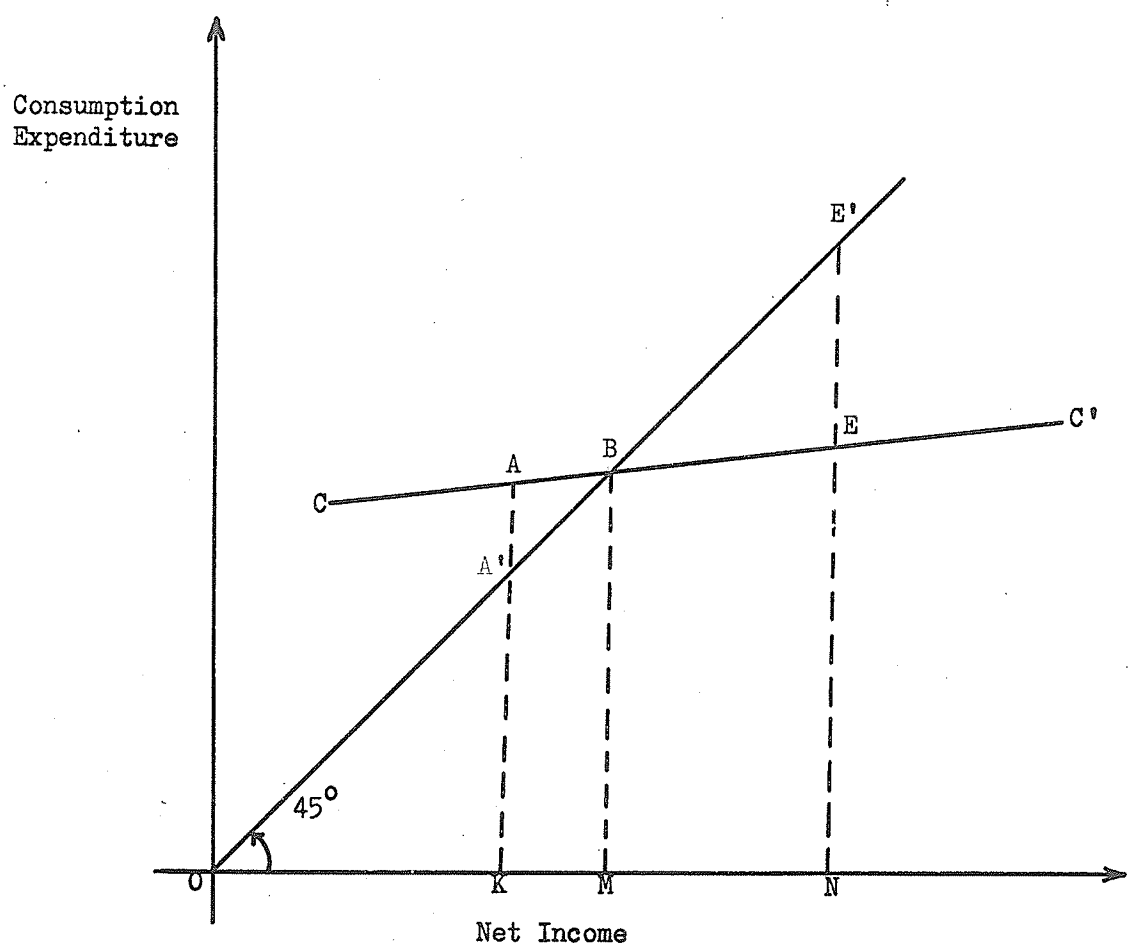

FIGURE 6

CONSUMPTION SCHEDULES

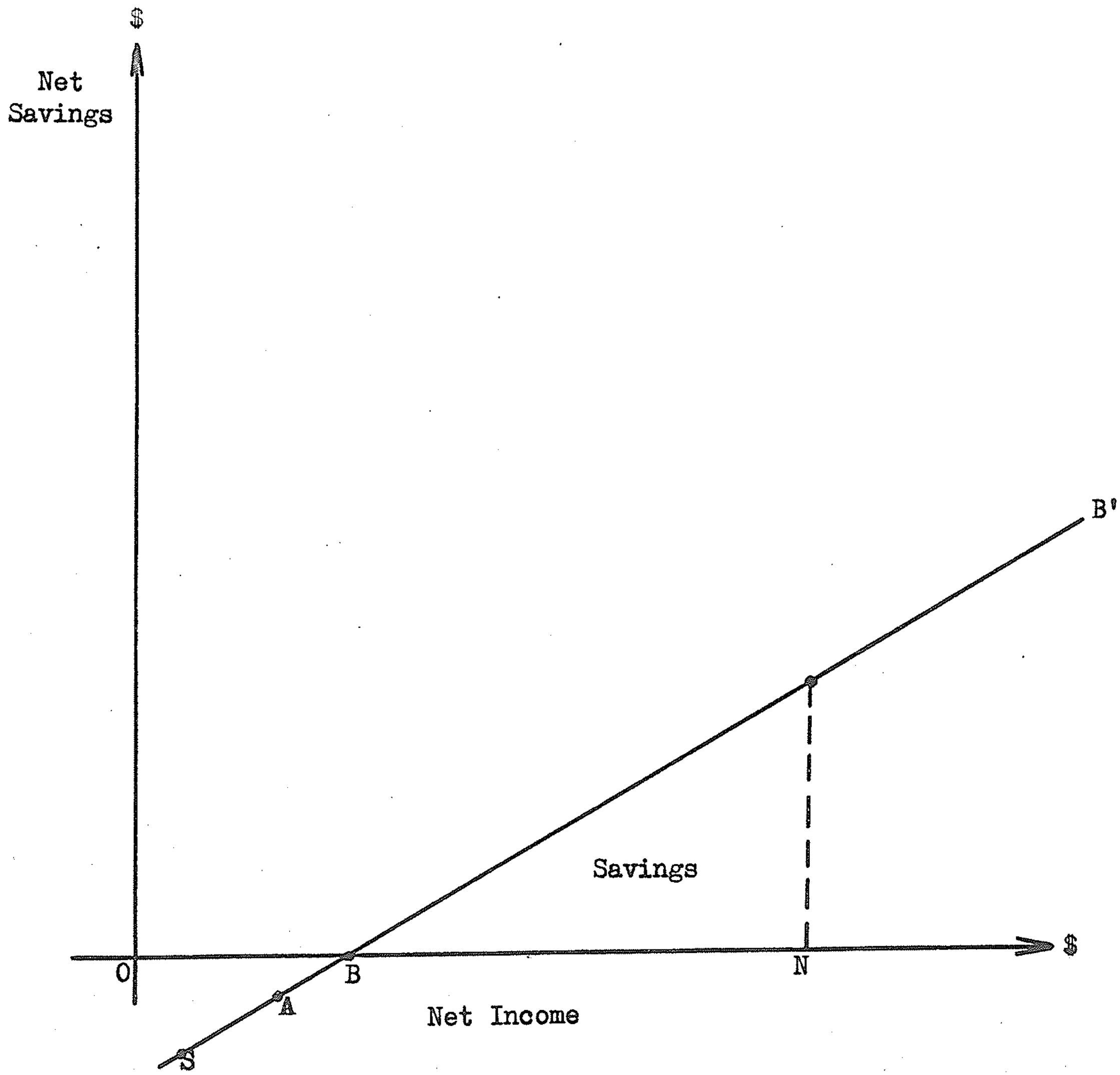

FIGURE 7

THE SAVING SCHEDULE

schedule can be depicted in Figure 7.

At a point such as A in Figure 6, the fact that the farm family's savings were negative was indicated by the prosperity-to-consume schedule laying above the 45° line. Figure 7 shows this fact directly, and similarly for the positive saving that starts when family income increases to the right point B.

The above two figures (6 and 7) can be integrated into one by assuming that the consumption fluctuates much less than proportionately to income.[38] In Figure 8 net income of the farm family is measured along the vertical axis and the total output of the farm which gives corresponding net income, is measured on the horizontal axis. The line CC' which is parallel to the X axis is the constant propensity to consume and shows the necessary family expenses of the farm. The curve SS' is the farm's saving schedule. The net income of the farm firm is obtained by subtracting total farm expenses from the gross farm income under the assumption that the firm operates under perfect competition and the prices of the firm's input and output are constant. In Figure 8, point M is the firm's 'maintenance limit'. That is, at point M, OK amount of output gives OC amount of net income which just covers necessary living expenses and nothing is saved nor is anything sacrificed. Any level of output which is less than OK will reduce the family and farming expenses below the previously acceptable levels. The farm family may try to attain the 'maintenance limit' by reducing certain long-run or short-run postponable

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[38] See for example Martin J. Bailey, <u>National Income and the Price Level</u>, (McGraw-Hill Book Company, Inc., Toronto, 1962) pp. 306-208.

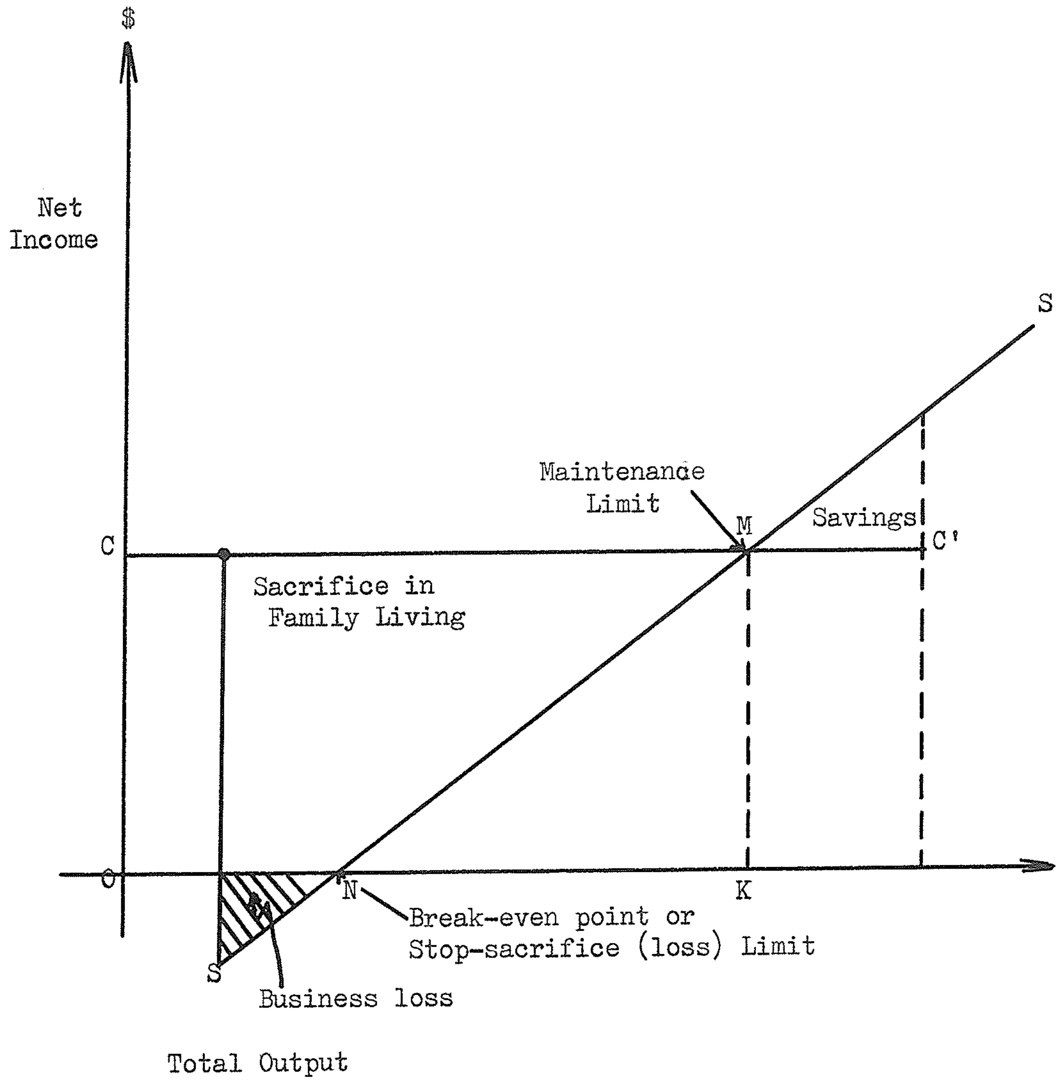

FIGURE 8

THE MAINTENANCE AND STOP-SACRIFICE LIMITS expenses.[39] If the family is very vulnerable[40] it may try to achieve the 'maintenance limit' by increasing debts. But there is a limit to increasing debts as shown by point N (Figure 8). If the firm's output is less than ON, it will go out of business and the entrepreneur, in our case the farmer may very likely sell his farm property to pay up the debts and leave the farm. However, the farmer may try to avoid this unfortunate happening by diversifying his business or by insuring the 'risky' enterprise; if there exists any insurance facilities. But all this requires owned liquid assets or the availability to obtain them in the case of the crop failure.

Instead of asking what the farmer does if his farm production is less than ON or the 'stop sacrifice limit', (Figure 8), we should ask what the farmer does or what he should do if the farm production is less than OK or the 'maintenance limit'? Should he postpone or reduce his expenditure on household

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[39]Postponable expenses during one crop year (defined as the short run), include expenses on fertilizer, insecticides and pesticides, crop insurance, expenses on consumption goods for non-farm use and other variable expenses such as seeds and machinery repairs etc., which a farmer would deem necessary to reduce.

Long run postponable expenses include investment on machineries, land, livestock and the grain storage and the barn construction. These are the long run expenses since they are assumed to be used on the farm for more than one crop year.

The fixed farm expenses include the long-run expenses plus the farm and property tax paid by the operator during one or more than one crop year whether or not these expenses are postponed by the farmer would depend on his level of vulnerability. For a more explicit discussion on fixed and variable cost see pp. 72-73.

[40]Vulnerability is defined as the farmer's susceptability to crop yield instability in terms of cash and grain reserves. A highly vulnerable farmer will have less or no cash or grain reserves. Vulnerability determines the amount of postponable farm expenses.

consumption? He cannot do this since he has a family and food is a necessity. Should he reduce his expenditure on fertilizer, gasoline, insecticides, or farm electricity? He cannot postpone the expenditure on gasoline because machinery would be of no use without it. Likewise he cannot reduce electricity consumption since it, like food, is a necessity for living. Can he postpone or even reduce the expenditure on insecticides? The answer would depend upon the vulnerability of the farmer. However the experts recommend that:

> Dicamba, under the name of Banvel D, has had three years of testing in the prairies, including institutional, and in 1963 some farm testing. Dicamba has proven highly effective in the control of many troublesome weeds which are resistant to 2, 4-D and MCPA..... ....Rates of from 2 to 4 ounces of acid per acre will provide control approaching 100%. Wheat and oats are sufficiently resistant to tolerate up to 2 ounces without yield reduction. Barley is more sensitive and 1 ounce appears to be the maximum dosage which will have no adverse effect.[41]

Another expert committee reports:

> Extensive damage to field and canning peas by the pea aphid was reduced to minimum by an extensive chemical control program. Many wheat fields were heavily infested with the English grain aphid which attacks wheat heads[42] .....

Should he postpone the use of fertilizer? Probably not because of the findings (Table VI) of fertilizer experiments on summerfallow.[43]

The farmer cannot reduce the use of fertilizer because the fertilizer use is profitable not only in dry years (for example the year 1961 in Manitoba)

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[41] *Proceedings of the Annual Conference of Manitoba Agronomists*, (Dec. 11 and 12, 1963) pp. 35-36.

[42] *Proceedings of the Annual Conference of Manitoba Agronomists*, (Dec. 12 and 13, 1962) p. 43.

[43] The Eighth Annual Manitoba Soil Science Meeting, (December 3 and 4, 1964) p. 78.

but also in the years of normal precipitation. On the fertilizer response the Manitoba Agronomists Conference[44] reveals the facts (Table VI) which indicates that a rational producer will always follow the recommendations:

TABLE VI

FERTILIZER EXPERIMENTS ON SUMMERFALLOW

Yield (Bus./Ac.)	Yield Increase over strip with no fertilizer	Value of Income (per acre)	Cost price of fertilizer	Profit
		($)	($)	($)
33.2	—	—	—	—
36.0	2.8	4.48	2.75	1.73
36.7	3.5	5.60	3.85	1.95
7.8	—	—	—	—
17.1	9.3	14.88	2.20	12.68
18.9	11.1	17.76	2.30	14.46
19.5	11.7	18.72	4.40	14.32
18.5	—	—	—	—
28.7	10.2	6.12	2.20	3.92
26.7	8.2	4.92	3.30	1.62
31.7	13.2	7.92	4.40	3.52
21.1	—	—	—	—
27.3	6.2	9.92	3.30	6.62
30.6	9.5	15.20	4.40	10.80

Three hundred field experiments with fertilizers have been conducted in Manitoba since 1950. The results indicate that with recommended rates of fertilizer a Manitoba farmer can expect that on

[44] Annual Conference of Manitoba Agronomists, (Dec. 19 and 20, 1961, and Historical Review of the Manitoba Agronomists, 1920-1960) pp. 73-74.

the average he will obtain a six bushel increase of wheat on fallow and a ten bushel increase of barley on fallow. There is an eighty percent chance (odds of 4:1) that the increase for wheat will be at least two bushels or more and for barley three bushels or more.

The Conference further revealed that:

....on suitable stubble land recommended rates of fertilizer on the average, give increase of 12 bushels of barley and 13 bushels of oats. Again there is an 80% chance of obtaining an increase of at least five bushels of barley and eight bushels of oats.

The Conference concluded that:

....contrary to popular opinion, except when there is a crop failure or near crop failure, fertilizer use is usually as profitable in dry years as in years of normal precipitation.

These research findings are directly concerned with the concept of the 'maintenance limit', that is, the annual gross farm income should cover annual household expenses and the yearly cost of production. Theoretically total cost of production includes both fixed and variable costs of operating the farm business. Fixed costs include overhead charges (real estate taxes, insurance on equipment and buildings, interest on debt) depreciation on buildings and machinery and the capital purchases that is the machinery and improvements purchases. Variable costs (v) refer to those outlays which are a function of output (Q) in the production period. That is, $V = f(Q)$. More specifically variable costs include the costs of crops and livestock production, repairs and maintenance of machinery and equipment and the repairs of buildings. Farmers in practice do not make any distinction between fixed and the variable costs of production. They think of any cost which they incur in one time period as part of the cost of production whether or not it is fixed or variable.

A more realistic definition of the 'maintenance limit' can be given on the basis of the farmer's concept of the cost of production. That is, the yearly gross farm income must cover all the costs (fixed or variable) which the farmer incurs in one production year. In other words, the net farm income must cover the necessary family expenses. As previously stated, if the net farm income just covers the necessary family expenses in one year, it has, then, achieved the 'maintenance level'. Obviously the 'maintenance limit' will vary from one year to another depending on the family expenses and the net farm income. Also it is very likely that the level of net farm income may not cover even the yearly family expenses in an abnormal year like 1961 in Manitoba. Then the farmer tries to attain the 'maintenance limit' by postponing certain postponable farm expenses or accumulates debt. When the farmer makes sacrifices in his family living due to crop losses it means he is very vulnerable and is not in a position to cut the farm expenses.

However, it should not be interpreted here that if the 'maintenance limit' is not met the farmer will go out of business and will cease to be in the farming business. It simply means that if this limit is not met by the net farm income or farm production in one year some borrowing will be done by the vulnerable farmer in order to reach the maintenance limit. If the farmer is not vulnerable and has some cash or grain reserves he will postpone certain expenses on the farm for attaining the 'maintenance limit'. However, the 'maintenance limit' thus defined may vary from one farm size group to another, and from one period to another. But the idea that the maintenance limit (farm production or the net income) should cover the necessary family expenses of every farm in every year, remains unaltered.

The above theoretical concept of the 'maintenance limit', therefore, must be empirically verified before making any recommendations or conclusions about the phenomena in the real world. It is towards this goal that the remaining chapters are directed.

Hypotheses

From the problematic situation and review of the literature related to the problem the following hypotheses are formulated for empirical verification:

1. Under imperfect knowledge (uncertainty) crop insurance reduces the crop income losses due to the yield instability.

2. Diversification of the farm business reduces the possibility of farm income losses in the event of crop failure. But the income is not maximum as it would be from the specialized (crops) farming without any crop failure.

3. Diversification of the farm business proves to stabilize income more than crop insurance is able to in the event of a crop failure.

4. Purchase of the greater proportion of inputs in the form of capital investment on the farm increases the risks of income loss in a bad crop year.

CHAPTER IV

SOURCE AND NATURE OF DATA USED IN EMPIRICAL ANALYSIS

The sources, nature and method of collecting data for the factual verification of hypotheses is a major controversial issue in agricultural economics research. Research workers have used data compiled from census, surveys, random and purposive samples. A recent trend in production economics research is to use data from farm business records. The source of data used in this study is the Carman District Farm Business Association (C.D.F.B.A.).

The controversy is over the issue of random versus purposive samples for making inferences about the population. Statisticians emphasize random sampling since it increases the scope of the inferences of the investigations and gives unbiased estimates of the sample statistics and population parameters. The sample used in this study is purposive. This sample would be considered less efficient by the statistician, but provides an acceptable basis for analysing the impact of crop yield variability on various crops. In addition, the most important feature of taking data from the Association's records is that it allows the researchers to obtain a continuous picture through time of the process of growth in the size of the farms.

This is a crucial point to be considered in searching for a solution to the particular problem underlying this study. Research is a continuous process, The search for truth never ends since knowledge is never complete. Time and experience invalidate old ideas. Doubts, confusions and conflicts give rise to scientific enquiry, pulling back the researchers' attention to find the components of the problem. The results (end) of one enquiry serve as a means for the other, thus the importance of the data from Association records can hardly be overlooked.

The sample used in this study is not representative of the whole population of over 43 thousand Manitoba farms[1], however. According to Webster's Dictionary the word sample is defined as a "part or piece taken or shown as representative of the whole group". Thus on the basis of this criterion, the group of farms in the C.D.F.B.A. does not make a sample since they are not representative of the population. Statistically these farms do not make a sample since they are not from a normal population and are not randomly and independently distributed. Now the question is what name should be given to the associating farms? The study of specific farms from the group of farms (C.D.F.B.A.) constitutes a special case study and may or may not be representative of the population. Therefore, for all practical purposes the analysis, collection, classification and interpretation of data from farm records can be regarded as case studies.

However, inferences based upon the case study method do not permit a basis for inductive generalizations. The case study approach is important for problem recognition and problem solution by continuous research. The results obtained from the case study method require a high degree of care in interpretation and drawing inferences about the population. Alfred Marshall defines the case study method as "the intensive study of all the details of the domestic life of a few carefully chosen families".[2] He suggests that to use

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[1] Canada Year Book, 1965, p. 497.

[2] A. Marshall, Principles of Economics, 8th Ed., (The MacMillan Co. of Canada Ltd., Toronto, 1962) vide Footnote p. 97.

it well requires a rare combination of judgement in selecting cases and of insight and sympathy in interpreting them. However, Marshall warns that in ordinary hands it is likely to suggest more untrustworthy general conclusions than those obtained by randomly selected cases through more extensive statistical methods.

Lundberg[3] holds that the case and statistical methods are not opposed to each other. However, they are independent of each other because of three principal reasons: (1) the case method is not in itself a scientific method at all, but merely the first step in scientific method; (2) individual cases become of scientific significance only when classified and summarized in such form as to reveal uniformities, types, and patterns of behaviour; (3) the statistical method is the best scientific method of classifying and summarizing large numbers of cases. Thus, he concludes, the two methods are in no circumstance opposed to each other nor is the one a substitute for the other. Elmer also argues that the case method and the statistical method are interdependent and complementary. He states:

> The statistical method points out the existence of repetitious units, which may show the presence of a desirable or undesirable situation. The case method may on the one hand call attention to problems to which the statistical method may be applied, and on the other hand may follow a statistical conclusion by a comprehensive analysis of the particular phenomena which has been shown statistically to be repetitious unit.[4]

Sheffield summarized this effectively by stating:

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[3]M.C. Elmer, Social Research (Prentice-Hall Incorporated, New York, 1939), vide p. 123.

[4]Ibid., pp. 122-123.

> The situation defining (case method) and the quantitative methods (statistical methods) of social study should be thought of as complementary to each other.[5]

Preliminary statistical studies may guide the selection of cases for detailed study and may bring those factors into attention which need special study.

Bernard points out that, inspite of the supplementarity between case and statistical methods one important distinction could be noted between them:

> A case description is, if accurate, always a time record of what occurs, while a statistical generalization, except in those instances when all included cases are identified, is only an abstract approximation. Definiteness and correctness of detail must in some degree be sacrificed to the more inclusive view of the statistical generalization.[6]

Two typical farm records from C.D.F.B.A. have been selected for a detailed study. The case farm records reveal an exact picture of what has happened or what is happening, whereas a statistical approach provides only abstract approximations. Thus in statistical generalizations, say, on the basis of random sample, it is very difficult to maintain the same degree of definiteness and correctness of detail. But this is not true for the case description. Heady[7] claims that aggregate production and income figures underemphasize the degree of instability on individual farms and a true picture of the impact of crop yield instability can better be found by

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[5] Ibid., vide p. 120.

[6] W. Gee, Social Science Research Methods (Appleton-Century-Crofts, Inc., New York, 1950), vide p. 233.

[7] See for an example E.O. Heady, Economics of Agricultural Production and Resource Use (Prentice-Hall Inc., Englewood Cliffs, N.J., 1961), p. 461.

studying one or a few cases. Bernard claims that:

> ....the case method corresponds roughly to the laboratory experiment, except, that the social case describes situations as they are, while the laboratory case describes conditions under artificial control. Even here there is no essential difference, except that it is usually difficult to subject the social case to a high degree of artificial control and thus eliminate unmeasurable or disturbing factors.[8]

Bernard concludes that the social or group case study is very much nearly comparable to an ecological study of lower organisms, 'or to a study of a geological formation or a geographical area, than it is to be the measurement of the behaviour of physical bodies in a laboratory'.

Shaw contends that:

> Case study method emphasizes the total situation or combination of factors, the description of the process or sequence of events in which behaviour occurs, the study of individual behaviour in its total setting, and the analysis and comparison of cases leading to formulation of hypotheses. Case studies, then, are to furnish a total view, 'to take into account the richness of fact'[9] concerning the farm firm.

Each farm or a group of farms belonging to C.D.F.B.A. is an experimental unit or a "case" to study like a plant or a group of plants in plant pathology. Since a case study is the first step in scientific method, and leads directly into the statistical method as a basis for the statistical generalizations, it should be viewed as supplementary to the survey method which also resembles the experimental method. The statistician in using the statistical method is concerned with the common denominator, while the researcher using the case study method includes a vast amount of material

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[8] Gee, Ibid., vide pp. 233-234.

[9] Elmer, op. cit., vide p. 116.

which appears to be unique for the 'case'. Furthermore, by the case study method it is possible to link a very large number of traits and factors as they appear in the cases under study, into cause and effect relationships, whereas the statistical method of correlation cannot deal with more than three or possibly four factors at a time.[10]

Use of the Association's records for farm production studies provides a continuous picture with the passage of time and the growth of the business. It also emphasizes the combination of social, economic and political factors, and describes the sequence of events (for example farmers' attempt to deal with uncertain crop yields) leading eventually to the formulation of hypotheses. As far as possible the data provide all necessary information to the investigator--whereas data collected through the random surveys have limited use because of the inherent sociological, psychological and institutional problems in such surveys.

> Social Science, writes Young, aims to study social reality. It is difficult to conceive social reality in the form of a statistical table, since social reality is real only when taken together with the social setting, the social happenings and all the personal and group elements which produced it.

Young further quotes that the case data are the means by which:

> ....we must reach the actual human experiences and attitudes which constitute the full, live, and active social reality beneath the formal organization of social institutions, or behind the statistically tabulated mass-phenomena which taken in themselves are nothing but symptoms of unknown casual processes and can serve only as provisional grounds for sociological hypotheses.[11]

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[10] See for example P.V. Young, Scientific Social Surveys and Research (Prentice-Hall Inc., New York, 1942), pp. 234-235.

[11] Ibid., p. 248.

The Association's data increase the comprehensiveness and depth in the inductive approach of the problem and the results obtained by using these data point out the area for further analytical research. It was mentioned earlier, that the case study method helps the investigator to formulate specific hypotheses about the problem. One of the hypotheses of this study suggests that the yearly farm income must at least cover the family and the farm expenses. If the 'maintenance level' is not provided by income from some existing farm plans, the farmer may insure certain crops or he may diversify his business. This suggests that the 'maintenance level' will vary from one year to another and from one farm to the other. The study of two contrasting farms using the case method will help the researcher to test this hypothesis which would otherwise be difficult with data obtained by the random sample which would not provide a common 'maintenance level' for all farms included as it would differ from farm to farm. Therefore, the analysis of two farm records furnishes the best method of analyzing the impact of crop yield instability on the farms which are confronted with limited resources and different types of soil.

However it should be mentioned again that to make inductive generalizations on the basis of few farm records is likely to be misleading. Research based on the farm records has no claim to be the basis for empirical generalizations. Young maintains that the subjective data gathered by the case-study method do not lend themselves to the quantitative check, "sampling is usually neglected and generalizations may thus be false".[12] Because of this limitation

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[12] Op. cit., p. 250.

generalizations on the basis of empirical results obtained by case study should be reserved. The role of the case study in farm production studies is to identify problems and to formulate certain hypotheses regarding the problem so that hypotheses may be verified and the problem may be solved through further research. However, if the investigator has an intimate knowledge about the situation, about the habits and the attitudes of the persons, and about the sociological environment of the area studied, then generalizations can be made without any hesitation. But this ideal situation is rarely attained. The "case-study" as Charles H. Cooley mentioned; "deepens our perception and gives us a clearer insight into life.... It gets at behaviour directly and not by an indirect and abstract approach of the random sample surveys".

Lundberg considers as futile the controversy over the superiority or inferiority of different research procedures in the social sciences because: "each has its place, and, for a particular purpose, or at a particular stage of investigation is best". The controversies over the value of the case method and the statistical method lies in looking each method as sufficient, independent and complete in itself, which they rarely are. "Any method which achieves its purpose is valid for that purpose".[13]

It is to be reiterated that the case study is the first step in scientific method and forms a basis for the statistical generalizations. Furthermore, each method, the case or the statistical, has its own merits and demerits. It is up to the research worker to use the method that is appropriate for his problem.[14]

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[13] George A. Lundberg, Social Research (Longmans, Green & Co., 1942), p. 116.

[14] For the details on types of case farms and reasons for selecting them see pp. 85-88.

CHAPTER V

METHODOLOGY

Fluctuations in extreme weather conditions are the main causes of crop yield instability in all the Prairie Provinces. Studies have shown that the long, medium and short-run weather cycles significantly affect the crop yields in Manitoba.[1] However, the weather effect on crop yields per acre varies among different farming areas. Farmers must meet, from year to year, farm expenses, living costs, debt payments and other similar expenses. Partial or complete crop failure like that of 1961 weakens or jeopardizes the financial status of the farm firm. In the Prairie Region where 26.3 percent of the total civilian labor force is employed in agriculture[2] and where 46.2 percent of the cash income earned in the prairies is derived from agriculture[3], two or three crop failure years would prove disastrous not only to the prairies but also to the nation as a whole. The 1961 drought conditions in the prairies not only damaged the crop enterprises, but the livestock enterprises were also seriously affected due to the shortage of forage. The variations in crop yields

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[1] See for example M.H. Yeh and L.D. Black, Weather Cycles and Crop Predictions (Faculty of Agriculture and Home Economics, the University of Manitoba, Tech. Bull. No. 8, November 1964).

[2] L.K. Li, A Market for Hired and Family Labor in Canadian Agriculture (Unpublished Master's Thesis, Department of Agricultural Economics and Farm Management, University of Manitoba, Winnipeg, August 1965).

[3] Handbook of Agricultural Statistics, Part II, Farm Income 1926-63, (Dominion Bureau of Statistics, Agriculture Division Farm Finance Section), p. 37.

are so unpredictable that within a period of four years crops might fail[4] two times or even more. For example during 1960 and 1964, farmers belonging to the Carman District Farm Business Association suffered financial loss in 1961 and 1963 (Table XIV). The crop production was reduced to such an extent that it did not cover even the 'maintenance level' on thirty-five farms.

There are perhaps many other districts in Manitoba like the Carman district where crop yields and farm incomes fluctuated violently over short periods. The bad crop years draw the public or government's attention in every society. In the events of crop losses farmers may react in two ways: first they may take action to stabilize farm income or to meet crop losses. Their actions may be in the form of business diversification or adoption of crop insurance. Secondly if they are not in a position to diversify the farm or to insure crops they will at least expect the government to help them. Government help may be in the form of subsidies, crop loans or other kinds of credit facilities. However, credit or borrowing has certain limits and is advanced only to "credit worthy" farmers.

When crop losses threaten the maintenance limit of the farm and the farmer is not "credit worthy", what should a farmer do? Quitting the farm may further complicate the issue because the farmer or his family members may not be skilled enough to earn reasonable livelihood outside the farm. His family may not be in the situation to move off the farm. In other words, the difficulties caused by quitting the farm may be more, than staying on the farm and suffering the crop losses. Thus the farmer is forced to stay on the

[4] Any crop year which does not cover the necessary production and living expenses in one year is a crop failure year.

farm in spite of crop failures. His farm income must be sufficient to 'maintain' the farm and the family. The ultimate objective of this study is to find the ways of helping farmers, to avoid bankruptcy levels of living when crops fail through no fault of the farmer under average management.

The fundamental questions answered in this study are: Given prices of the farm output what level of production would reasonably cover the farm and family expenses? This was defined as the "maintenance limit". If farmer is unable to obtain the 'maintenance limit' due to the crop failures, what is the best method to stabilize his farm income, crop insurance or business diversification?

In order to answer the above questions two farmers from the Carman District Farm Business Association, were purposely selected. The reason for purposive selection was to get farms on different types of soil. Two farms belonging to C.D.F.B.A. were respectively called A and B. Farm A is on the Altona Fine Loam Soils. These soils are classified as Group I.[5] The soils of this group are good to excellent, light clays and loams. This soil group is probably the best of all soils in the province and is suitable for growing any crops. These soils are moderately calcareous loam to clay textured water laid deposits on level to very gently sloping topography. Drainage is predominantly very good. These soils are highly productive, with no serious limitations.

These soils in general do not require any special attention for soil

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[5]J.P. Hudson, Carman District Farm Business Association Annual Report 1964 (Faculty of Agriculture and Home Economics, University of Manitoba, Report No. 20, June 1965), p. 3.

management other than those practiced necessary to maintain soil fertility and prevent erosion. Wheat, oats, barley, flax, rapeseed, sugar beets and sunflowers are suitable crops for these soils. Practically all these crops have been included in different rotations, followed on Farm A. Forage crops do extremely well on these soils and have been included in two rotations in order to examine the most profitable program by introducing the livestock enterprises.

Farm B is on Group II soils. These soils are slightly to moderately calcareous, water-laid deposits mainly of clay texture on level to very gently sloping topography. These soils are poorly drained because of fine textures and level topography. Farm B is on Osborne Clay Soils which tend to become water-logged and are susceptible to flooding. All soils in Group II are hard to work because of fine texture and have poor tilth if worked when they are too dry or too wet. The organic matter content is low to medium.

Crop sequences recommended for these soils generally include sweet clover as a green manure crop in the fallow year, or alfalfa-grass mixtures for hay in a longer rotation. Lack of sufficient moisture infrequently limits crop production on these soils. Beneficial effects on soil fertility and tilth are commonly given as reasons why legumes should be included in the cropping program. Therefore, continuous cropping to annual grains, rape and flax can be considered on these soils, provided weeds can be controlled by crop rotations and selective herbicides. These soils are also well suited to the production of forage crops for feed or seed. Because of these reasons the crop sequences recommended for the Farm B include, wheat, oats, barley, rapeseed, sweet clover, timothy seed and alfalfa. Again the object of this recommendation is to find the most profitable program for the Farm B with and without livestock enterprises.

One of the main objectives of this thesis is to compare the profitability of crop insurance and diversification given the possibility of crop failure. The incidence of crop failure affects the farmers no matter to what soil group they belong. But the Crop Insurance Corporation decides premiums and indemnities on the basis of soil productivity. Selection of two farms on two different soil groups did not only facilitate the study of the impact of crop yield instability on the farms in general but it also allowed a realistic evaluation of the crop insurance and diversification as income stabilizer in particular.

Both farms were pure grain farms without any building space for the livestock enterprises. Different crops and livestock programs, discussed later, were worked out separately by linear programming. The focal point of this study was the 1961 crop year. This year was extremely dry and did not only damage the crop enterprises but also seriously affected livestock enterprises due to the shortage of forage supply. Dry weather conditions in 1961 heavily damaged the crop yields and in fact the crop production per acre for certain crops was half of the previous year and for a few crops it was less than half (Table VIII).

In order to study the impact of the 1961 dry year, on the farm businesses, the 1960 year was taken as a base. This was a fairly normal year and was free from the wet and dry effects of the weather. The farm size, crop yields, costs of production, farm prices, land use pattern and other input-output coefficients, discussed later, for linear programming were taken from the 1960 crop year. Tables VII and VIII show farm size, the existing cropping pattern and yield per acre for both farms during 1960.

TABLE VII

LAND USE PATTERN AND CROP YIELDS ON CASE FARMS DURING 1960

CROPS	ACREAGE		YIELD PER ACRE	
	Farm A	Farm B	Farm A	Farm B
Wheat	100	160	43.0 bu	22.5 bu
Oats	40	228	75.0 bu	26.3 bu
Barley	70	—	30.0 bu	—
Flax	60	80	13.8 bu	5.9 bu
Sunflowers	50	—	1000 lbs	—
Hayseed	40	—	75.0 lbs	—
Tame hay	—	12	—	1.7 tons
Summerfallow	175	140	—	—
Total improved acres	535	620	—	—
Farmstead	13	20	—	—
Total acres in farm	548	640	—	—

As mentioned earlier these two farms are straight crop farms, since more than 75 percent of the total farm income was received from the crops. However, Farm B raised a few steers and hogs every year. For the linear programming analysis different livestock enterprises in conjunction with the crop programs were selected for each farm. Necessary building space was also worked out for those farms with livestock enterprises.

The crop yields on both the farms were greatly reduced by the 1961 drought in comparison to 1960. The crop yields per acre shown in Table VIII were nearly half or even less for cereal crops in 1961 as compared to 1960.

TABLE VIII

CROP YIELD ON CASE FARMS DURING 1960-61

CROPS	Yield per acre on Farm A		Yield per acre on Farm B	
	1960	1961	1960	1961
	- - - - - - - - - - b u s h e l s - - - - - - - - - -			
Wheat	43.0	17.6	22.5	10.7
Oats	75.0	25.3	26.3	12.1
Barley	30.0	--	--	--
Flax	13.8	0.5	5.9	--
Total improved acres	535	611	620	620

Since 1961 crop yields were less than half of 1960 and the same crop sequence was not followed in both the years, 1961 yields were normalized in terms of 1960 wheat yield assuming 1960 as a normal year.[6] The reason for normalization of 1961 yields was to compare the income obtained from the optimum plans based on 1960 and 1961 crop yields. This normalization facilitates comparison between 1960 and 1961 net farm incomes.

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[6]Normal does not have any statistical connotations. In fact crop yields in 1960 were a little higher than the average of 1957-1964 yields (Tables XVIII and XIX). The terms normalized and standardized yields are used synonymously. Since the main objective of this study was to study the impact of 1961 drought year in terms of 1960 year, 1960 was used as the basis of comparison.

TABLE IX

ACTUAL AND NORMALIZED YIELDS ON CASE FARMS

Crops	FARM A			FARM B		
	Actual yield per acre in 1960 (cwt)	Actual yield per acre in 1961 (cwt)	Normalized yield per acre in 1961 (cwt)	Actual yield per acre in 1960 (cwt)	Actual yield per acre in 1961 (cwt)	Normalized yield per acre in 1961 (cwt)
Wheat	25.80	10.56	10.56	13.50	6.42	6.42
Oats	30.00	10.12	$\frac{10.56}{25.8} \times 30 = 12.28$	10.52	4.84	$\frac{6.42}{13.5} \times 10.52 = 5.01$
Barley	14.40	—	$\frac{10.56}{25.8} \times 14.4 = 5.89$	17.76	—	$\frac{6.42}{13.5} \times 17.76 = 8.45$
Flax	7.73	0.28	$\frac{10.56}{25.8} \times 7.73 = 3.17$	3.31	—	$\frac{6.42}{13.5} \times 3.31 = 1.58$
Rapeseed	10.50	—	$\frac{10.56}{25.8} \times 10.50 = 4.30$	10.00	—	$\frac{6.42}{13.5} \times 10.00 = 4.76$
Sunflowers	10.00	8.75	$\frac{10.56}{25.8} \times 10.00 = 4.10$	—	—	—
Sugar beets	190.00	—	$\frac{10.56}{25.8} \times 190.00 = 77.77$	—	—	—
Cloverseed	—	—	—	3.50	—	$\frac{6.42}{13.5} \times 3.50 = 1.67$
Timothy Seed	—	—	—	2.50	—	$\frac{6.42}{13.5} \times 2.50 = 1.19$
Hay	34.00	—	$\frac{10.56}{25.8} \times 34.00 = 13.92$	34.00	—	$\frac{6.42}{13.5} \times 34.00 = 16.17$

These standardized yields were used as output coefficients in the linear programming analysis. In other words, maximum profit plans were found twice on the basis of two different coefficients. The first output coefficients used were the actual yields per acre in 1960 and the second coefficients were the standardized crop yields for 1961 in terms of 1960 wheat yield. The method of normalization is shown in Table IX.

LABOR SUPPLY

The labor on both the farms is mainly supplied by the owner-operator together with some unpaid family labor. Additional labor is hired in the busy seasons of spring and fall on both farms. Total labor on Farm A is 2,300 hours and on Farm B it is 2,530 hours. These labor hours are divided into spring, summer, fall and winter as follows with the allotted number of hours used as restrictions for linear programming.

TABLE X

LABOR SUPPLY ON CASE FARMS

SEASONS	RESTRICTED NO. OF HOURS	
	Farm A	Farm B
Spring Labor (May 1st - June 30th)	760	800
Summer Labor (July 1st - August 15th)	460	540
Fall Labor (August 16th - October 15th)	370	410
Winter Labor (October 16th - April 30th)	710	780
TOTAL	2,300	2,530

The operating capital in the beginning, that is in 1960, was $29,444 on Farm A and $23,365 on Farm B. Moreover, it was assumed that both operators could borrow $30-40,000 for operating expenses. The capital requirement for beef and hog enterprises include the construction of barns for suitable accomodation.

Selection of Farm Enterprises

For each case farm three types of enterprises were selected: (1) crop rotations (2) livestock enterprises and (3) buying and selling activities.

Crop Rotations

Five crop rotations were developed for each farm. Each rotation is fertilized at the recommended rate.[7] Two rotations contain hay which is an alfalfa-brome mixture and is used as ensilage for cattle feeding. A certain amount of land was kept fixed for buy-calf-graze activities since there was no pasture on either of the farms. As mentioned before, the crop sequences recommended for Farm A is for class I soils and for Farm B it is on class II soils. The crop rotations, land use, and yield per acre is outlined in Tables XI and XII for each farm.

Livestock Enterprises[8]

A. Cattle Enterprises

1. Buy calf, overwinter, finish on pasture: Since the farmers did

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[7]The crop rotations for each case farm were developed by Professor A.O. Ridley, Dept. of Soil Science, University of Manitoba. For detailed information see Appendix II.

[8]The livestock enterprises for both the farms were developed by Professor M.E. Seale, Dept. of Animal Science, University of Manitoba. See Appendix II for detailed information on the livestock enterprises.

TABLE XI

CROP ROTATIONS, LAND USE AND YIELD PER ACRE ON FARM A

Type of crop on Farm A	TOTAL ACRES Rot 1 5 Year	Rot 2 5 Year	Rot 3 5 Year	Rot 4 7 Year	Rot 5 9 Year	Yield per acre without any crop losses[a] (cwt)	Standardized yield/acre[b] (cwt)
Summerfallow	64	-	-	107	-	-	
Wheat	268	160	268	107	91	25.80	10.56
Oats	134	118	-	107	91	30.00	12.28
Barley	-	123	80	-	91	14.40	5.89
Flax	-	107	81	107	91	7.73	3.17
Rapeseed	-	-	53	-	-	10.50	4.30
Sunflowers	-	-	53	-	37	10.00	4.10
Sugar beets	69	27	-	-	-	190.00	77.77
Hay	-	-	-	96	134	34.00	13.92
Pasture	-	-	-	11			
TOTAL	535	535	535	535	535	-	-

[a]Crop yield per acre in the 1960 crop year.

[b]Crop yield per acre in 1961 in terms of the 1960 yield per acre.

TABLE XII

CROP ROTATIONS, LAND USE AND YIELD PER ACRE ON FARM B

Type of crop on Farm B	TOTAL ACRES Rot 1 4 Year	Rot 2 7 Year	Rot 3 5 Year	Rot 4 6 Year	Rot 5 11 Year	Yield per acre without any crop losses[a] (cwt)	Standardized yield/acre[b] (cwt)
Summerfallow	-	-	93	-	93		
Wheat	310	186	310	310	93	13.50	6.42
Oats	124	62	155	155	62	10.52	5.01
Barley	93	124	-	-	62	17.76	8.45
Flax	-	124	-	-	62	3.31	1.58
Rapeseed	93	93	-	-	62	10.00	4.76
Cloverseed	-	31	-	-	-	3.50	1.67
Timothy seed	-	-	62	93	-	2.50	1.19
Hay	-	-	-	62	186	34.00	16.17
TOTAL	620	620	620	620	620		

[a]Crop yield per acre in the 1960 crop year.

[b]Crop yield per acre in terms of the 1960 yield per acre.

not have any land under pasture, the buy -calf program was substituted for the cow-calf, overwinter activity. In this program a calf weighing 430 pounds is bought in the fall. Then the animal is fed to gain one pound per day up to May 15. Then the animal is kept on pasture to gain two pounds a day and is sold on October 15, when it weighs 940 pounds to 980 pounds. This enterprise is slightly different than the usually followed cow-calf program. In the cow-calf activities the cow is bred and the calf is raised on pasture up to 430 pounds and is sold sometime during November. In other words the cow-calf activity requires land for pasture. Since there was no provision for pasture land on both the farms, the buy calf overwinter activity was considered in place of the cow-calf program. It was assumed that some portion of the land which would have been used for hay would be kept fixed as the pasture land for buy calf overwinter activities. Four activities were included in the matrix.

2. Buy calf, full feed: In this activity a 430 pound calf would be bought in mid-October. Then it would be fed during winters to gain 2.3 pounds per day and would be sold on May 15th at 925 pounds of weight. Two activities were considered in the matrix.

3. Buy calf winter-graze: At 430 pounds calf would be purchased on October 15th and would be wintered to gain one pound per day. Then the calf would be grazed for 120 days during the summer and would be sold on September 15th as a feeder steer weighing 815 pounds. Two activities were included.

4. Buy calf, winter-graze, finish: This enterprise is similar to the previous activities except that the calves are wintered on ration to gain 1.5 pounds per day rather than one or 2.3 pounds. The feeder would be

kept on pasture for 90 days then in the feed lot for 70 days. In the mid-October the finished animal would be sold at 1,050 pounds of weight. Two activities were considered in this enterprise.

5. Yearlings: The steer weighing 700 pounds would be purchased on April 15. In order to gain 2.5 pounds per day, the animal would, then, be kept in a feed lot for 140 days. The animal would be sold in early September when it would weigh 1,050 pounds. Two activities were included.

B. Swine Enterprises

1. Farrowing activities: The matrix provided two and four different farrowing activities for Farm A and B respectively. These activities provided the best combination of buildings and capital which would give maximum return from the farrowing program. The activities provided for: (1) No barn improvements with space for 14 sows on Farm B. (2) The renovation of the old barn on Farm B at a cost of approximately $2,400.00 provided space for 38 sows. (3) Since farmer A did not have any livestock building an activity with new farrowing buildings with a feed mill was considered for Farm A and also for B. (4) Another activity with the same building as in (3) was considered for both the farms without any feed mill. In this case processing of feed was assumed hired as in the other activities which provided for no feed mill. The farrowing activities assumed 16 weanlings per sow per year to be sold at 30 pounds.

2. Farrow and finish activities: On Farm B two activities were considered. One using the present barn with no improvement and having a limit of six sows, the other assuming a renovation of the barn at a cost of $2,400.00 and providing space for 19 sows. Two farrow and finish activities were considered for Farm A also.

3. Feeder hogs: The matrix provided for two feeder hog activities, each using new buildings at an investment cost of $21.00 per unit capacity. One activity provided for a feed mill, the other assumed custom hiring of feed processing. These activities assumed the purchase of weanling at 30 pounds and the sale of market hogs at 200 pounds or 148 pounds dressed weight. They provided for a turnover of three lots of hogs per year.

C. Buying and Selling Activities

These activities are introduced to permit the purchase of production resources or the selling of the farm products. Crops grown in the rotation can be either sold or fed to the livestock. If crops grown are fed to the livestock they serve as resources similar to land, labor, capital and building space. For example hay produced on the farm can be fed to livestock or if not in the rotation can be purchased to serve as a resource. When buying activities are included in the simplex table, a negative price is charged similar to the hired labor or the borrowed capital. Selling enterprises are included for wheat, oats, barley, flax, rapeseed, sunflowers, sugar beets and alfalfa hay on both farms. Buying activities include oats, barley and hay. Corn for grain or silage is not included in the rotations recommended for either farm. Therefore, corn silage must be purchased if the livestock activities require corn silage in their ration.

Basic Data for Linear Programming Application

The starting point in linear programming is the collection of basic quantitative data. The validity of linear programming analysis depends on the reliability of the input-output coefficients. The input-output coefficients used in this study were obtained from various sources.[9] The data

[9]J.C. Gilson et al., Principles and Practices of Commercial Farming (The

required includes: (a) resources supplies or restrictions, (b) prices of the resources used and products produced, and (c) input-output coefficients defining per unit (per acre or per animal) resource requirements of the activities used.

The available land and labor on both the farms have been mentioned in Tables VIII & X respectively. The 1960 prices were used for the resource purchases and the product sales. The production costs per acre for each crop were calculated on the basis of actual cost incurred by the farmers in 1960. The cost of production was budgeted for the crops which farmers did not grow and were in the rotation. Similarly the cost of feeding animals in the livestock rotations was calculated by budgeting.

Only operating (variable) costs per acre were budgeted to use as the input coefficients in the linear programming. Operating costs included tractor and machinery use, seed, fertilizer and miscellaneous costs which are the variable costs of planting, growing and harvesting crops.

The cost of producing alfalfa was calculated for three different time periods. This was done because the establishment cost was prorated over the number of years alfalfa appeared in the rotation. An additional three dollars per acre for fertilizer was charged where alfalfa is produced more than one year in succession.

Net Prices

There are various alternative methods for establishing the net prices for the activities in the program. The most realistic method is to treat them

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Public Press Ltd., Winnipeg, 1st Ed., 1965), and J.A. Jeanneau, *Optimum Combination of Enterprises* (Unpublished Master's thesis, Dept. of Agricultural Economics and Farm Management, University of Manitoba, June 1965).

as incurred by the farmer. The activities which are used as resources are called the intermediate activities or products. In fact, the intermediate activities, for example oats or corn, are the products used as resources. The farmer realizes the return when he sells the crop in the market. The variable costs[10] incurred by the farmers to produce different crops have been used as the net prices for those crops. Thus rotations have negative prices equal to their per unit variable costs. The selling activities have positive prices. Buying and intermediate activities have negative prices since they will subtract the equivalent costs from the profit. Under this procedure of pricing, the net prices for livestock are equal to gross market value minus per unit variable costs. However, the cost of feed consumed by the livestock has not been included in the per unit variable costs for livestock. The value of oats, barley, and hay consumed by the livestock rotation has been expressed in the value of livestock sales. Since the farmers could not sell hay, the hay selling activity was considered with a zero price. This means that the amount of hay sold with a zero price is the surplus left after the cattle consumption. But if it was purchased, a negative price of 60 cents per hundredweight was charged as a cost of handling, hauling and putting it in the barn.

The Maintenance Limit

As defined in Chapter III (pp. 64-74) the 'maintenance limit' of the gross farm income must cover the cost of production and necessary family expenses

[10] Appendix II.

every year.[11] In order to find the maintenance limit, various crop plans were permitted to compete for the restricted farm resources in linear programming. Thus out of various alternative crop plans, one most profitable program was selected. Then the normalized crop yields of 1961 were used as the output coefficients to find another optimum crop program. In doing this, 1960 input coefficients and the prices were kept constant. The same crop plans were allowed to compete with each other for fixed farm resources with the normalized yield coefficients. The most profitable plan was again selected and was compared with the maintenance limit of 1960 which was worked out on the basis of the operator's own planning. If this optimum plan was more than the 1960 maintenance limit, it was compared with less efficient plan or rotation which approximately gave the 1960 maintenance limit. For example the maintenance level in 1960 according to farmer's own planning is $7,000 ($4,000 for variable cost of production and interest on borrowed capital plus $3,000 for the family living expenses) for the farm size of 600 acres. Suppose four crop rotations, R1, R2, R3, and R4, were programmed with the normalized output coefficients and the rotations were four, three, five and seven yearly respectively. Further suppose rotation R4 gave an average net annual income of $8,000, R1, $5,000, R2, $10,000, and R3, $12,000. Then we would say, the five year rotation R3 gives maximum return to the farmer but his maintenance limit is approached by rotation R4. The maintenance limit was found for each farm, so that a comparison between two different levels of the maintenance limit could be made on two

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[11] No distinction has been made here between fixed and variable costs of production. The gross farm income must cover all the costs fixed or variable, in one production year. For a detailed discussion on the costs of production relevant to the maintenance limit see pp. 69-73.

different soils.

The maintenance limit may not be jeopardized by crop failures in one or two years. It may be approached after four or five years of crop failures in succession. In order to see "how serious is the crop yield instability in terms of the modern farm business?" or what is the impact of crop yield variability on the farm firm, the net incomes obtained from crop, livestock and crop insurance programs were compared for good and poor crop years on each farm.

Diversification Versus Crop Insurance

Diversification

All the five crop rotations used in 1960 and 1961 straight crop farming matrix were combined with livestock enterprises on each case farm. These combined activities were allowed to compete for the available farm resources in the program. The most profitable plan was thus selected for each farm. Again income obtained by this plan was compared with the maintenance limit of 1960. This combination of the crops and the livestock enterprises gave the maximum net return under two different contingencies. This was done to find answers to the question: How far diversification of the farm business helps to maintain the 'maintenance limit' with the incidence of crop failure? Here again the net return obtained by diversification may be more than the maintenance limit or limits. But the maintenance levels of net income may be matched with the less efficient diversification programs. This will indicate the number of years after which it will maintain the 'maintenance limit'. For example, three livestock enterprises with a certain number of beef cattle and hogs are combined with four yearly crop rotation. Suppose the cattle enterprises L1, L2, L3, with this crop rotation give \$12,000, \$9,000 and \$7,500, net income respectively. If the maintenance limit is $7,000, then the cattle enterprise L3 with four yearly crop rotation will maintain the maintenance limit, but the combination of the crop plan with the cattle enterprise L1 will give maximum return. Supposing the net return obtained by the four yearly crop rotation was only $1,000 without any diversification, we would then say that it takes four years for the beef cattle enterprise L3 to give the maintenance level of net income. However, it may happen that the four year crop rotation may not attain the 'maintenance limit' with either of the cattle enterprises, L1, L2, and L3. Under such conditions these three cattle enterprises should be combined with a more than four year crop rotation. The volume of the cattle enterprises can not be enlarged without increasing the resource supplies in this case since the building space or capital are the main restrictions.

Crop Insurance

One of the objects of this inquiry was to study the roles of diversification and crop insurance in stabilizing farm income in the event of crop failure. In order to study the influence of diversification and crop insurance the crop programs which were combined with the livestock enterprises were selected. Net returns from each crop plan was obtained. Since these crop programs were based on the normalized crop yield coefficients, the crop insurance premiums were decided for insurable crops in these rotations. The premiums paid to the insurance company were deducted from the amount of indemnities paid by the Crop Insurance Corporation. The balance was added in the net return obtained by the crops included in the crop insurance matrix. The net income thus obtained was compared with the net income obtained by combining the livestock enterprises with the crop rotations for the 1961 crop year.

This comparison of net returns obtained by diversifying the business and by insuring the crops also facilitated the verification of the third hypothesis. This hypothesis postulates that in the event of the crop failure diversification of the farm business would stabilize the income more than the crop insurance.

Application of Linear Programming to Selected Farms

Linear Programming[12] and Marginal Analysis

In determining the maxima and minima according to the principles of the theory of the firm, the technique of linear programming as well as the marginal analysis is used. In the former the objective function is stated as a linear function of the independent variables subject to the linear inequalities stated in terms of these variables. In the latter the quantity maximized (or minimized) is stated as a continuous function of independent variables with continuous first and second order partial derivatives.[13] The inequalities of resource supply break the similarity between the two approaches. The marginal analysis technique deals with equalities whereas the linear programming approach encompasses problems with inequalities of resource supplies. Problems involving inequalities of resource supplies cannot be handled by the conventional marginal analysis but can be handled by linear programming. Figure 9

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[12] For a detailed discussion on the definition and assumptions of linear programming see: E.O. Heady and W. Candler, Linear Programming Methods (The Iowa State University Press, Ames, Iowa, 1963).

[13] James M. Henderson and Richard E. Quandt, Micro Economic Theory (McGraw-Hill Book Company, Inc., Toronto, 1958), p. 75.

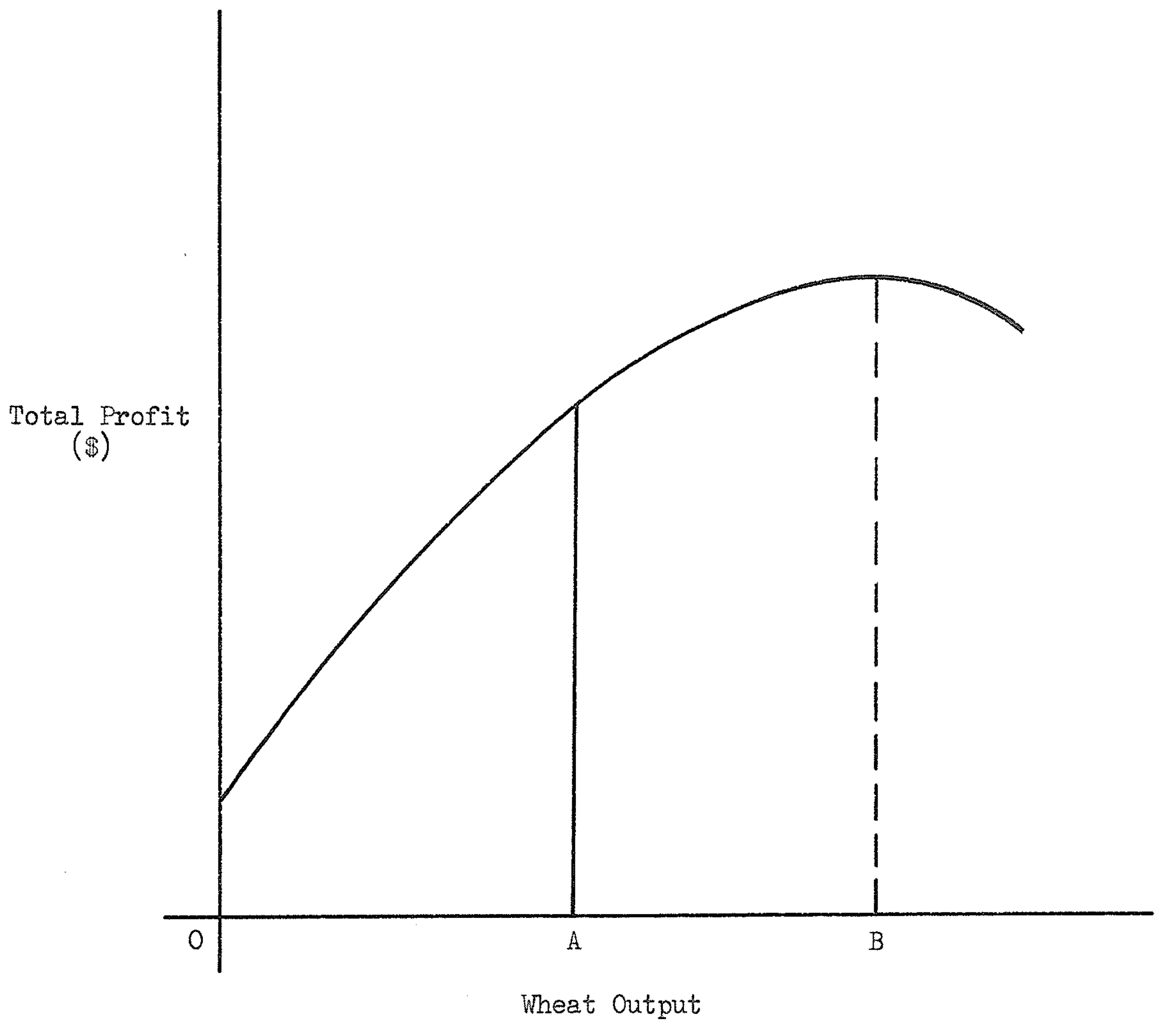

FIGURE 9

OUTPUT AND PROFIT RELATIONSHIP

illustrates this difference.

According to the marginal analysis the farmer maximizes his profit where marginal profit (the slope of the total profit curve) equals zero, or marginal revenue equals marginal cost (e.g., at output OB in Figure 9). But if the output is limited due to input restrictions and wheat production cannot be increased beyone OA, the maximum profit condition (MR=MC) under perfect competition will never be satisfied. The problem is, then, to produce OA amount of wheat or some amount to its left. This is not an easy problem to be solved by marginal analysis approach in the n- dimensional n- variable case.[14]

In many areas of Manitoba and particularly in the Carman District (the area studied), the resource restrictions are such that it is not possible to produce up to the level OB. In the Carman area of Manitoba increasing returns to scale exist.[15] In other words production is being carried in the first stage of production function. The best thing that remains to do is to find out the maximum attainable profit within the limited resources. The use of marginal analysis which requires a production function of the type,

$$Q = f\ (X_1,\ X_2,\ ----,\ X_n) \text{ where } Q = \text{Output};\ X_i = \text{Input};\ i = 1 ---- n.$$

appears to be limited as a direct planning tool for individual farms. The marginal analysis may be useful in determining the likely directions of desir-

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[14] W.J. Baumol, "Activity Analysis in One Lesson", (American Economic Review, No. 5, December 1958), pp. 837-873.

[15] J.C. Gilson and M.H. Yeh, Productivity of Farm Resources in the Carman Area of Manitoba (Tech. Bull. No. 1, September 1959, Faculty of Agriculture and Home Economics, University of Manitoba).

able change in resource use.[16] But to find the efficient use of a particular resource is not the concern of this study. Rather how efficiently all the resources available on the farm can be combined, is one of the main concerns of this problem. Linear programming is a very useful tool in determining an optimum organization of the farm from various alternatives (crop and livestock enterprises) each having a specified technology. Linear programming technique applied to the theory of the firm specifies a technology in a way which is more specific and detailed than the production function of marginal analysis.[17]

The limited resource supplies of the selected farms and the problem of finding an optimum allocation of resource use in different crop and livestock plans provide important reasons for using linear programming technique in the present investigation. This will not only facilitate the selection of an optimum farm plan in terms of the 'maintenance limits' but also help to evaluate the role of diversification and crop insurance in stabilizing the farm income in the event of crop failure.

Apart from unequal resource supplies, there is no basic difference between linear programming and marginal analysis which considers a finite number of activities.[18] In linear programming terminology, the conventional

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[16] Earl R. Swanson, "Determining Optimum Size of Business from Production Function" in Resource Production, Returns to Scale and Farm Size, edited by Earl O. Heady, et al (Iowa State College Press, Ames, 1956), p. 13.

[17] R.G.D. Allen, Mathematical Economics (MacMillan & Co. Ltd., London, 2nd Edition, 1964), p. 619.

[18] Robert Dorfman, Paul A. Samuelson and Robert M. Solow, Linear Programming and Economic Analysis (Prentice, McGraw-Hill Co. Inc., New York, 1958), p. 133.

marginal analysis assumes that an infinite number of different processes are available, each derived from a similar one by a slight alternation in the proportion of inputs and outputs.[19]

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[19] *Ibid.*, p. 141.

CHAPTER VI

ANALYSIS OF RECORDS OF THE CARMAN DISTRICT FARM BUSINESS ASSOCIATION

The analysis of the impact of crop yield instability on the farm business was based on the records of thirty-five farmers belonging to the Carman District Farm Business Association (C.D.F.B.A.). Of the eighty-two members in the C.D.F.B.A. in 1964, complete records for the period 1957-1964 were available only for the thirty-five member farmers used in this analysis.

Table XIII provides an indication of the crop yield characteristics in the area studied. The income figures from the sale of farm products were calculated for the period 1957 to 1964. Crop prices[1] were fairly constant during this period (except in 1959 and 1962) whereas crop yields varied widely. Therefore, variation in the gross or net farm income was mainly due to wide variations in crop yields. The percentage contribution of different sources of farm income shows an increasing trend towards diversification (Table XIII). Income obtained from the livestock enterprises was 47.7 percent in 1957, increasing continuously each year, and in 1962 reached the maximum of 62.8 percent. This increase in income from livestock is due to an increase in livestock prices.[2] The percentage income received from crops decreased approximately by four percent within eight years and the income from livestock enterprises increased by three percent. Again this shift is due to unstable crop yields and favourable livestock prices.

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[1] See Appendix VI

[2] *Ibid.*

TABLE XIII

PERCENTAGE CONTRIBUTION OF DIFFERENT SOURCES OF INCOME TO THE GROSS FARM INCOME, CDFBA, 1957-1964

Source of Income	1957	1958	1959	1960	1961	1962	1963	1964
Wheat	20.1	24.4	25.1	21.0	15.3	14.2	14.1	13.5
Oats	4.0	3.9	3.9	3.0	1.6	1.5	1.5	3.2
Barley	3.9	3.0	3.9	1.6	0.8	0.7	1.2	2.7
Flax	8.4	5.1	8.1	7.6	7.1	8.2	8.5	15.2
Corn (grain)	1.4	1.6	1.0	1.3	1.1	2.5	3.1	0.9
Sunflower	3.3	1.5	1.7	3.7	7.0	4.6	6.2	3.3
Sugar beets	8.1	5.9	3.6	4.6	4.3	4.2	4.2	1.6
Miscellaneous	3.0	2.2	2.1	3.0	3.3	1.2	2.2	8.2
Total Crop Income	52.3	47.6	49.4	45.8	40.5	37.2	41.1	48.6
Cattle	29.1	25.4	20.9	27.9	31.2	35.0	37.3	36.4
Hogs	6.8	9.8	15.6	13.3	16.7	16.8	14.0	11.6
Eggs	3.3	3.4	4.5	2.9	4.6	3.3	2.3	-
Poultry	1.2	5.6	2.8	4.6	2.3	2.8	1.5	0.7
Dairy	7.3	8.2	6.8	5.5	4.7	4.9	3.8	2.7
Total Livestock Income	47.7	52.4	50.6	54.2	59.5	62.8	58.9	51.4
GROSS FARM INCOME	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

High prices of livestock (particularly cattle) in 1959 increased income from this enterprise by four percent in 1960. Similarly high prices of steers and calves in 1962 increased the livestock income by three percent in this year.

Table XIV shows a remarkable increase in the operating expenses during 1957-1964. The cost of production more than doubled within eight years. This increase in the annual farm production costs is due to the elimination or reduction of small enterprises, like eggs, poultry and dairy and concentration on the cattle or hog enterprises (Table XIII). That is, the farmers are trying to eliminate the small enterprises by enlarging their business. Besides the high profit motives, enlargement of the cattle and hog enterprises with less emphasis on growing crops is an attempt to live with unpredictable crop yields.[3]

The fluctuations in the net farm income (Table XIV) were partly due to crop yield instability and partly due to the increase in demand for Canadian wheat in the foreign market after 1960. Severe drought in 1961 and a wet spring in 1963 reduced crop production heavily and the gross income received did not cover the costs of production during these years. The necessary family living expenses, in addition, required around $3,200 (Table XIV). These living requirements at average yields approximately absorbed the entire net farm income in 1957. The crop failures in 1961 and 1963 gave negative net farm incomes. On account of this, the farmers had to borrow approximately $3,037 and $5,859 respectively in both years (Table XIV), or draw on their savings, or live on depreciation reserves included in the total cost of production as

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[3]See Appendix III.

TABLE XIV

AVERAGE INCOME FROM GRAIN IN THE CARMAN DISTRICT OF MANITOBA DURING 1957-1964 (AT 1960 PRICES)

ITEMS	1957	1958	1959	1960	1961	1962	1963	1964	Average
Acres in farm	442	530	532	506	533	504	546	553	518.3
Acres under crop except forage	271	297	384	312	333	338	422	466	352.9
Standardized yield of wheat/acre (bu.)[a]	19.7	22.4	20.1	22.8	13.9	21.5	11.5	21.4	19.1
Gross farm income from wheat @ $1.50/bu.[b]	8,008.05	9,979.20	11,577.60	10,670.40	6,943.05	10,900.50	7,279.50	14,958.60	10,110.58
Total operating cost of production[c]	4,442.45	5,759.33	5,865.12	6,201.91	7,014.74	6,549.00	9,003.00	9,860.00	6,836.94
Net farm income[d]	3,565.60	4,219.87	5,712.48	4,468.49	- 71.69	4,351.50	-1,723.50	5,098.60	3,202.66
Necessary family living expenses[e]	2,102.48	2,505.08	2,890.71	3,207.31	2,965.31	2,976.08	4,135.48	4,699.91	3,185.29
Net income available for debt payments, expansion of business & savings	1,463.12	1,714.79	2,821.77	1,261.18	-3,037.00	1,375.42	-5,858.98	398.69	-17.37

[a] See Appendix III for standardization procedure.

[b] The gross farm income represents the value of crops produced on the farm at an average price of $1.50 per bushel of wheat. This does not include income from livestock enterprises.

[c] Operating costs are all items purchased for use in the farming operation, whether paid or not. They include the annual depreciation on buildings and equipments. Farm costs such as land taxes, insurance, interest and depreciation occur whether or not any production takes place. The amount spent on such things as seed, fertilizers, sprays, gas, oil and labor depends upon the amount of business and production activity taking place on the farm. However, in the calculation of operating costs, feed costs for livestock have not been included.

[d] Net farm income is the returns which the business provides the operator and his family for their own labor, management and capital. It is calculated by subtracting the total operating cost of production from the gross farm income.

[e] Necessary family living expenses include, groceries, fruit and meat, fuel and lighting, telephone bills, furnishing, clothing and material, income tax, hospital, dental, medical, education, insurance and personal use of car.

a capital cost allowance. It appears that borrowed money was used to cover the "maintenance limit" in 1961 and 1963. The net income remaining after satisfying the necessities for family living was available for paying income taxes, debt, expansion of the business, better living and savings. However, this balance was not sufficient for business expansion except in 1959, 1962 and 1964, and on the average, each farmer included in the sample borrowed about $17 annually to satisfy the necessities for family living (Table XIV).

Table XV shows the effects of the crop yield variation on the net farm income. An average yield of 13.9 and 11.5 bushels per acre in 1961 and 1963 respectively did not cover the necessary family expenses in these years. An average yield of 19.7 bushels (as obtained in 1957) satisfactorily covered the average family expenses of about $3,200 (Table XIV). That is, the standardized wheat yield of 19.7 bushels gave approximately $3,500 as the net income (Table XV). Thus assuming that the necessities for family living required $3,185 each year during 1957-1964, the "stop-loss" limit in the Carman district was fourteen bushels of wheat. This yield left nothing for family living or for other purposes (Figure 10) and on the average, each farmer lost above $71 as the net farm income in 1961. In the 1963 crop year the crop yield was also below this "stop-loss limit". The farm families lived during these years by making sacrifices in the level of family living, by using cash or grain reserves or by accumulating debts (Table XV). During 1957-1964 the wheat yield "maintenance limit" for thirty-five farms was nineteen bushels. Figure 10 indicates that as soon as the crop yield dropped below nineteen bushels on an average, the farmers in the Carman district started sacrificing the level of their standard of living or began increasing debts (Table XV).

For example, the "sub-maintenance limit" crop yields in 1961 increased debts in 1962 by $2,865 and the 1963 crop failure increased the borrowing by $9,039 in 1964. These increased debts, like the cost of production, might have been used partly for meeting the production and family expenses and partly to enlarge the farm business. It is noteworthy that the Carman farmers borrowed less money ($5,178) in 1961, than in 1960 and 1962 (Table XV). On the other hand in 1963 the amount of money borrowed was more than the 1962 and 1964 crop years. Both years 1961 and 1963 were poor crop years. The fourth hypothesis (p.74) in general suggests that debt would increase in low income years in order to provide for necessary production and living expenses. Then why a debt decrease in 1961 and not one in 1963? The answer may be found by observing the figures for the value of grain and feed and cash in hand in Table XV. Farmers in 1961 used their grain reserves and the current bank balance to cover necessary production and living expenses with an additional $5,178 from borrowing. In 1963 the debt increased even though the farmers used cash and grain reserves. This is due to the lowest wheat yield per acre over the eight years of the business operation (Table XV). The wheat yield per acre in 1963 was even lower than the 1961 yield. Due to poor crop production, the farm operating expenses in 1963 were more than the gross farm income by over $1,732. In addition, farmers required over $4,100 for family living in 1963. Thus, the net income loss due to crop failure and the necessary family living expenses were more in 1963 than in 1961. Therefore, in order to cover the net income loss and the family living expenses, farmers not only used their cash and grain reserves but also increased their borrowings in 1963.

The wheat yield "maintenance limit" indicates that these thirty-five

TABLE XV

EFFECT OF CROP YIELD INSTABILITY ON NET FARM INCOME IN THE CARMAN DISTRICT OF MANITOBA DURING 1957-1964

Year	Normalized wheat yield in bu. per acre	% of 1960 wheat yield/acre	Gross Income ($)	Production Costs ($)	Net Income ($)	Order of increase in net income	Money borrowed ($)	value of grain & feed	PERSONAL ASSETS ($)			
									cash on hand	stocks & bonds	life insurance (cash surrender value)	household goods
1957	19.7	86.4	8,008.05	4,442.45	3,565.60	3	2,120.70	6,460.91	499.26	728.57	1,341.25	2,071.02
1958	22.4	98.3	9,979.20	5,759.33	4,219.87	4	2,548.40	7,682.60	983.00	978.54	1,229.02	2,265.91
1959	20.1	88.2	11,577.60	5,865.12	5,712.48	8	3,421.30	6,749.57	1,163.57	8,948.71	1,442.20	2,068.20
1960	22.8	100.0	10,670.40	6,201.91	4,468.49	6	6,118.16	8,027.22	1,524.51	1,377.22	1,508.65	2,146.48
1961	13.9	61.0	6,943.05	7,014.74	- 71.69	2	5,177.80	7,040.68	1,018.48	1,789.25	1,553.82	2,483.82
1962	21.5	94.3	10,900.50	6,549.00	4,351.50	5	8,043.30	9,444.51	1,103.05	2,170.68	1,871.71	2,348.60
1963	11.5	50.5	7,279.50	9,003.00	-1,732.50	1	10,143.73	8,831.80	1,018.84	3,110.85	2,022.48	2,619.00
1964	21.4	93.9	14,958.60	9,860.00	5,098.60	7	19,183.11	10,701.57	1,080.45	2,519.31	2,619.23	2,745.25
"Stop-loss limit" of yield bus/ac.	14.0											
"Maintenance limit" of yield bus/ac.	19.5											

farmers could stand a drop of about seventeen percent,[4] below the 1960 yield, without lowering their standard of living. The crop yield of nineteen bushels per acre and approximately 353 acres under crop gave about $3,200 of net farm income. This was the "maintenance limit" for the period 1957-1964. The nineteen bushel criterion applies to all farmers regardless of the acreage, provided that the net farm income was at least $3,200. For example, in years when the net farm income was below $3,200, farmers borrowed money, used cash or grain reserves in order to cover family expenses (Table XV).

In Figure 10 all the firms' business expansion path (saving schedule) is not a straight line because of changes in the prices and cropping pattern during 1957-1964.

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[4]Average yield in 1960 (22.8 bushels) minus the maintenance limit yield (19 bushels) equals 3.8 bushels. $\frac{3.8}{22.8} \times 100 = 16.7\%$

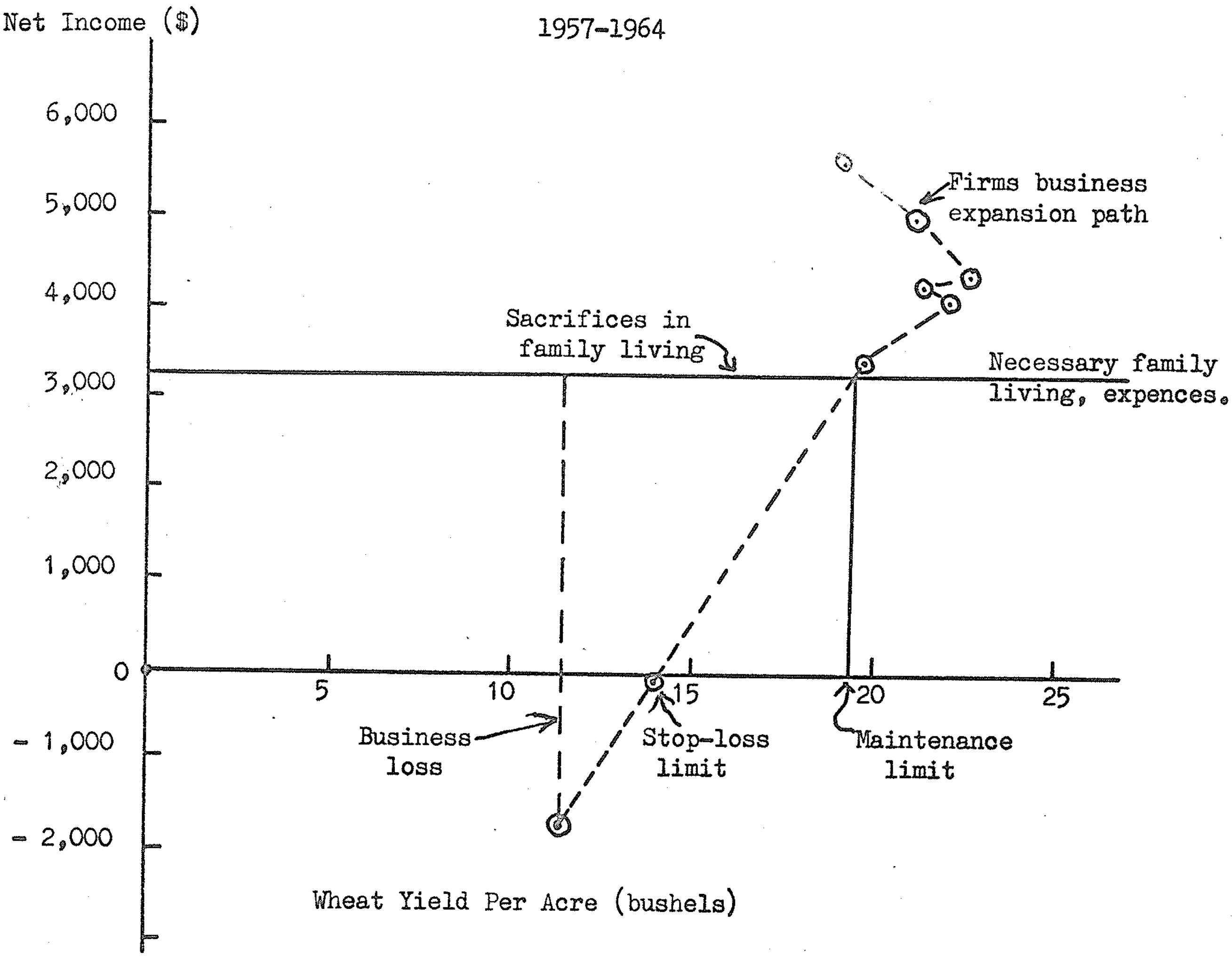

FIGURE 10

EFFECT OF THE CROP YIELD INSTABILITY ON NET INCOME FROM GRAINS IN THE CARMAN DISTRICT OF MANITOBA

CHAPTER VII

FARM RECORD ANALYSIS

The present chapter analyzes two farm businesses in detail. It reveals strengths and weaknesses of the farm businesses chosen for the study. The costs of production, farm incomes inventory changes and net worths are calculated for eight years (1957-1964) for each of the farms. The maintenance levels of net farm income have been worked out for the base year 1960. In later sections, linear programming is used to calculate net returns from different alternative farm plans. Also the role of business diversification and crop insurance in stabilizing farm incomes has been compared for each case farm. In the final section the expected net farm returns from different alternatives in any year (good or poor) have been worked out. Tables XVI and XVII show an anatomy of the farm business during the eight years of operation.[1]

Structure of the Farm Businesses

Yearly fluctuations in the net farm income are mainly due to changes in the farm prices and the weather conditions. Though the weather conditions in the area studied were fairly normal in 1958, relatively low crop prices[2] reduced the net income in this year on Farm A (Table XVI). Farmer A received over $3,200 net income in the 1961 drought year. This income was the lowest during the eight years (1957-1964) of the business operation.

The value of the total farm capital reflects the firm's business expan-

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[1] See Appendix IV for a glossary of terms used in this chapter.

[2] See Appendix VI.

TABLE XVI

SIZE AND FINANCIAL COMPARISON (1957-1964) FOR FARM A

ITEM	1957	1958	1959	1960	1961	1962	1963	1964
Acres Improved	638	608	578	535	611	658	681	753
" Total	648	628	591	548	624	708	691	788
P.M.W.U. (i) crops	279	263.75	231	185	256	280.5	247.4	361.9
(ii) livestock	42	18.50	4	-	-	-	-	-
" Total	321	282.25	235	185	256	280.5	247.4	361.9
Farm Receipts								
1. a) crops	7,638.88	8,321.69	8,959.47	11,042.46	11,215.71	12,141.03	18,246.72	24,025.00
b) livestock	2,424.93	69.00	510.00	-	-	-	-	-
c) custom work	844.75	1,006.60	770.00	298.28	1,473.21	2,401.00	781.94	422.00
2. Miscellaneous[a]	628.70	1,776.36	911.30	700.72	1,311.72	1,049.95	1,052.20	2,617.00
3. Crop Inventory (±)	1,365.00	- 1,073.00	1,700.00	1,550.00	- 1,800.00	9,530.00	300.00	- 2,400.00
TOTAL RECEIPTS	12,901.76	10,100.65	12,850.77	13,591.46	12,200.64	25,121.98	20,380.86	24,664.00
Farm Expenses ($)								
1. Cash operating	5,302.08	4,659.88	3,713.45	4,067.23	5,056.96	6,184.59	7,429.02	8,881.00
2. Depreciation (bldgs & mach)	850.88	981.73	289.34	1,368.53	1,970.00	2,375.80	3,259.08	2,615.00
3. Farm overhead	1,180.83	1,067.15	1,164.38	2,221.25	1,944.00	2,386.62	1,304.72	1,318.00
TOTAL EXPENSES	7,333.49	6,708.76	5,167.17	7,657.01	8,970.96	10,947.01	11,992.82	12,814.00
NET FARM INCOME	5,568.27	3,391.89	7,683.60	5,934.45	3,229.68	14,174.97	8,388.04	11,850.00
Interest on operator's equity[b]	1,105.45	926.60	1,315.45	1,594.40	1,659.80	2,324.70	3,637.75	3,904.95
Operator's labor earnings[c]	6,673.72	4,318.49	8,999.05	7,528.85	4,889.48	16,499.67	12,025.79	15,754.95
Land	19,400.00	19,400.00	19,400.00	31,400.00	31,400.00	31,400.00	55,000.00	55,000.00
Buildings	785.00	493.00	-	-	-	200.00	4,611.00	2,339.00
Livestock	500.00	350.00	150.00	-	-	-	-	-
Grain & Feed	4,913.00	-	5,590.00	6,140.00	5,340.00	14,870.00	13,250.00	10,850.00
Supplies[d]	18.00	-	-	-	-	-	-	-
Machinery	8,124.00	9,205.00	13,928.00	19,723.00	20,093.00	25,088.00	26,496.00	37,240.00
TOTAL FARM CAPITAL	33,740.00	29,448.00	39,068.00	57,263.00	56,833.00	71,558.00	99,357.00	105,429.00
Personal Assets	2,450.00	2,500.00	2,925.00	3,600.00	3,800.00	4,050.00	1,300.00	178.00
TOTAL ASSETS	36,190.00	31,948.00	41,993.00	60,863.00	60,633.00	75,608.00	100,657.00	105,607.00
Liabilities								
1) long term	9,000.00	4,870.00	8,642.00	20,000.00	20,000.00	19,678.93	19,341.81	18,985.00
2) intermediate term	2,631.00	6,046.00	4,117.00	5,375.00	3,637.00	5,385.00	7,260.00	8,345.00
TOTAL LIABILITIES	11,631.00	10,916.00	12,759.00	25,375.00	23,637.00	25,063.93	26,601.81	27,330.00
Net Worth	24,559.00	21,032.00	29,234.00	35,488.00	36,996.00	50,544.07	74,055.00	78,277.00
Financial Progress	-	- 3,527.00	8,202.00	6,254.00	1,508.00	13,548.07	23,510.93	4,222.00
Asset-Liability Ratio	3.1	2.9	3.3	2.4	2.6	2.1	3.8	3.9
Operator's equity in business	22,109.00	18,532.00	26,309.00	31,888.00	33,196.00	46,494.07	72,755.19	78,099.00
TOTAL FARM CAPITAL-LIABILITIES Ratio (%)	65.5	62.9	67.4	55.7	58.4	65.0	73.2	74.1
Rate of Capital turnover	2.6	2.9	3.1	4.2	4.7	2.9	4.9	4.3

[a] Miscellaneous receipts include cash received under Wheat Board Payment programs, hail and crop insurance, landlord's share and patronage payments.

[b] Operator's equity in business= Total farm capital - Total liabilities.

[c] Operator's labor earnings = Net farm income + 5% interest on operator's equity in business.

[d] Farm supplies include gasoline, oil, grease, fertilizer, spray, supplements, etc.

sion path and the tendency towards enlarging the business size. A regular increase in the land value and relatively less investment in cattle during 1957-1964 shows the farmer's tendency towards specialization in crop production (Table XVI). Similarly, a regular increase in the investment for machinery and implements is due to a complementary increase in the land investment.

Farm liabilities are classified on a time basis. Long term loans are taken as five years or over, intermediate term loans as one to four years and short term loans are taken as less than one year. The latter do not appear on Farm A. This indicates that annual farm receipts have been sufficient to cover yearly farm expenses. Increases in the long and intermediate term liabilities were due to increase in machinery investment.

Net worth figures during 1957-1964 reflect the financial progress on the farm. There was no financial progress during 1957-1958. This was due to the decrease in crop inventory. The farm business had progressed except for a slight setback during 1960-1961. Relatively low prices in 1960 and extremely dry weather in 1961 were again the causes of this recession.

The asset-liability ratio, operator's equity in the business and the rate of capital turnover varied greatly on Farm A during 1957-1964. This variation has been mainly due to the fluctuations in the farm production and prices. The rate of capital turnover indicates the number of years for a dollars value of the annual farm production which can be invested during these years, for example, in 1963 it was 4.9 (Table XVI). It shows that the annual farm receipts of approximately $20,381 in 1963 could be invested for about five years. In other words, if the farm capital and the receipts in 1963 remained unchanged, the farm receipts of $20,381 will equal the annual investment in about five years. The rate of capital turnover does not indicate farm profit, however. The lowest rate of capital turnover in 1957, can be interpreted similarly.

Table XVII provides the record analysis of Farm B, which is on an entirely different type of soil from Farm A. Yearly fluctuations in net income on Farm B are mainly due to farm production and price changes.

The net farm incomes in the 1962 crop year was not enough even to cover the necessary family living expenses[3] ($3,161) on Farm B (Table XVII). The farmer might have covered his living expenses by using borrowed capital, or grain reserves or by sacrificing the savings included in the personal assets (Table XVII). The net farm income in the 1961 drought year was the third highest during eight years of business operation inspite of the lowest yields per acre in this year.[4] This was due to a higher level of wheat prices in 1961.[5] The increased level of prices in 1961 offered an opportunity to the farmer to dispose of his surplus grain on the farm.

The farm capital during 1957-1964 shows an upward but fluctuating trend. Investment in cattle and other livestock increased regularly from 1957-1960. It dropped relatively in 1961 and reached the maximum in 1962. In 1963 the investment in the beef cattle was only $300 but in 1964 it increased to $2,380.

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[3]See Table XXII.

[4]See Table XIX.

[5]See Appendix VI.

TABLE XVII

SIZE AND FINANCIAL COMPARISON (1957–1964) FOR FARM B

	1957	1958	1959	1960	1961	1962	1963	1964
	620	620	620	620	620	637	635	635
	640	644	640	640	640	640	640	640
	230.7	296.0	231.5	241.8	202.5	240.0	180.6	187.7
	41.5	54.4	55.5	94.0	98.5	25.0	26.8	20.9
	272.2	350.4	287.0	315.8	301.0	265.0	207.4	208.6
	6,143.31	7,709.82	11,909.02	4,502.08	8,543.09	10,136.87	5,470.00	11,148.00
	563.12	1,740.90	5,908.74	10,707.06	19,817.27	12,186.81	12,482.00	4,316.00
	-	-	15.00	-	45.00	85.00	-	-
	1,413.68	991.81	1,570.23	2,034.08	2,259.74	2,269.27	1,682.00	1,495.00
	512.12	3,911.00	- 6,770.00	1,410.00	1,260.00	- 2,120.00	-	-
	8,632.23	14,353.53	12,632.99	18,654.12	32,225.10	22,557.95	19,364.00	16,959.00
	2,980.52	4,352.96	7,201.47	12,351.16	22,589.97	16,700.77	9,281.00	10,629.00
n)	1,052.25	1,679.59	699.00	740.00	1,018.00	1,315.00	1,160.00	860.00
	1,240.95	1,136.19	1,225.27	1,354.07	1,645.75	1,975.21	1,317.00	1,546.00
	5,273.72	7,168.74	9,125.74	14,445.23	25,253.72	19,990.98	11,758.00	13,035.00
	3,358.51	7,184.79	3,507.25	4,208.89	6,971.38	2,566.97	7,606.00	3,924.00
	2,124.96	2,384.02	2,138.95	2,113.82	2,163.71	1,715.14	1,758.30	2,960.75
	5,483.47	9,568.81	5,646.20	6,322.71	9,135.09	4,282.11	9,364.30	6,884.75
	25,600.00	25,600.00	25,600.00	25,600.00	31,000.00	32,000.000	32,000.00	52,000.00
	750.00	-	-	-	8,315.00	-	-	-
	730.00	1,565.00	5,714.00	8,190.00	5,020.00	11,000.00	300.00	2,380.00
	6,860.00	12,570.00	5,800.00	7,160.00	6,620.00	4,300.00	8,198.00	7,626.00
	300.00	110.00	318.80	320.60	305.60	205.60	330.00	350.00
	12,439.28	10,705.89	10,811.30	10,019.30	8,745.00	7,830.00	7,155.00	8,180.00
	46,679.28	50,550.89	48,244.10	51,289.90	60,005.60	55,335.60	47,983.00	70,536.00
	11,765.00	10,800.00	13,950.00	10,500.00	14,451.18	11,201.18	13,048.00	13,303.00
	2,885.00	2,409.51	462.96	457.46	394.46	207.00	65.00	-
	61,329.28	63,760.45	62,659.06	62,247.36	74,851.24	66,743.78	66,096.00	83,839.00
	-	1,875.30	3,914.10	-	14,500.00	12,214.44	10,225.00	8,075.00
	4,180.00	1,000.00	1,551.00	9,013.44	2,231.24	8,814.29	2,592.00	3,246.00
	4,180.00	2,870.30	5,465.10	9,013.44	16,731.24	21,032.73	12,817.00	11,321.00
	57,149.28	60,890.15	57,191.96	53,233.92	58,120.00	45,711.05	48,279.00	72,518.00
	-	3,740.87	- 3,698.19	- 3,958.04	4,886.08	-12,408.95	2,567.95	24,239.00
	14.7	22.2	11.5	6.9	4.5	3.2	4.8	7.4
	42,499.28	47,680.59	42,779.00	42,276.46	43,274.36	34,302.87	35,166.00	59,215.00
	91.1	94.3	88.7	82.6	72.1	62.1	73.3	83.9
	5.4	3.5	3.8	2.8	1.9	2.5	2.5	4.2

lude cash received under Wheat Board Payment programs, hail and crop insurance, landlord's share

ess = Total farm capital = Total liabilities.

= Net farm income + 5% interest on operator's equity in business.

The investment in the livestock enterprises reflects the farmer's investment decisions after a crop failure. In a poor crop year or in the following year the farmer increased the investment in the beef cattle or other livestock. For example, in 1961 which was a year of crop failure, the operator invested $11,000 in beef cattle enterprise, which was the highest amount of investment in cattle during eight years of business operation (Table XVII). Similarly a low receipt from crops in 1963 ($5,470) is followed by increased investment in cattle during 1964. The implication of this increase in livestock investment is that: (a) either the farmer expected a poor crop year in future following a crop failure or (b) he wanted to compensate for crop income loss by raising some livestock in an unfavorable crop year. A sudden increase in the real estate value after 1960 is due to farm rentals.

Unlike Farm A, Farm B had no long-term liabilities. It shows that the farmer's own funds and the intermediate loans during 1957-1964 were enough to rent land or to construct buildings for livestock. Short-term loans varied according to the investment in land and in the livestock enterprises. This indicates that yearly net farm income did not cover the feed expanses for the livestock and the seed, fertilizer and the miscellaneous expenses for the crop enterprises. In order to meet these yearly farm expenses the farmer resorted to the short term loans.

The yearly net worth figures which reflect the farm's financial progress are affected mainly by the levels of farm production and prices, annual farm expenses, and the assets and the liabilities. However, the negative financial progress during 1959-1960 and in 1962 was due to a relatively low price level in 1959-1960 and the drought in 1961. Similarly a great variation in the asset-liability ratio was due to the variations in the crop yields and prices. The reason for this variation was a proportionately higher farm capital than farm receipts in 1957 and relatively lesser farm capital and higher farm receipts in 1961.

Technical Efficiency of the Case Farms

The farmer's technical ability and the degree of efficient use of the farm resources are the key factors affecting farm production. The technical ability of the farmer is reflected in the gross expense ratio, machinery costs and investment per improved acre, yield per acre, value of production per improved acre and the units of productive work per month of labor on the farm. This is shown in Tables XVIII and XIX for both Farms A and B for the period 1957-1964.

A high gross expense ratio on Farm A, and the corresponding low crop yields per acre show that this farm failed to allocate resources efficiently during 1957-1964. In every year except in 1959 the gross expense ratio is above 45 percent and reaches the climax in 1961 (82.4%). This again indicates that the resource combination on this farm was not efficient and more was being spent than the value of the farm production. A gross expense ratio of about 43 percent would have given the maximum returns to this farm.

Comparison of the machinery investment per acre and the value of crop production per acre is another measure of farm efficiency. The value of crop production per acre was higher than the machinery investment per acre during 1957-1964. This shows that the manual labor saved due to investment in machinery increased the labor efficiency and the value of the farm production every year.

TABLE XVIII

RESOURCE EFFICIENCY ON FARM A (1957-1964)

	1957	1958	1959	1960	1961	1962	1963	1964		
Improved Acres	638	608	578	535	611	658	681	753		
No. of animal units	2.4	2.4	1.7	-	-	-	-	-		
Cost of farm production ($)	7,333.49	6,708.76	5,167.17	7,657.01	8,970.96	10,947.01	11,992.82	12,814.00		
Value of farm production* ($)	12,273.06	9,027.65	11,939.47	12,890.47	10,888.92	24,072.03	19,328.66	22,047.00		
Gross Expense Ratio (%)	59.8	74.3	43.3	59.4	82.4	45.5	62.1	58.2		
Value of Cattle Inv. ($)	1,410.00	350.00	350.00	-	-	-	-	-		
Value of Hog Inv. ($)	140.00	-	-	-	-	-	-	-		
Value of Cattle Prod. ($)	1,087.00	147.00	310.00	-	-	-	-	-		
Value of Hog Prod. ($)	290.00	-	-	-	-	-	-	-		
Value of Crop Prod. ($)	9,003.38	7,284.69	10,659.47	12,592.46	9,415.71	21,671.03	18,546.72	21,625.00		
Value of Cattle Prod./$100Inv.	70.09	42.00	88.57	-	-	-	-	-		
Value of Hog Prod./$100Inv.	207.14	-	-	-	-	-	-	-		
Value of Crop Prod./Imp. ac.($)	14.12	11.98	18.44	23.54	15.41	32.94	27.24	28.72		
Mchn. Cost /Imp. ac. ($)	6.57	6.95	6.65	10.30	9.76	12.38	11.98	10.58		
Mchn. Inv./Imp. ac. ($)	2.09	2.98	12.75	10.02	8.92	13.03	10.57	10.28		
Units of Prod. work/month of labor	17.2	15.4	14.5	11.7	16.3	16.2	20.6	28.7		
<u>Yield per Acre</u>									Total	Average
Wheat (Bushels)	24.6	26.3	31.9	43.0	17.6	28.3	9.4	27.0	208.7	26.1
Oats "	36.5	41.1	50.0	75.0	25.3	60.0	60.0	54.6	402.5	50.3
Barley "	20.0	20.0	25.0	30.0	-	-	-	-	95.0	11.8
Flax "	4.7	-	-	13.8	0.5	11.8	15.8	9.3	55.9	6.9
Peas "	20.0	-	83.0	-	7.4	21.8	17.0	25.9	175.1	21.8
Buckwheat "	-	7.5	-	-	-	24.1	-	-	31.6	3.9
Corn "	-	-	-	-	-	-	-	16.5	16.5	2.6
Sunflowers (lbs.)	448.0	375.0	8,000.0	1,000.0	875.0	1,500.0	765.7	887.0	13,850.1	1,731.3
Hayseed "	-	-	-	75.0	-	-	-	-	75.0	9.3
Tame hay (tons)	-	-	7.5	-	-	-	-	-	7.5	0.9
Alfalfa hay (bales)	75.0	0.4	-	-	-	-	-	-	75.4	9.4

*Total Farm Receipt minus miscellaneous receipts; see Table XVI

TABLE XIX

RESOURCE EFFICIENCY ON FARM B (1957-1964)

	1957	1958	1959	1960	1961	1962	1963	1964		
Improved Acres	620	620	620	620	620	637	635	635		
No. of animal units	3.1	7.4	6.6	9.4	14.0	5.0	26.8	20.9		
Cost of farm prod. ($)	5,273.72	7,168.74	9,125.74	14,445.23	25,253.72	19,990.98	11,758.00	13,035.00		
Value of farm prod. ($)*	7,218.60	13,361.72	11,062.76	16,619.11	29,665.36	20,388.68	17,952.00	15,464.00		
Gross expense ratio (%)	73.1	53.7	82.5	86.9	85.2	98.1	65.5	84.3		
Value of Cattle Inv. ($)	380.00	380.00	4,594.00	13,220.00	17,820.00	17,294.00	11,000.00	4,669.00		
Value of Hog Inv. ($)	300.00	677.00	955.00	374.00	190.00	-	132.00	120.00		
Value of Cattle Prod. ($)	539.00	371.00	996.00	2,163.00	10,100.00	- 257.60	1,476.00	1,403.00		
Value of Hog Prod. ($)	167.00	1,085.00	1,019.00	559.00	86.00	-	168.00	80.00		
Value of Crop Prod. ($)	6,665.43	11,620.82	5,139.02	5,912.08	9,803.09	8,016.87	5,470.0	11,148.00		
Value of cattle prod./$100Inv.	141.80	97.63	21.65	16.36	56.68	-1.49	13.42	30.05		
Value of hog prod./$100 Inv.	55.67	159.56	106.15	147.11	45.27	-	12.00	66.67		
Value of crop prod./Imp. ac ($)	10.74	18.75	8.20	9.54	15.81	12.59	8.62	17.56		
Mchn. cost /Imp. ac. ($)	6.20	6.90	6.70	7.82	7.64	6.94	4.81	5.25		
Mchn. Inv./Imp. ac. ($)	7.42	0.45	5.37	-	0.38	0.44	2.31	3.07		
U. of Prod. work/month of labor	13.4	16.7	13.8	11.7	13.5	14.2	15.1	15.7		
Yield per Acre									TOTAL	AVERAGE
Wheat (Bushels)	23.0	23.2	10.5	22.5	10.7	21.4	11.2	15.7	138.2	17.2
Oats "	44.4	58.8	27.1	26.3	12.1	42.1	34.9	36.1	281.8	35.2
Barley "	14.0	30.0	-	-	-	-	21.7	40.5	106.2	13.2
Flax "	5.0	10.0	6.0	5.9	-	5.9	3.0	7.9	43.7	5.4
Sunflowers (lbs)	-	216.4	-	-	-	-	-	-	216.4	27.0
Brome seed "	280.0	-	-	-	-	-	-	-	280.0	35.0
Tame hay (tons)	-	-	3.6	1.7	-	7.5	-	1.0	13.8	1.7

*Value of the farm production = Total farm receipts minus miscellaneous receipts,; See Table XVII.

Farmer A kept beef cattle for three years. Returns from this activity were not very satisfactory. The value of cattle production for a one hundred dollar investment during 1957-1959 varied from $42 to over $88 per annum. Hogs were raised only in one year 1957, and the return was over $207 per $100 invested. This rate of return, unlike that from the beef cattle enterprise, was very promising.

This indicates that further investigation should be made in the cattle enterprises in order to find the causes of the low return to investment. The problem in this case seems to be of the farmer's preference rather than of size. Besides obtaining a low investment return from cattle, the farmer raised them for three years and although hogs gave a high investment return, he gave them up after one year. Thus the problem of low efficiency in the livestock enterprises is not the main concern of this farmer. It appears that either the farmer had no liking for the particular profitable livestock enterprise or he wanted to use the labor thus saved for custom work (Table XVI).

The value of crop production per acre varied from about $12 to over $32. As can be expected the reasons for this variation are changes in the price level and in the volume of farm production. In spite of the low price level in 1960 the return per acre from crops was over $23 due to the high yields per acre. Though the 1963 crop year was very similar to the 1961 crop year so far as the yields per acre are concerned, a high price per bushel due to the increase in the foreign demand for Canadian wheat resulted in a return of about $28 per acre. Crop production on Farm A has been reasonably efficient in covering increasing farm costs, except for the years when certain unavoidable factors such as the prices and weather reduced the returns from crops. But from the gross expense ratio point of view Farm A suffered from inefficiency: farm expenses were greater than the value of farm production between 1957 and 1964. Farm A did not hire any extra labor during 1957-1964. All the labor was supplied by the operator himself or by his family. This farm accomplished over twelve units (ten hour day) of productive work per month of available labor in 1960 and over twenty-eight units of productive work per month of available labor in 1964. These labor units are the standard measure of the directly productive work which is associated with a livestock or crop program. The farmer has been doing substantial custom work outside the farm (Table XVI). It appears that farmer A has been 'overworked' and perhaps will be overworked in the future since from 1962 on units of productive work each month of labor have increased (Table XVIII). Assuming that livestock prices like wheat prices will be reasonably stable in the future, introduction of livestock on this farm will not only minimize the income losses due to the crop failures but also provide a well balanced productive workload and a greater return.

Table XIX shows the gross expense ratio of production and investment on Farm B during 1957-1964. The gross expense ratio was over fifty-three during the eight years of the business operation. The yield per acre in the corresponding years were also not high. A comparison of the gross expense ratio and the corresponding crop yields in the same year gives a picture of the resource inefficiency. For example, the gross expense ratio in 1958, gave a greater yield per acre than the higher gross expense ratio experienced in the later years. It means that the same output can be obtained by using less inputs or at a lower cost.

Such a high gross expense ratio also reflects the farmer's inability to organize his business. For example the farmer did not invest money to buy the machines, but the machinery cost per acre was higher than the machinery investment during 1957-1964 except in 1957. This indicates that the farmer used old machines and paid a high cost for repairing them. The size of the farm was unchanged during 1957-1964. This shows that a high gross expense ratio was due to the farmer's inability to organize and operate the farm efficiently. Reduction in the gross expense ratio may be brought by replacing the old machinery by the new one, and introducing the hog program on the farm which, assuming the prices remained reasonably constant, would give as high a return to the investment as was obtained in 1958.

The beef cattle enterprise appears to be weak on Farm B. The value of cattle production per $100 investment was not sufficient to cover the cost of cattle production except for the year 1957. In fact, in 1962, this enterprise gave a loss of $1.49 per $100 investment (Table XIX). Given proper care beef cattle may be replaced by hogs which would give higher returns in conjunction with crops.

On Farm B the available family labor was sufficient for the farm enterprises. More units of productive work per month of labor are accompanied by a higher value of livestock production each year. This indicates that the operator's productive labor got more employment in association with a crop and livestock enterprise. The present labor employment seems to be well balanced and if the farmer carries on this program higher returns from the crops and livestock enterprises may be expected in the future.

<u>Production Assets and the Net Farm Income</u>

Table XX shows the amount of farm capital investment required to generate one dollar of the net income on Farm A. The proportion of farm income needed to cover cash expenses varies with the farm capital investment. In 1961 and 1963, the capital investment required to produce one dollar of net income was over eleven dollars and was higher than any other crop year. This was due to low crop yields per acre in these years compared with other crop years (Table XVIII). The amount of cash or gross farm income required to cover the production expenses was also higher in the poor yield or price years than the normal years. For example, the farm income spent to cover the farm expenses was over 66%, 73% and 58% in 1958, 1961 and 1963 respectively and a high (over 58%) percentage of the farm income was spent to cover these expenses. It indicates that a poor price or yield year brings a much greater threat of loss and bankruptcy than a normal year without the weather or price hazards.

Table XXI shows the production assets and the net farm income on Farm B. The amount of capital investment required to generate one dollar of the net income varied from over $8 to over $21 during 1957-1964. Though 1961 and 1963 were relatively low crop years and 1958 was a low price year, the amount of capital investment required to generate one dollar of the net farm income was over $8, $6 and $7 respectively. It shows that uncertainty of crop production and prices did not affect Farm B in these years. Unlike Farm A, the capital requirement was not high during the low production and price years on Farm B. However, a cumulative effect of 1958, 1961 and 1963 years was shown in the subsequent years, 1959, 1962 and 1964 (Table XXI). In these years a higher capital investment than the preceding year was required to generate one dollar of the net farm income. Similarly, though gross farm incomes required to cover the cash expenses during 1958, 1961 and 1963 were relatively

TABLE XX

PRODUCTION ASSETS, NET FARM INCOME AND RATIO OF ASSETS TO THE NET FARM INCOME ON FARM A, 1957-1964

Year	Farm Production Assets or Farm Capital ($)	Net Farm Income ($)	Asset/Dollar of Net Income ($)	Total Cash Expenses as a % of the Total Farm Receipts (%)
1957	33,740.00	5,568.27	6.05	56.84
58	29,448.00	3,391.89	8.68	66.41
59	39,068.00	7,683.60	5.08	40.20
60	57,263.00	5,934.45	9.64	56.33
61	56,833.00	3,229.68	17.59	73.52
62	71,558.00	14,174.97	5.04	43.57
63	99,357.00	8,388.04	11.84	58.84
64	105,429.00	11,850.00	8.89	51.95

TABLE XXI

PRODUCTION ASSETS, NET FARM INCOME AND RATIO OF ASSETS TO THE NET FARM INCOME ON FARM B, 1957-1964

Year	Farm Production Assets or Farm Capital ($)	Net Farm Income ($)	Asset/Dollar of Net Income ($)	Total Cash Expenses as a % of the Total Farm Receipts (%)
1957	46,679.28	3,358.51	13.89	61.09
58	50,550.89	7,184.79	7.03	49.94
59	48,244.10	3,507.25	13.75	72.23
60	51,289.90	4,208.89	12.18	77.43
61	60,005.60	6,971.38	8.60	78.36
62	55,335.60	2,566.97	21.55	88.62
63	47,983.00	7,606.00	6.30	60.72
64	70,536.00	3,924.00	17.97	76.86

lower, the cumulative effect of the low price and production years was shown by a high cash expense and the total farm receipts ratios in the subsequent years. The implications of this fact are that a poor price or yield year may not necessarily make the farmer more vulnerable to yield or income losses in the same year, but a much greater threat of loss and bankruptcy might come in the following year.

Tables XX and XXI call for some planning strategies. How do farmers meet these growing risks? How do they cover the rapid increase in inputs and capital investments? The answer to these problems is provided by the farmers' management or planning activities. The farmer's experience with diversification and the crop insurance (discussed later) will tell how to meet these contingencies. Tables XX and XXI support the fourth hypothesis which asserts that the risk of income loss increases when the greater proportion of inputs are purchased in the form of capital investment to generate the income.

The Maintenance Limits

This section discusses the maintenance limits of the crop yields and the net farm income on each of the farms. The "maintenance limits" were calculated for the base year 1960 on the basis of actual crop yields and prices received by the farmers during that year. The crop production and prices were converted into a common unit of a hundredweight so that the maintenance limits of crop yield are in hundredweight per acre. The actual family expenses and the costs of crop production during 1960 were used to define the maintenance and the stop-loss limit of the crop production. Table XXII shows average incomes, crop yields and maintenance limits on both the farms in 1960.

The postponement of certain farm expenses in one year leaves more money

TABLE XXII

AVERAGE INCOME AND YIELD FROM CROPS ON FARMS A AND B IN 1960 (AT 1960 PRICES)

	FARM A	FARM B
Acres in farm	548	640
Acres under crops	535	620
Gross income from crops[a]	$19,067.40	$12,759.60
Total cost of the crop production[b]	7,657.01	14,445.23
Postponable expenses[c]	3,589.78	2,094.07
Net income without postponing the expenses	11,410.39	- 1,685.63
Net income with the postponment of the expenses	15,000.17	408.44
Family expenses[d]	2,036.30	3,160.88
Income available for the business expansion over one year	9,374.09	- 4,846.51
Income available for business expansion in one year	12,963.87	- 2,752.44
Average crop yield: cwt per acre	10.8	8.4

[a]In calculating the gross income for Farm A, an average crop price of $3.30 per cwt and average crop yield of 10.8 cwt per acre were used. The gross income for Farm B was calculated at the price of $2.45 per cwt and an average crop yield of 8.4 cwt.

[b]Total cost of farm production includes fixed and variable expenses. The former includes depreciation on buildings and machinery, taxes and interest. The latter includes hired labor, farm machinery operating cost, seed, commercial fertilizer, pesticides and other crop expenses.

[c]Postponable expenses are the part of the fixed expenses and include depreciation on machineries, buildings and the interest on the investment.

[d]The total family expenses on Farm B were $6,160.88 in 1960. But an amount of $3,000.00 was deducted from the original family expenses since the farmer spent approximately $3,000.00 for the non-farm use.

(Table XXII) for business expansion than without any postponement. However, this depends on the vulnerability of the business.

In Table XXIII the effect of the variable crop yields on both the farms have been analysed. This is based on the assumption that the cropping program and the production costs are about the same whether crop yields turn out to be two or twenty hundredweight per acre.

With a crop yield of two to four hundredweight per acre Farm A gets negative net farm income. Farm B is more affected than Farm A, and gets negative net farm income with a crop yield of two to about nine hundredweight per acre. With the crop yield approximately 5.4 and 10.1 hundredweight per acre, farmers A and B are left with a net income of $1,877 and $897 respectively. These net incomes would not cover the family expenses even for one year on Farm A and four months on Farm B. At the actual cost and prices in 1960, the "stop-sacrifice limit" for Farms A and B is 4.4 and 9.6 hundredweight respectively. At these yields per acre, both the farms just break even, leaving practically nothing for the family expenses or the business expansion. The "maintenance limit" of crop yield per acre is 5.5 and 11.6 hundredweight for farmers A and B respectively. These yields give net incomes of approximately $2,053 and $3,175, which just covers the family living expenses of Farms A and B respectively.

Figures 11 and 12 show that as soon as the crop yields drop below the maintenance limit, sacrifices in the family living expenses and consumption debts begin. However, regarding the maintenance limit, Farm A which is on the Altona Fine Loam soils has a greater advantage than Farm B which is on the Osborne Clay soils. Farm A can stand a forty-nine percent below average yield

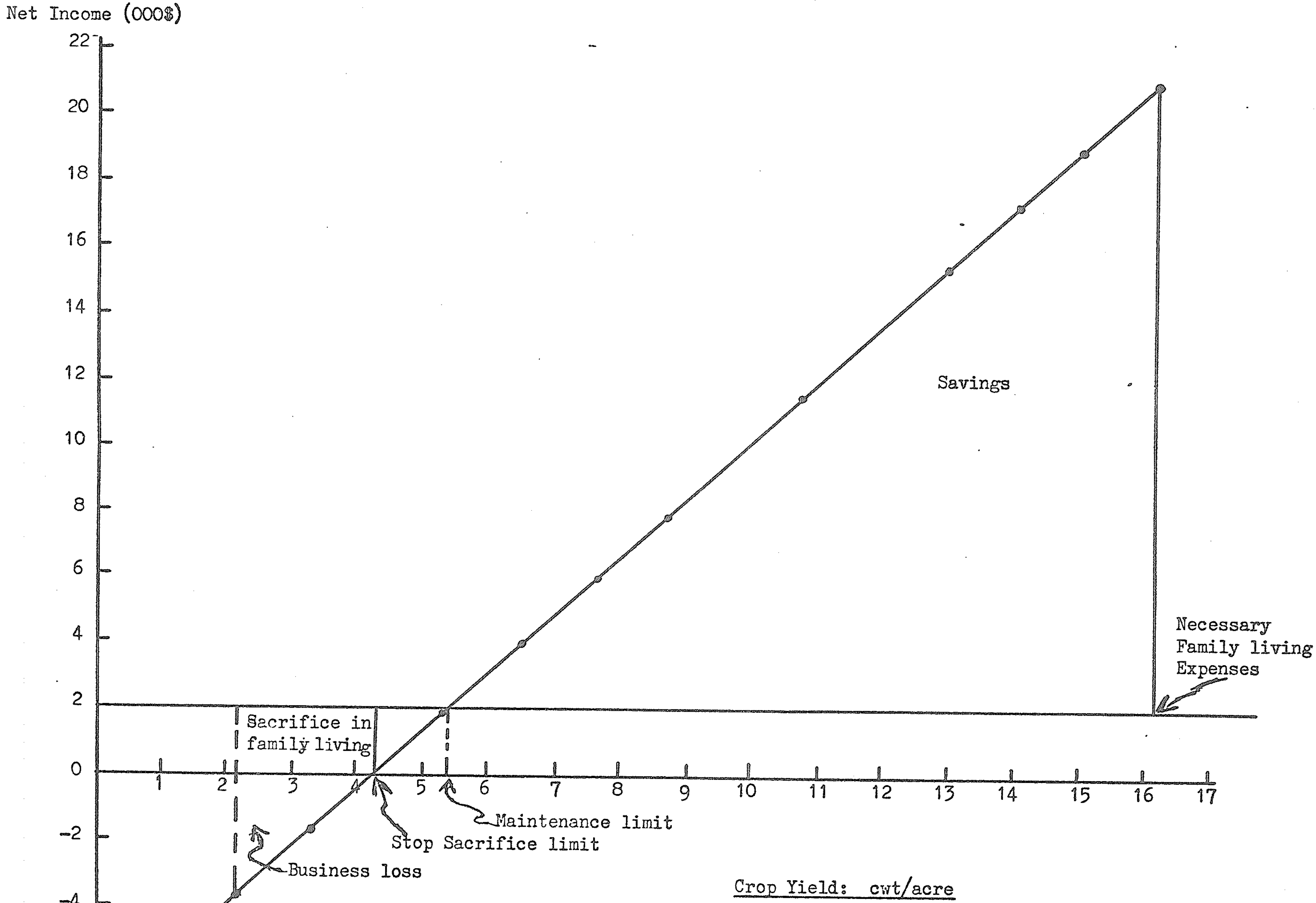

FIGURE 11

MAINTENANCE AND THE STOP-SACRIFICE LIMITS ON FARM A IN 1960

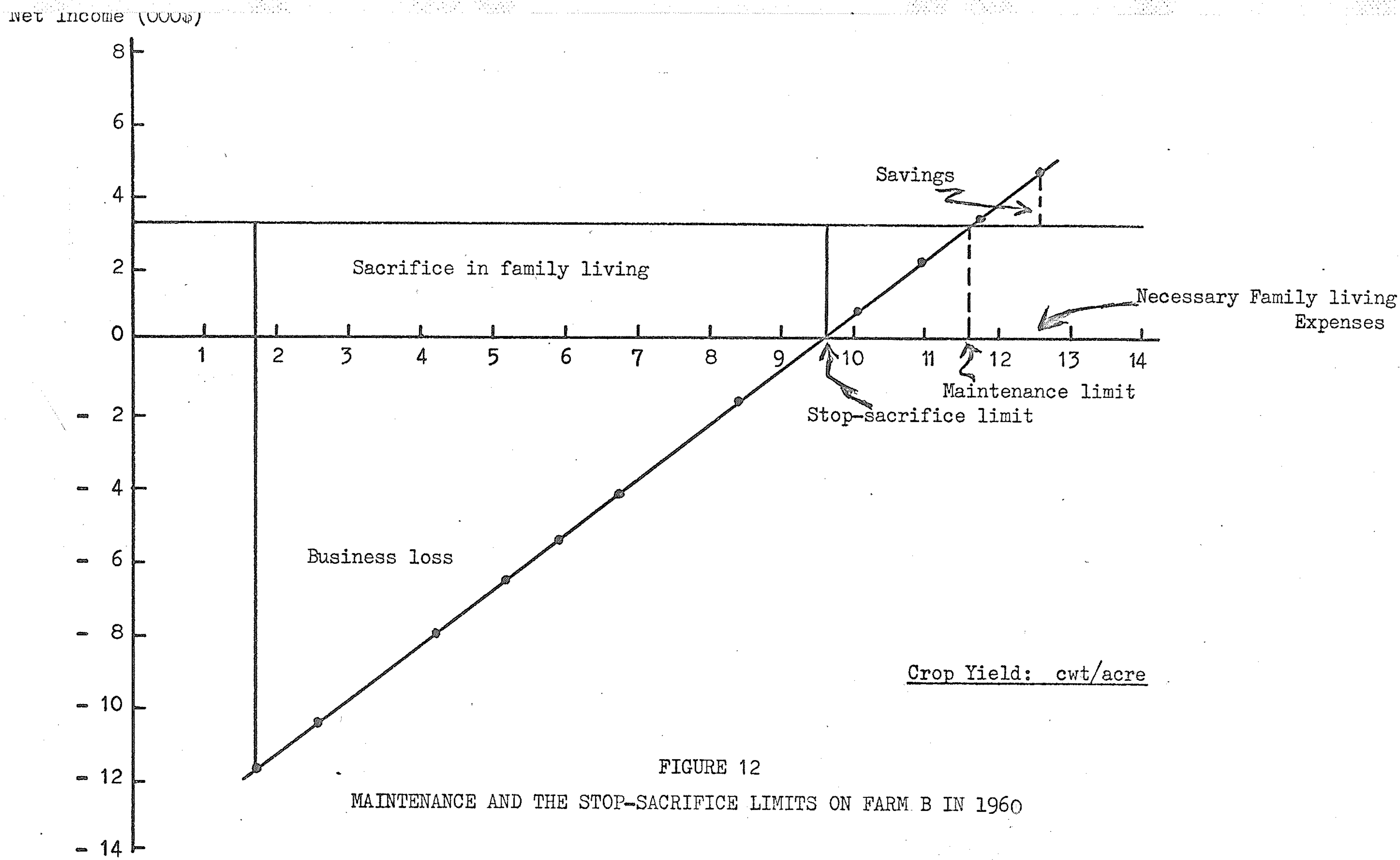

FIGURE 12

MAINTENANCE AND THE STOP-SACRIFICE LIMITS ON FARM B IN 1960

TABLE XXIII

STOP SACRIFICE AND THE MAINTENANCE LIMITS OF CROP PRODUCTION DURING 1960 AT DIFFERENT CROP YIELDS

	Crop Production/acre (cwt)		Net Income ($)		Net Income after deducting family expenses ($)	
	Farm A	Farm B	Farm A	Farm B	Farm A	Farm B
20% of average	2.2	1.7	-3,772.91	-11,862.93	-5,809.21	-15,023.81
30% of average	3.3	2.6	-1,830.86	-10,495.83	-3,867.16	-13,656.71
50% of average	5.4	4.2	1,876.69	- 8,065.43	- 159.61	-11,226.31
60% of average	6.5	5.1	3,818.14	- 6,698.33	1,782.44	- 9,859.21
70% of average	7.7	5.9	5,937.34	- 5,483.13	3,901.04	- 8,644.01
80% of average	8.7	6.7	7,702.84	- 4,267.93	5,666.54	- 7,428.81
100% of average	10.8	8.4	11,410.39	- 1,685.63	9,374.09	- 4,846.51
120% of average	13.0	10.1	15,294.49	896.67	13,258.19	- 2,264.21
130% of average	14.1	11.0	17,236.54	2,263.77	15,200.24	- 897.11
140% of average	15.1	11.7	19,002.04	3,327.07	16,965.74	166.19
150% of average	16.2	12.6	20,944.09	4,694.17	18,907.79	1,533.29
"stop-sacrifice limit" of crop yield: cwt/acre	4.4	9.6	119.19	137.17		
"maintenance limit" of crop yield: cwt/acre	5.5	11.6	2,053.24	3,175.17	16.94	14.29

(10.8 cwt) without lowering the standard of living, whereas Farm B cannot cover even the necessary family expenses with the average yield (8.4 cwt) per acre. The average yield of 8.4 hundredweight per acre incurs a loss of over $1,685. This drop in the average crop production can be expected to occur in more than half of the 37 year (1926-1963) period.[6] At an eighty percent loss in the crop

[6] See Appendix V.

yields Farm A has $5,666 for the business expansion or as savings, but Farm B lacks over $7,400 to cover even the family expenses.

Results and Interpretations of Linear Programming Computations

As mentioned in Chapter V, five different crop programs were considered on each case farm, with or without different livestock enterprises. To facilitate the analysis of the impact of uncertain crop yields on the farm business, the results of linear programming analysis have been summarized in the succeeding tables separately.

As far as possible all the results supplied by the computer for each plan have been summarized in various tables in this section. Results of the linear programming analysis are presented in the following order:

(1) A summary of the results obtained from crop farming (without livestock enterprises) on both the case farms with actual and normalized crop yields.

(2) Summary of the results obtained from diversified farming (with crops and livestock enterprises) with the actual and normalized crop yields.

(3) Comparison of the results supplied by the computer on Farms A and B, with and without livestock enterprises.

(4) A summary of the results obtained from crop insurance on both the farms.

(5) Comparison of the results obtained from crop insurance and diversification on both the farms.

(6) The implications of the results with respect to crop insurance and diversification in the farmers' decision making to cover the maintenance limit in the event of crop failure.

Summary of the Results--Crop Farming

Results in Table XXIV show the net farm returns from crops on each case farm. Farmer A would have received higher returns than farmer B under the normal as well as under the poor crop years. This is partly because of the differences in soil fertility and partly due to the sequences followed on both

TABLE XXIV

SUMMARY OF THE NET CROP RETURNS ON CASE FARMS IN TERMS OF THE 1960 CROP YIELDS

FARM	NET CROP RETURNS ($)		
	Actual Crop Yields in 1960	Normalized Crop Yields in 1961	% Reduction Due to the 1961 drought[a]
A	18,512.76	7,879.83	57.4
B	12,818.65	2,271.00	82.2

[a] $\frac{\text{Net Returns in 1960} - \text{Net Returns in 1961}}{\text{Net Returns in 1960}} \times 100$

the farms, for example, Farm A was recommended to grow sugar beets whereas B's crop rotations could not include sugar beets due to the unsuitability of the soil. Farm A invested over $22,000 to get a net crop return of approximately $18,513 in 1960, whereas Farm B invested over $16,000 to get a net return of over $12,000. Farm A invested about $24,000 to get a net return of $7,880 in 1961. Farm B invested approximately the same amount of capital as in 1960, to obtain $2,271 as the net crop return in 1961. This shows that the uncertain crop yields do not bring a reduction in the production costs, rather they increase the costs and make the farmer more vulnerable to weather hazards.

Table XXV shows a comparison of the adjusted[7] net returns (net farm income) from linear programming and the net farm income from the records analysis. Farm A by his own plan received over $5,900 and $3,200 as the net farm incomes in 1960 and 1961 respectively. However, the programmed net farm incomes are higher than the actual incomes in both years. This difference again is due to the crop rotations suggested for Farm A. For example, Farm A did not grow

TABLE XXV

COMPARISON OF NET FARM INCOMES DERIVED FROM THE RECORD ANALYSIS AND LINEAR PROGRAMMING DURING 1960 AND 1961

	NET FARM INCOMES ($)					
	RECORD ANALYSIS*		LINEAR PROGRAMMING			
	Year		Year			
	1960	1961	1960		1961	
FARM			Straight Crops	Crops and Livestock	Straight Crops	Crops and Livestock
A	5,934.45	3,229.68	15,305.36	19,559.06	4,931.18	7,158.25
B	4,208.89	6,971.38	10,963.59	13,040.87	187.99	7,986.18

*Source: Tables XVI and XVII. Net farm incomes shown in the farm record analysis include income from crops and livestock enterprises. Because of the joint costs of production these net farm incomes have not been separated from crop and livestock enterprises. Linear programming analysis does not encounter this difficulty.

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[7]In order to have a valid comparison of the net farm incomes from linear programming and the record analysis five percent depreciation on machinery investment in 1960 and 1961 (Tables XVI and XVII) and the overhead costs in these years were deducted from the programmed crop returns. This adjustment of the

sugar beets in his actual farm plan, neither did he follow a systematic crop program. Since his land was suitable for this crop and his farm was located near the Manitoba Sugar Company in Winnipeg, he was able to get a contract to grow this crop. Sugar beets, therefore, was included in the recommended crop rotations. Rapeseed was also included in his crop programs, though farmer A did not grow this crop during 1957-1964. The final linear programming solution showed that during 1960, sugar beets could have contributed $1,440[8] to the net farm returns and in 1961 it could have given over $1,300[9] as the net farm returns. Rapeseed was similarly calculated as potentially contributing $2,232 to the 1960 net farm returns.

Linear programming analysis on Farm A showed that the farmer could have obtained the net crop returns (Table XXIV) by growing wheat, oats, barley, flax,

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returns is based on the assumption that case farms used the existing machineries on their farms and hired those machines which were not owned by them. The adjusted net returns from crops are shown in the following table:

	Farm A		Farm B	
	Year		Year	
	1960	1961	1960	1961
	$	$	$	$
Net Returns from Crops	18,512.76	7,879.83	12,818.65	2,271.00
- 5% depreciation on mchn. inv.	986.15	1,004.65	500.99	437.25
- overhead costs	2,221.25	1,944.00	1,354.07	1,645.76
Adjusted Net Returns (net farm income).	15,305.36	4,931.18	10,963.59	187.99

[8] 2,400 cwt. x $0.60 = $1,440.00

[9] 2,273 cwt. x $0.60 = $1,363.00

rapeseed, sunflowers and sugar beets. The net returns of above $18,000 should have been received by selling 126, 833, 1,118, 558, 5,058, 608 and 2,400 hundredweight of sunflowers, oats, barley, rapeseed, wheat, flax and sugar beets. The farmer could have received over $7,000 as the net returns in 1961 by growing wheat, oats and sugar beets. In 1960, only 120 hours of the spring labor and 30 hours of the summer labor would have been necessary for these crops. Thus an excess of 640 labor hours in the spring and 430 hours in the summer could have been employed for other productive work on the farm, or in off farm employment. Similarly in 1961, the farmer could have made use of the spring and summer labor.

Farm B could have received the net crop returns (Table XXIV) in 1960 and 1961 by growing wheat, oats, barley and rapeseed. But the net farm income based on his own plan was lower than the programmed income in 1960 and higher than the programmed income in 1961 (Table XXV). The reasons for the difference in 1960 income are similar to those on Farm A. Farm B grew only four and two crops respectively in 1960 and 1961 (Table XIX). This crop program combined with livestock gave the net income of over $4,200 in 1960. However, the programmed net income was higher than the actual (Table XXV) because four additional crops barley, rapeseed, cloverseed and timothyseed were included in the suggested crop programs. The programmed net farm income in 1961 was approximately $188, whereas the net income based on the farmer's own plan was over $6,900 (Table XXV). The answers to the question why the net income based on the record analysis was higher than the programmed income in 1961 are: (a) the prices used for the 1961 programmed income were those of 1960, (b) Farm B in his own planning not only received higher prices in 1961 but also disposed of his surplus grain stock (Table XVII), and (c) the livestock enterprise contributed over $19,800 to the gross income whereas the programmed income did not include any livestock activities (Table XXV).

On Farm B, the spring and summer labor along with the capital requirements, needed to grow wheat, oats, barley and rapeseed were practically the same in 1960 and 1961. Crop production required 38 hours of the spring labor and 311 hours of the summer labor. Thus a surplus of 762 hours in the spring and 229 hours in the summer could have been used for some other productive purpose on Farm B.

Farm B was severely affected by the 1961 drought. His crop returns in this year were reduced by more than 82 percent, whereas A's returns were lowered by more than 57 percent (Table XXIV). Farm B in 1961 could not have covered his annual maintenance expenses of about $3,200 even by following the recommended crop rotations. The recommended crop sequences on Farm A would have given sufficient net farm income even in the drought year of 1961. As previously mentioned, the reason for this reduction of the crop returns in 1961 is the difference in the soil fertility. Farm A is on Altona Fine Loam soils whereas Farm B is located on Osborne Clay soils which are inferior to the Fine Loams.

<u>Summary of the Results--Diversified Farming</u>

Table XXVI shows the net farm returns from diversification with the 1960 and 1961 crop yields on each case farm. Farm A could have received $19,559 as the net farm returns had he diversified his farm in 1960 and a net farm return of $7,158 in 1961. Only one livestock activity, out of 12 appeared in the program. This was the feeder hog enterprise with no feed mill. The farmer could have received over $19,500 as the net farm returns by raising 76 feeder

TABLE XXVI

SUMMARY OF THE NET FARM RETURNS FROM DIVERSIFICATION

IN TERMS OF THE 1960 CROP YIELDS

	NET FARM RETURNS ($)		
FARM	Crop Yields in 1960	Normalized Crop Yields in 1961	% Reduction Due to the 1961 Drought
A	19,559.06	7,158.25	63.4
B	13,040.87	7,986.18	38.7

hogs, and by selling 730, 4,140, 785, 1,016, 711 and 1,039 hundredweight of rapeseed, wheat, flax, sunflowers, oats and barley respectively. The net farm returns of $19,559 required 123 hours of the spring labor, 39 and 500 hours of the summer and winter labor respectively with $19,478 of operating capital and $37,999 of the long-term capital for the hog barn. Thus surplus labor during the spring, summer, fall and winter was 637, 421, 370 and 210 hours respectively. The operating capital saved would have been $9,966 and $2,001 would have been saved from the fixed capital. These results again show the existence of the surplus labor on Farm A.

Farmer A could have received $7,158 as the net farm returns in 1961, had he diversified his farm business. This return would have been obtained by raising 35 yearlings without silage with a gain of 2.5 pounds in the body weight and by raising 258 feeder hogs with no feed mill. It is interesting to note that no grain selling activity appeared in the final program. High returns from livestock programs compared with the low returns from the 1961 crop rotations (with normalized yields) is the reason for grain selling activities not appearing in the final solution. The crops grown acted as inputs for the livestock enterprises. This finding justifies the assumption implicit throughout the whole study. That is under the condition of instable crop yields the farmer is interested in minimizing the probability of bankruptcy and diversification acts as a "safeguard" in a poor crop year like 1961. As a corollary, the linear programming technique used in this study also supposed that farmer A would be interested in minimizing the variance of income not only in a poor crop year (1961) but perhaps in his farming career.[10] Since unfavorable outcomes in a single year may bankrupt the farmer with little capital or low equity,[11] he might diversify in order to increase the chance that high income as well as low income (Table XXVI) might be realized. Here the logic used can be that of sampling theory where it is known that as the number of observations drawn from a single population is increased, the variance will decrease. In the drought year of 1961, Farm A might have simply viewed different enterprises (crops and livestock) as if they were different observations drawn from a single observations of incomes.[12] The livestock enterprises required 360 and 60 hours of the spring and summer labor respectively. The operating

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[10]See Table XXIX.

[11]If farmer A would have decided to pay even intermediate term loans from his net farm income during 1957-1964 he would have become bankrupt in 1958 and 1961. Also he would not have covered the necessary family living expenses in 1958, 1960, 1961 and in 1963. See Table XVI.

[12]Sampling theory also states that variance can be decreased as homogeneity of the population is increased. Here the assumption of this thesis, that the farmer interested in stability should select single enterprises with few fluctuations, can be justified in the logic of statistics.

and the long-term capital required were respectively, $9,130 and $32,620.

Table XXVI indicates that Farm B could have received approximately $13,041 as the net farm returns from diversifying his farm in 1960. He could have received this amount by selling 1,904 hundredweight of barley, 320 hundredweight of flax, 690 hundredweight of rapeseed and 1,697 hundredweight of oats. Along with these crops the farmer should have raised 5 calves on full feed without silage at 2.3 pounds gain in the body weight per day. Only one livestock activity out of 16 appeared in the final program. The buy calf activity required 5,079 square feet of the building space. The labor requirement to get $13,041 as the net farm returns in 1960 would have been 396 hours of winter labor, 356 hours of summer labor and 62 hours of spring labor. The operating capital requirement would have been $21,959 and $41,715 would have been required as the long-term capital. Linear programming analysis again showed the existence of surplus labor on Farm B.

Farm B would have received approximately $7,986 as the net farm returns in 1961, had he diversified his business. He would have received this amount by growing oats, barley, rapeseed and wheat, and by raising 284 feeder hogs. This is consistent with previous findings.[13] Crop and livestock activities together would have required 349 hours of spring labor, 90 hours of summer labor, $5,940 as operating capital and $34,043 as the long-term capital. The hog enterprise would have required 3,480 square feet as building space. This program also indicates surplus of the farm labor and the operating capital on Farm B. The net returns obtained from diversification (Table XXVI) show that

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[13] See Table XVII.

like Farm A, Farm B might have also viewed different enterprises (crops and hogs) as if they were different observations drawn from a single observation of incomes in 1961.[14]

A comparison of the net returns on Farms A and B (Table XXVI) shows that farm returns by diversifying the business in the drought year of 1961, would have been more on Farm B than on Farm A. This is the opposite of the net returns shown in Table XXIV. As is clear from Table XXIV, the drought year of 1961 reduced the net returns on Farm A by 57.4 percent, whereas it reduced Farm B's net returns by 82.2 percent in comparison to the normal year of 1960. Table XXVI shows that in 1961, A's returns would have been reduced by 63.4 percent and B's by 38.7 percent as compared to 1960 normal year. These results indicate that Farm A could get more income from straight crop farming than from the business diversification in unfavorable crop year like 1961. On the other hand farmer B could get a higher income than straight cropping if he diversifies his business in an abnormal crop year. This is because of the fact that A's land is more suitable to crops since Altona Fine Loam soils are the best soils of the province. Farm B is on the Osborne Clay soils. These soils are inferior to the Fine Loams and have low soil fertility. As the linear programming analysis has revealed, these soils can best be used for livestock enterprises.

The above comparison of the net farm returns under normalized crop yields in Table XXVI with that of the net crop returns under actual and normalized crop yields in Table XXIV indicates that in 1961 the net returns from

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[14] See Footnote No. 12, p. 141.

straight crop farming were higher on Farm B than the net returns from diversified farming. What does this mean in terms of crop yield stability? This means that a diversified business reduces the probability of the farm income losses in the event of crop failure. However, the returns from diversification is less than the specialized or crop farming under normal weather conditions. Tables XXIV and XXVI show that the net returns even under normalized crop yields ($7,880) from crop farming are higher than the net returns ($7,158) from diversified farming on Farm A. This is due to the fact that in the linear programming solution of the diversification matrix under normalized yields, not even one grain selling activity appeared and the net returns of $7,158 (Table XXVI) were contributed by hog and yearling enterprises. On the other hand, on Farm B, the hog enterprise appeared in the program under the normalized crop yields. This enterprise along with some crop activities gave a net return of approximately $7,986 (Table XXVI). This return is obviously greater than the net return obtained from crop farming under normalized yields on Farm B (Table XXIV).

The above empirical evidence (Tables XXIV and XXVI) supports the second hypothesis (p. 74) on Farm B. However, the first part of this hypothesis is not accepted on Farm A. Since Farm A is on better soil type than B, even in a drought year income (returns) contributed by straight crops is higher than the income obtained from diversification. The second hypothesis asserts that diversification of the farm business reduces the possibility of farm income losses in the event of crop failure. But the income is not as high as it would be from the specialized (crop) farming when there are no crop failures.

Summary of the Results--Crop Insurance

In order to study the role of crop insurance in stabilizing the farm income in the event of crop failure, crop insurance matrices were set up for both the case farms. This also facilitated the comparison of crop insurance and diversification in stabilizing the farm incomes. The normalized crop yields of 1961 on both the case farms were used as the output coefficients in the crop insurance matrices.

All the five crop rotations were included in the crop insurance matrices for the case farms. However, the premiums and indemnities were calculated only for the insurable crops in the rotations. For the 1961 crop year these were wheat, oats, barley and flax.

The net farm returns from crop insurance on each case farm are shown in Table XXVII. Farmer A could have received over $6,000 as the net returns from crops had he insured the insurable crops in the 1961 drought. The farmer

TABLE XXVII

SUMMARY OF THE NET FARM RETURNS FROM CROP INSURANCE IN 1961

Farm	Net Farm Returns
A	$ 6,458.91
B	$ 2,603.93

could have received $6,459 as the net returns by selling 450 hundredweight of barley, 361 hundredweight of oats, 224 hundredweight of rapeseed; 2,090 hundredweight of wheat, 244 hundredweight of flax, 1,038 hundredweight of sugar beets and 313 hundredweight of sunflower at the prevailing prices in 1961. Spring and summer labor required to grow these crops would have been 116 hours and 25 hours respectively. To insure 402 acres of land under wheat, barley, flax, rapeseed and sunflowers, the operating capital required would have been $2,283. Like crop farming and diversification programs, the crop insurance plan also showed a surplus of farm labor on Farm A. The program did not use the fall labor at all and thus 370 hours of the fall labor was unused. Similarly 644 hours of the spring labor and 445 hours of the summer labor were unutilized on Farm A.

Farmer B could have received over $2,000 as net farm returns by insuring oats and wheat in 1961. The linear programming solution showed that the farmer should have insured 184 acres under oats and wheat. Rotation three appeared in the final program. This rotation included oats, wheat and timothy seed. The insurance premium for the insurable crops in this rotation required $2,095. This program would have required 546 hours of spring labor and 473 hours of summer labor. Thus the surplus labor would have been 254 hours, 67 hours and 410 hours in the spring, summer and fall respectively. The net farm returns of over $2,000 would have been obtained by insuring the insurable crops and by selling 156 hundredweight of oats, 391 hundredweight of wheat and 111 hundredweight of timothy seed respectively.

However, a comparison of the net farm returns obtained from the normalized crop yields in 1961 (Table XXIV) and the crop insurance (Table XXVII) indicates that the first hypothesis (p. 74) is accepted on Farm B but not on Farm A. That is, the crop insurance on Osborne Clay soils reduces the crop income losses due to the crop failure more than it does on the Fine Loam soils. This is because the extent of crop damage is greater on the clay soils than on the loam soils. Thus the indemnity received on the former is more than the latter. However, this net income of over $2,000 in 1961 would not have covered even the maintenance level (Table XXII) on Farm B.

Diversification Versus Crop Insurance

A comparison of the net farm returns from diversification and crop insurance in Table XXVIII shows that both the case farmers would have been better off by diversifying their business in the 1961 drought year. On Farm B, crop insurance would not have covered even the maintenance limit in 1961 drought year. On Farm A, though it would have covered the maintenance level, the increase in the net farm income by diversification would have been more than buying the crop insurance. Table XXVIII indicates that farmer A would have received approximately $700 more in the 1961 drought year by diversifying the business rather than by insuring the crops. Similarly in the same year farmer B would have received over $5,000 more net farm returns from diversification than from crop insurance. This evidence supports the third hypothesis (p. 74). In the event of crop failure, and under imperfect knowledge about

TABLE XXVIII

COMPARISON OF DIVERSIFICATION AND CROP INSURANCE PLANS

	NET FARM RETURNS ($)		
FARM	Diversification in 1961	Crop Insurance in 1961	Increase in 1961 by diversification
A	$ 7,158.25	$ 6,458.91	$ 699.34
B	7,986.16	2,603.93	5,382.23

the weather the empirical evidence shows that diversification does not only reduce the losses due to the crop yield instability but it also stabilizes income at a higher level than the crop insurance program currently available.

Table XXVIII reveals that contrary to the common belief,[15] the maintenance limit is not jeopardized by a crop failure in one or two years. Farmers may withstand a crop failure as severe as that in 1961 for about two years in a row by diversifying the farm business.[16]

Use of the Empirical Results in Decision Making

Given the empirical results in the current chapter, the recommended crop and livestock programs (Appendix II) and the limited resources (Chapter V) on the case farms, the following questions may be answered: What crop and livestock programs the Carman District farmers in general and the case farms in particular should follow in the coming years, so that in the event of crop failure they can at least cover the maintenance level of the net farm income every year?[17]

The future planning of the case farms would be based on the experience on their own farms as well as on their experience about the Carman District as a whole.[18] By considering certain probabilities of the income losses, a

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[15]Cf. Chapter I.

[16]This generalization assumes that the farmers would follow the same crop and livestock programs as used in the linear programming analysis, can borrow as much capital as needed to expand the business, farm prices will not significantly deviate from 1960 level and the necessary family living expenses in future will not significantly vary from 1960 expenses.

[17]I am indebted to Professor Tom Harris, Dept. of Agricultural Economics, University of Manitoba, for drawing my attention to these questions.

[18]To simplify the discussion it is assumed that the case farms will make

choice between straight crop farming, diversified farming and crop insurance can be made which will assure some maximum net income in any one crop year.[19] It is also possible that with the experience of crop losses, the farmers may buy crop insurance and diversify their business in the same year. However, this possibility has not been considered with a view to making comparison between crop insurance and diversification.

In Table XXIX it is assumed that on the basis of the empirical findings of this study, the case farmers will make their farm plans in the future. Thus if farmer A grows only crops on his farm and does not buy crop insurance, he would expect over $15,000 as the net farm returns. But if he insures the insurable crops, he would expect over $13,000 as the net farm returns. If he diversifies his business he would expect over $16,000 as the net farm returns. On the basis of this planning the necessary family living expenses would be

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their farming decisions on the basis of their experience about the district rather than their own. That is, in making their future farm plans they will keep in mind the probability of crop failure to the minimum of 0.25. This is because the crops failed twice during 1957-1964 in the Carman District of Manitoba. This crop failure gave negative net income in 1961 and 1963 (Table XIV) and could not cover the necessary family expenses. Thus the certainty of a successful crop would be 75% and the farmers will expect the net farm income with 25% discount to uncertainty. However, if the farmers make their future farm plans on the basis of their own farming experience, it will not distort the method of analysis. If their experience is exactly similar to the Districts', the same results will follow while if their experience is better or worse, then expectations will be proportionately changed.

[19]Compare again the logical consistency of this dynamic planning model with the probability of bankruptcy minimizing models (diversification and crop insurance) under imperfect knowledge in Tables XXVI and XXVII and the related discussion on pp. 140-141 and pp. 145-147.

TABLE XXIX

EXPECTED NET FARM RETURNS IN GOOD AND POOR CROP YEARS[a]

	NET RETURNS ($)														
	ACTUAL						EXPECTED NET RETURNS IN ANY ONE CROP YEAR[b]								
	1960 Crop Year			1961 Crop Year			Crops			Diversification			Crop Insurance		
Farmer	Crops	Diversification	Crop Insurance	Crops	Diversification	Crop Insurance	Good	Poor	Total	Good	Poor	Total	Good	Poor	Total
A	18,512.76	19,559.06	16,229.16	7,879.83	7,158.25	6,458.91	13,884.57	1,969.95	15,854.52	14,669.29	1,789.56	16,458.85	12,171.87	1,614.72	13,786.59
B	12,818.65	13,040.87	10,723.53	2,271.00	7,986.18	2,603.93	9,613.98	567.75	10,181.73	9,780.65	1,996.54	11,771.19	8,042.64	650.98	8,693.62

[a]Good Crop Year = crop yields approximately those of 1960 crop year.

Poor Crop Year = a year like 1961 when crop yields were drastically reduced.

[b]Expected Net Farm Returns = $\frac{3}{4}$ (Net farm returns in a good crop year) + $\frac{1}{4}$ (net farm returns in a poor crop year).

better off in diversifying his business since it gives the maximum expected returns of over $16,000.

From straight crop farming, farmer B would expect over $10,000 as the net farm returns in any crop year. On this farm the expected net returns, by diversifying the farm business would be over $11,000 and if he insures the insurable crops he would expect over $8,000 as the net farm income in any crop year. Again the necessary family expenses would be covered by any one of the three alternatives in any one crop year. However, like farmer A, farmer B would also expect a maximum net return (in his case of over $11,000) if he diversifies his business.

CHAPTER VIII

SUMMARY AND CONCLUSION

Summary

The extreme drought in 1961 led some people to believe that due to the resultant low farm production, incomes in the prairies would be well below the level of farm incomes required to cover necessary family and production expenses. This study was conducted to test this belief for the Carman area of Manitoba. Since the year of 1960 did not experience any weather hazards it was taken as a basis of comparison of farm production and income.

The study was aimed primarily at the impact of crop yield instability on the farm business. In addition it included an investigation of the factors which help stabilize farm incomes subject to extreme weather risks. Straight crops, diversification and crop insurance were considered as factors which stabilize farm incomes in crop years like 1961.

Linear programming was used as a research tool in this study. The input-output coefficients used were those of the 1960 crop year. In order to facilitate the comparison of farm incomes between 1960 and 1961, crop yields in 1961 were standardized in terms of 1960.

In order to see a general production and planning pattern in the Carman district, the records of the thirty-five farmers belonging to the Carman District Farm Business Association (C.D.F.B.A.) who had complete records were examined for the period 1957-1964. For a detailed analysis of the impact of crop yield instability, two case farms on different soil types were selected for the same period. However, for the linear programming analysis of the case farms only two years (1960 and 1961) were used. This facilitated the analysis of the impact of crop yield variability under two extreme situations.

A comparison was made between farm incomes obtained from farmers' own plans and incomes derived from linear programming. This not only facilitated the analysis of impact of crop yield instability but also provided a measure of the current inefficiency of farmers in planning their farm business.

The present investigation was guided by four hypotheses. The first hypothesis was that under imperfect knowledge or uncertainty crop insurance reduces the crop income losses resulting from yield instability. The second hypothesis was formulated in two parts: (a) diversification of the farm business reduces the possibility of farm income losses in the event of crop failure and (b) the income obtained from diversification is less than that from straight crop farming with no crop failure. The third hypothesis was that in the event of crop failure diversification of the farm business stabilizes income more than crop insurance can. The fourth hypothesis was that the risk of income loss increases as the proportion of inputs which are purchased in the form of capital investment to generate income increases.

Table XXX summarizes the results obtained in investigating the above hypotheses. A comparison of the net farm returns obtained from straight crops in 1961 with the returns obtained from crop insurance indicates that the first hypothesis is accepted on Farm B but not on Farm A. The reason for this as discussed in Chapter V is the difference in soil productivity.

The comparison of the net farm returns obtained from crops and diversification during 1960 and 1961 (Table XXX) indicates that both parts of the second hypothesis are accepted on Farm B. Although the evidence in Table XXX supports part (b) of the second hypothesis on Farm A, part (a) of this hypothesis is not accepted for this type of farm.

The comparison of farm returns obtained by diversification and crop insurance in 1961 (Table XXX) indicates that the third hypothesis is accepted on each case farm. This comparison shows that under imperfect knowledge about the incidence of crop failure due to weather, diversification not only reduces the losses from yield instability but it also stabilizes expected returns at a higher level than that offered by the crop insurance program currently available.

A comparison of the net farm incomes obtained by linear programming and the farm record analysis shows a difference (Table XXX). The reasons for this disparity, are the crop and livestock programs followed on case farms, the 1960 prices used in linear programming and farmers' technical inability to make efficient use of the farm resources. The net farm incomes based on the individual farm record analysis covered the necessary family expenses in 1960 and 1961 on each case farm (Table XXX).

Intra-year production, income and assets variability were investigated on each case farm. The loss of income was greater on the farm with inferior soils (Osborne Clay) than on the farm with superior soils (Altona Fine Loams). The fourth hypothesis was used as a basis for further investigations to verify the first, second and third hypothesis. The results obtained supported the fourth hypothesis on each case farm.

Conclusion

On the basis of the evidence in support of the above mentioned hypotheses, and other facts collected by this study, it can be concluded that farmers in Manitoba in general and in the Carman district in particular are faced with

TABLE XXX

SUMMARY OF NET FARM INCOMES DERIVED BY LINEAR PROGRAMMING AND THE RECORD ANALYSIS

	NET FARM RETURNS ($)						NET INCOMES ($)		Necessary Family Living Expenses in 1960 ($)
	LINEAR PROGRAMMING						RECORD ANALYSIS		
	1960 crop year			1961 crop year			1960 crop year	1961 crop year	
FARM	Crops	Diversification	Crop Insurance	Crops	Diversification	Crop Insurance			
A	18,512.76 (15,305.36)*	19,559.06	16,229.16	7,879.83 (4,931.18)	7,158.25	6,458.91	5,934.45	3,229.68	2,036.30
B	12,818.65 (10,963.59)	13,040.87	10,723.53	2,271.00 (187.99)	7,986.18	2,603.93	4,208.89	6,971.38	3,160.88

*Figures within brackets were adjusted to facilitate the comparison between the net incomes derived by the linear programming and the farm record analysis.

the problem of crop yield instability. The present investigation has revealed an increasing trend towards diversification in the area studied. This is indicated by the percentage increase in the income from livestock enterprises and the percentage decrease in the income from crop enterprises.

Under conditions of uncertain crop production, diversification (crop and livestock enterprise combination) would give a maximum expected net farm income compared with the straight crop farming (with or without crop insurance) with a discount to certainty equivalent every year. Thus if farmers in the area studied follow the combination of the recommended crops and livestock programs they will get the maximum expected income in any crop year (good or poor) compared with straight crop farming. This income will not only cover the necessary family expenses but will also cover the capital requirement for the growth of the firm.

The empirical evidence in this study illustrated that livestock act as an income stabilizer on farms. However, the individual farm record analysis has shown that farmers dissipate their efforts over a few hogs, cows and chickens. This course of action does not make efficient use of the limited farm resources and, as a result, yields a low level of farm incomes (Tables XVIII and XIX). As Table XXV has shown it is wiser to concentrate on one livestock enterprise in addition to what is needed for direct family consumption.

The kind of livestock to be raised is a matter of the farmer's preference and his particular farm situation. For example, Table XVIII showed that on one of the case farms (Farm A), the hog enterprise was more promising than the beef cattle enterprise. Linear programming results (Table XXV) also reached the same conclusion. However, probably because of a dislike for the hog enterprise, Farm A did not retain this enterprise.

Linear programming analysis showed that opportunities for diversification in the Carman district do exist along two lines: (1) fuller use of non-crop land, and (2) fuller use of under-employed family labor, especially during the winter season. Diversification that takes advantage of these two opportunities helps to prevent income from falling below the maintenance limit in three ways: by raising the level of income, by reducing the variability of total farm production, and by reducing price uncertainty.

Farm record analysis showed that yield reduction due to crop failures does not reduce the production costs of the farm (Tables XVI and XVII). Operating costs, family living requirements, and debt and tax payments remain approximately the same whether it is good or poor crop year.

Since the Canadian Wheat Board keeps grain prices stable, the main sources of unstable farm incomes lie in crop production and livestock prices. Weather brings major uncertainty to crop production and uncertain livestock prices affect livestock production. However, this study has provided evidence that instability of the farm income can be reduced by raising some livestock enterprises along with crops suited to the appropriate soil types.

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APPENDIX I

CROP YIELDS, MANITOBA, 1921–63*

Crop District	$\bar{X}$					S^2					S					$S/\bar{X}$				
	W a/	O b/	B c/	F d/	R e/	W	O	B	F	R	W	O	B	F	R	W	O	B	F	R
Melita	17.99		21.17	7.76	14.28	32.95		85.32	9.96	27.66			9.24	3.16	5.25	.32		.44	.41	.37
Killarney	15.47	29.84	22.95	8.62	15.14	38.64	137.51	62.15	6.24	17.82	6.22	11.73	7.88	2.50	4.22	.40	.37	.34	.29	.28
Morden(Carman)	18.73	31.89	23.72	8.91	14.99	23.59	60.18	31.92	3.60	9.04	4.86	7.76	5.65	1.89	3.00	.26	.24	.24	.21	.20
Winnipeg		33.37	25.22	9.00	12.75		62.37	37.31	3.36	55.22		7.90	6.11	1.83	7.43		.24	.24	.20	.58
Springfield	20.29	34.03	25.77	9.65	16.35	25.07	70.42	37.76	3.32	7.83	5.01	8.39	6.15	1.82	2.79	.25	.25	.24	.19	.17
Eastern	16.66	29.44	21.41	9.20	14.45	18.19	41.23	22.78	2.53	8.22	4.26	6.42	4.77	1.59	2.86	.26	.22	.22	.17	.20
Virden	18.78	31.03	23.82	8.47	14.78	31.49	128.81	33.04	6.02	14.61	5.61	11.35	5.75	2.45	3.82	.30	.37	.24	.29	.26
Brandon	19.53	31.41	24.38	9.04	15.26	37.33	100.80	40.69	3.89	9.66	6.11	10.04	6.38	1.97	3.11	.32	.32	.26	.22	.20
Neepawa	19.33	31.33	26.28	8.62	15.08	29.88	88.99	54.60	3.60	7.07	5.47	9.43	7.39	1.90	2.66	.28	.30	.28	.22	.18
Russell	21.55	34.71	24.11	9.13	17.73	36.80	128.99	40.88	5.41	15.27	6.07	11.36	6.39	2.33	3.91	.28	.33	.27	.25	.22
Dauphin	19.29	30.55	23.63	9.19	16.32	28.58	67.12	43.32	2.90	8.49	5.35	8.19	6.58	2.90	2.91	.28	.27	.28	.19	.18
Mid Lake	22.49	32.49	28.73	9.51	15.86	62.85	80.58	31.64	4.08	16.55	7.93	8.98	5.63	2.02	4.07	.35	.28	.20	.21	.26
Swan River	23.77	38.79	22.75	10.63	20.16	37.74	71.30	42.44	7.36	12.44	6.14	8.44	6.51	2.71	3.53	.26	.22	.29	.26	.17
West Shore	18.34	29.69	24.02	8.58	15.29	30.92	85.99	32.22	4.26	11.37	5.56	9.27	5.68	2.06	3.37	.30	.31	.24	.24	.22
Total	18.57	31.37	24.52	8.75	16.00	22.66	79.44	64.82	3.54	8.19	4.76	8.91	8.05	1.88	2.86	.26	.28	.33	.21	.18

*Source: (1) Reports on crops, livestock, etc., Manitoba Department of Agriculture.

(2) 1963 data—Yearbook of Manitoba Agriculture, Manitoba Department of Agriculture—1963.

a/ Wheat b/ Oats c/ Barley d/ Flax e/ Rye

NDIX II

OSTS AND RETURNS

COW-CALF Silage		BUY-CALF, Full-Feed Hay		BUY-CALF, Full-Feed Silage		BUY-CALF Winter 1#/ Day Finish. Hay	
102.81 Per Cow		$209.00 Per Steer		$209.00 Per Steer		$252.46 Per Steer	
uantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
	$ 1.50		$ 1.00		$ 1.00		$ 1.50
0.5	3.00	0.5	3.00	0.5	3.00	0.5	3.00
			.86		.86		.86
			1.72		1.72		1.72
1.58	2.84	15.02	27.04			2.1	3.78
1.27	2.36	14.45	26.88	27.91	51.91	33.06	61.49
21.81	14.72	7.51	5.07			32.56	21.99
70.43	14.09			20.31	4.06		
43.8	1.92	56.0	2.46	286.0	14.30	54.0	2.37
7.0	11.20						
		430.0	104.06	430.0	104.06	430.0	104.06
	.55		.90		.90		.90
	1.49		7.80		7.80		8.36
	53.67		180.79		189.61		210.03
53.67	3.22	180.79	10.85	189.61	11.38	210.03	12.60
206.25	6.19	32.50	.98	32.50	.98	32.50	.98
	3,25		2.18		2.18		2.18
	2.39		2.88		2.88		2.88
cow&calf	3.11		5.86		5.86		6.66
	$ 71.83		$ 203.54		$ 212.89		$ 235.33
	$ 30.98		$ 5.46		$ 4.13		$ 17.13

APPENDIX II

LIVESTOCK COSTS AND RETURNS

			COW-CALF Hay		COW-CALF Silage		BUY-CALF, Full-Feed Hay		BUY-CALF, Full-Feed Silage		BUY-CALF Winter 1#/Day Finish. Hay	
GROSS RECEIPTS PER UNIT ACTIVITY			$102.81 Per Cow		$102.81 Per Cow		$209.00 Per Steer		$209.00 Per Steer		$252.46 Per Steer	
EXPENSE ITEMS	UNIT	PRICE/UNIT	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Veterinary & Medicine				$ 1.50		$ 1.50		$ 1.00		$ 1.00		$ 1.50
Bedding	ton	$6.00	0.5	3.00	0.5	3.00	0.5	3.00	0.5	3.00	0.5	3.00
Livestock Buying Fees (a)								.86		.86		.86
Trucking Cost "in" (b)								1.72		1.72		1.72
Feed (d)												
Oats	cwt	1.80	1.73	3.11	1.58	2.84	15.02	27.04			2.1	3.78
Barley	cwt	1.86	1.42	2.64	1.27	2.36	14.45	26.88	27.91	51.91	33.06	61.49
Alfalfa-Brome	cwt	.675	30.11	20.32	21.81	14.72	7.51	5.07			32.56	21.99
Corn Silage	cwt	.20			70.43	14.09			20.31	4.06		
Straw	cwt	.30	18.3	5.49								
Protein & Minerals	lbs	varies	43.8	1.92	43.8	1.92	56.0	2.46	286.0	14.30	54.0	2.37
Pasture (h)	AUM	1.60	7.0	11.20	7.0	11.20						
Cost of Feeder	lbs	(j)					430.0	104.06	430.0	104.06	430.0	104.06
Maintenance Cost(new invest. and imp.)				.55		.55		.90		.90		.90
Miscellaneous Cost (g)				1.49		1.49		7.80		7.80		8.36
SUB TOTAL CASH COST				51.22		53.67		180.79		189.61		210.03
Interest on cash cost (c)		6%	51.22	3.07	53.67	3.22	180.79	10.85	189.61	11.38	210.03	12.60
Int. on new inv. required (e)		6% on 1/2	206.25	6.19	206.25	6.19	32.50	.98	32.50	.98	32.50	.98
Dep. on new inv. (f)				3.25		3,25		2.18		2.18		2.18
Selling Fees (a)				2.39		2.39		2.88		2.88		2.88
Trucking Cost "out" (b)			cull cow&calf	3.11	cull cow&calf	3.11		5.86		5.86		6.66
TOTAL ENTERPRISE VARIABLE COST				$ 69.23		$ 71.83		$ 203.54		$ 212.89		$ 235.33
RETURNS OVER VARIABLE COST				$ 33.58		$ 30.98		$ 5.46		$ 4.13		$ 17.13

APPENDIX II (continued)

LIVESTOCK COSTS AND RETURNS

			BUY-CALF Winter 1#/day Finish Silage		BUY-CALF Winter 1#/day, Graze Hay		BUY-CALF Winter 1#/day, Graze Silage		BUY-CALF Winter 1#/day, Graze, Finish Hay		BUY-CALF Winter 1#/day, Graze, Finish Silage	
GROSS RECEIPTS PER UNIT ACTIVITY			$252.46 Per Steer		$184.57 Per Steer		$184.57 Per Steer		$251.45 Per Steer		$251.45 Per Steer	
EXPENSE ITEMS	UNIT	PRICE/UNIT	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Veterinary & Medicine				$ 1.50		$ 1.00		$ 1.00		$ 1.50		$ 1.50
Bedding	ton	$6.00	0.5	3.00	0.5	3.00	0.5	3.00	0.5	3.00	0.5	3.00
Livestock Buying Fees (a)				.86		.86		.86		.86		.86
Trucking Cost "in" (b)				1.72		1.72		1.72		1.72		1.72
Feed (d)												
Oats	cwt	1.80	2.1	3.78	2.1	3.78	2.1	3.78	2.1	3.78	2.1	3.78
Barley	cwt	1.86	33.71	62.70	2.1	3.91	2.1	3.91	24.42	45.42	24,89	46.30
Alfalfa-Brome	cwt	.675	10.50	7.09	25.2	17.01	10.5	7.09	30.51	20.59	10.50	7.09
Corn Silage	cwt	.20	57.48	11.50			42.	8.40			53.16	10.63
Straw	cwt	.30										
Protein & Minerals	lbs	varies	209.	10.35	16.	.70	16.	.70	43.	1.89	155.	7.66
Pasture (h)	AUM	1.60			5.5	9.00	5.5	9.00	2.	3.20	2.	3.20
Cost of Feeder	lbs	(j)	430.0	104.06	430.0	104.06	430.0	104.06	430.0	104.06	430.0	104.06
Maintenance Cost (new imp. & invest.)				.90		.75		.75		1.00		1.00
Miscellaneous Cost (g)				8.36		1.89		1.89		6.23		6.23
SUB TOTAL CASH COST				215.82		147.68		146.16		193.25		197.03
Interest on cash cost (c)		6%	215.82	12.95	147.68	8.86	146.16	8.77	193.25(13m)	12.56	197.03(13m)	12.80
Int. on new inv. required (e)		6% on 1/2	32.50	.98	25.00	.75	25.00	.75	35.00	1.05	35.00	1.05
Dep. on new inv. (f)				2.18		1.87		1.87		2.42		2.42
Selling Fees (a)				2.88		2.88		2.88		2.88		2.88
Trucking Cost "out" (b)				6.66		5.17		5.17		6.66		6.66
TOTAL ENTERPRISE VARIABLE COST				$ 241.47		$ 167.21		$ 165.60		$ 218.82		$ 222.84
RETURNS OVER VARIABLE COST				$ 10.99		$ 17.36		$ 18.97		$ 32.63		$ 28.61

APPENDIX II (continued)

LIVESTOCK COSTS AND RETURNS

			BUY-CALF Winter 1.5# /day, Graze, Finish Hay		BUY-CALF Winter 1.5# /day, Graze, Finish Silage		YEARLINGS, Finishing (spring-summer) Hay		YEARLINGS, Finishing (spring-summer) Silage		Farrow--New Farrowing Barn pregnant sows in present barn	
GROSS RECEIPTS PER UNIT ACTIVITY			$252.46 Per Steer		$252.46 Per Steer		$259.58 Per Steer		$259.58 Per Steer		$184.92 Per Sow	
EXPENSE ITEMS	UNIT	PRICE/UNIT	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Veterinary & Medicine				$ 1.50		$ 1.50		$ 1.00		$ 1.00		$ 1.00
Bedding	ton	$6.00	0.5	3.00	0.5	3.00						1.50
Livestock Buying Fees (a)				.86		.86		1.59		1.59		
Trucking Cost "in" (b)				1.72		1.72		3.19		3.19		
Feed (d)												
Oats	cwt	1.80	5.25	9.45	5.25	9.45					11.90	21.42
Barley	cwt	1.86	17.85	32.20	18.12	33.70	25.20	46.87	25.73	47.86	19.00	35.34
Alfalfa-Brome	cwt	.675	24.00	16.20			5.99	4.04				
Corn Silage	cwt	.20			69.30	13.86			12.60	2.56		
Straw	cwt	.30										
Protein & Minerals	lbs	varies	36.0	1.54	88.0	7.46	31.0	1.36	157.0	7.85	520.0	32.40
Pasture (h)	AUM	1.60	3.	4.80	3.	4.80						
Cost of Feeder	lbs	(j)	430.0	104.06	430.0	104.06	700.0	161.56	700.0	161.56		
Maintenance Cost (new imp.)				.90		.90		.49		.49		2.46
Miscellaneous Cost (g)				6.44		6.44		4.62		4.62		8.10
SUB TOTAL CASH COST				183.67		187.75		224.72		230.72		102.22
Interest on cash cost (c)		6%	183.67	11.02	187.75	11.26	224.72(4m)	4.49	230.72(4m)	4.61	102.22(6m)	3.07
Int. on new inv. required (e)		6% on 1/2	32.50	.98	32.50	.98	16.25	.49	16.25	.49	162.44	4.87
Dep. on new inv. (f)			new impr.	2.25		2.25		.81	new imp.	.81	new imp.	5.96
Selling Fees (a)				2.88		2.88		2.88		2.88		.26
Trucking Cost "out" (b)				6.66		6.66		6.73		6.73	cull sows	.19
TOTAL ENTERPRISE VARIABLE COST				$ 207.46		$ 211.78		$ 240.12		$ 246.24		$ 116.57
RETURNS OVER VARIABLE COST				$ 45.00		$ 40.68		$ 20.06		$ 13.34		$ 68.35

LIVESTOCK COSTS AND RETURNS

			BUY-CALF Winter 1.5# /day, Graze, Finish Hay		BUY-CALF Winter 1.5# /day, Graze, Finish Silage		YEARLINGS, Finishing (spring-summer) Hay		YEARLINGS, Finishing (spring-summer) Silage		Farrow--New Farrowing Barn pregnant sows in present barn	
GROSS RECEIPTS PER UNIT ACTIVITY			$252.46 Per Steer		$252.46 Per Steer		$259.58 Per Steer		$259.58 Per Steer		$184.92 Per Sow	
EXPENSE ITEMS	UNIT	PRICE/UNIT	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Veterinary & Medicine				$ 1.50		$ 1.50		$ 1.00		$ 1.00		$ 1.00
Bedding	ton	$6.00	0.5	3.00	0.5	3.00						1.50
Livestock Buying Fees (a)				.86		.86		1.59		1.59		
Trucking Cost "in" (b)				1.72		1.72		3.19		3.19		
Feed (d)												
Oats	cwt	1.80	5.25	9.45	5.25	9.45					11.90	21.42
Barley	cwt	1.86	17.85	32.20	18.12	33.70	25.20	46.87	25.73	47.86	19.00	35.34
Alfalfa-Brome	cwt	.675	24.00	16.20			5.99	4.04				
Corn Silage	cwt	.20			69.30	13.86			12.60	2.56		
Straw	cwt	.30										
Protein & Minerals	lbs	varies	36.0	1.54	88.0	7.46	31.0	1.36	157.0	7.85	520.0	32.40
Pasture (h)	AUM	1.60	3.	4.80	3.	4.80						
Cost of Feeder	lbs	(j)	430.0	104.06	430.0	104.06	700.0	161.56	700.0	161.56		
Maintenance Cost (new imp.)				.90		.90		.49		.49		2.46
Miscellaneous Cost (g)				6.44		6.44		4.62		4.62		8.10
SUB TOTAL CASH COST				183.67		187.75		224.72		230.72		102.22
Interest on cash cost (c)		6%	183.67	11.02	187.75	11.26	224.72(4m)	4.49	230.72(4m)	4.61	102.22(6m)	3.07
Int. on new inv. required (e)		6% on 1/2	32.50	.98	32.50	.98	16.25	.49	16.25	.49	162.44	4.87
Dep. on new inv. (f)			new impr.	2.25		2.25		.81	new imp.	.81	new imp.	5.96
Selling Fees (a)				2.88		2.88		2.88		2.88		.26
Trucking Cost "out" (b)				6.66		6.66		6.73		6.73	cull sows	.19
TOTAL ENTERPRISE VARIABLE COST				$ 207.46		$ 211.78		$ 240.12		$ 246.24		$ 116.57
RETURNS OVER VARIABLE COST				$ 45.00		$ 40.68		$ 20.06		$ 13.34		$ 68.35

NDIX II (continued)

P COSTS AND RETURNS

		Forage Rotations Fertilized			
Rotation 3		Rotation 4		Rotation 5	
eat @ 43 bus x $1.47	$31.60	20% stubble oats @ 75 bu x .61	$ 9.15	17% smf wheat @ 43 bu x $1.47	$10.74
eseed @ 1050# x .04	4.20	20% smf wheat @ 43 bu x $1.47	12.64	17% stubble oats @ 15 bu x .61	7.77
x @ 13.8 bu x $3.00	6.21	20% summerfallow	-	17% barley @ 30 bu x .87	4.43
rley @ 30 bu x .87	3.91	20% flax @ 13.8 bu x $3.00	8.24	17% flax @ 13.8 bu x 3.00	7.03
nflowers @ 1000# x .04	4.00	18% hay @ 2T. x 13.50	4.86	7% sunflowers @ 1000# x .04	2.80
		2% pasture	.60	25% forage @ 2T. x 13.50	6.75
	$49.92		$35.49		$39.52
	2.86		1.97		2.05
	3.81		3.84		5.51
	.84		.24		.37
	1.05		/52		1.84
	3.82		2.89		2.03
	1.21		.47		.87
	1.52		1.34		2.10
	$15.11		$11.27		$14.77
	.91		.68		.88
6% on ½ of $2.10	.06	6% on ½ of $3.22	.09	6% on ½ of $1.57	.05
	.06		.09		.05
	$16.14		$12.13		$15.75
	$33.78		$23.36		$23.77

APPENDIX II (continued)

CROP COSTS AND RETURNS

Item	Non-Forage Rotations Fertilized					
	Rotation 1		Rotation 2		Rotation 3	
FARM A SALEABLE PRODUCTS	50% smf wheat @ 43 bus x $1.47	$31.60	5% sugar beets @ 9.5 T. x $12.	$ 5.70	50% wheat @ 43 bus x $1.	47
	25% stubble oats @ 76 bu x .61	11.44	30% wheat @ 43 bu x $1.47	18.30	10% rapeseed @ 1050# x .	04
	13% sugar beets @ 9.5 T. x $12.	14.82	20% flax @ 13.8 bu x $3.	8.28	15% flax @ 13.8 bu x $3.	00
	12% summerfallow	-	23% barley @ 30 bu x .87	6.00	15% barley @ 30 bu x .87	
			22% oats @ 75 bu x .61	10.07	10% sunflowers @ 1000# x	.04
GROSS RECEIPTS PER ACRE (i)		$57.86		$48.35		
EXPENSE ITEMS						
Seed		3.60		3.75		
Machine operation		5.42		4.80		
Maintenance (new improvements		.69		.83		
Supplies (twine)		1.97		.94		
Fertilizer		3.76		3.61		
Other chemicals		1.10		.98		
Miscellaneous		1.70		1.47		
SUB TOTAL		$18.24		$16.38		
Interest on above cash cost		1.09		.98		
Interest on new improvements	6% on $\frac{1}{2}$ of $1.69	.05	6% on $\frac{1}{2}$ of $1.69	.05	6% on $\frac{1}{2}$ of $2.10	
Depreciation (new improvements only)		.05		.05		
TOTAL VARIABLE COST PER ACRE		$19.43		$17.46		
RETURNS OVER VARIABLE COST		$38.43		$30.89		

APPENDIX II (continue

CROP COSTS AND RETUR

Item	Non-Forage Rotations Fertilized Rotation 1		Rotation 2		Rotation 3
FARM B Saleable Products	50% smf wheat @ 22.5 bu x $1.47	$16.03	30% wheat @ 22.5 bu x $1.47	$ 9.62	50% wheat @ 22.5 bu x $1.4
	20% stubble oats @ 26.5 bu x .61	3.23	20% flax @ 5.9 bu x $3.	3.54	25% oats @ 26.5 bu x .61
	15% barley @ 37 bu x .87	4.83	20% barley @ 37 bu x .87	6.43	10% timothy hay seed @ 2 5
	15% rapeseed @ 1000# x .04	6.00	15% rapeseed @ 1000# x .04	6.00	15% summerfallow
			10% oats @ 26.5 bu x .61	1.61	
			5% cloverseed @ 350# x .04	.70	
GROSS RECEIPTS PER ACRE (i)		$30.08		$27.90	
EXPENSE ITEMS					
Seed		2.97		2.83	
Machine operation		3.03		3.51	
Maintenance (new improvements)		.42		.62	
Supplies (twine)		.64		.92	
Fertilizer		4.37		5.11	
Other chemicals		.60		.91	
Miscellaneous		1.68		1.94	
SUB TOTAL		$13.71		$15.85	
Interest on above cash cost		.82		1.02	
Interest on new improvements	6% on ½ of $1.54	.05	6% on ½ of $1.70	.05	6% on ½ of $1.90
Depreciation (new improvements only)		.05		.05	
TOTAL VARIABLE COST PER ACRE		$14.63		$16.97	
RETURNS OVER VARIABLE COST		$15.45		$10.93	

APPENDIX II (continued)

CROP COSTS AND RETURNS

Forage Rotations Fertilized					
Rotation 3		Rotation 4		Rotation 5	
0% wheat @ 22.5 bu x $1.47	$16.03	50% wheat @ 22.5 bu x $1.47	$16.03	15% wheat @ 22.5 bu x $1.47	$ 4.81
5% oats @ 26.5 bu x .61	4.04	25% oats @ 26.5 bu x .61	4.04	10% oats @ 26.5 bu x .61	1.61
0% timothy hay seed @ 250# x .18	4.50	15% timothy hay seed @ 250# x .18	6.75	30% forage @ 2T. x 13.50	8.10
5% summerfallow	-	10% forage @ 2T. x 13.50	2.70	10% flax @ 5.9 bu x 3.00	1.77
				10% rapeseed @ 1000 x .04	4.00
				10% barley @ 37 bu x .87	3.22
				15 % summerfallow	-
	$24.57		$29.52		$23.51
	2.88		2.93		1.52
	1.87		3.40		1.67
	.31		.51		.81
	.52		.83		.42
	3.92		2.84		2.07
	.50		.67		.61
	1.17		2.13		1.87
	$11.17		$13.31		$ 8.97
	.73		.92		.89
6% on ½ of $1.90	.05	6% on ½ of $1.80	.05	6% on ½ of $2.20	.07
	.05		.05		.07
	$12.00		$14.33		$10.00
	$12.57		$15.19		$13.51

APPENDIX II (continued)

ASSUMPTIONS USED FOR ARRIVING AT COST

(a) Livestock buying and selling fees used are as follows:

Selling Fees

calves to 300#	$ .60 per head
300 - 400#	.85
400-600#	1.30
600 - over	1.50
bulls over 100#	2.00
hogs	.30 per head
sows over 100#	.75
sheep & lamb	.30

Yardage

calves up to 400#	$ .50 per head
Calves over 400#	.85
hogs	.15
sheep	.12
yard insurance	.01 per head
transit insurance	
calves & cattle	.27
hogs & sheep	.22

Buying Fee .20/cwt

(b) Trucking "in" to farm .40/cwt
Trucking "out" from farm .65/cwt cattle and calves
.90/cwt hogs

(c) This was the interest at 6% on the cash outlay for expenses for the period the money was used.

(d) The value used here for livestock feed grains were applied here only to arrive at return figures for these livestock enterprises. In the programming model, livestock activities were not charged for feed grain but used these feed products produced by crops or purchased by the buying activity.

(e) This was the interest at 6% on half the value of new investment. Included in the new investment were new building, new equipment or other improvements required for the enterprise. Also included was the cost of the breeding stock, cows, bull, sows, boar, etc.

(f) This included depreciation on new improvements mentioned above. It also included the depreciation on the sire (bull, boar). Cows and sows are sold when culled and replacements are grown out. Feed is provided for this purpose in feed budget.

(g) Miscellaneous: This covers the cost of insurance, utilities, hormones, custom grinding, variable cost of miscellaneous machine use.

(h) AUM = animal unit months.

(i) Pasture and hay were not valued as salable, but were made available for use by the livestock enterprise.

(j) Price per cwt of feeders is:

calfs	$24.20
stockers	$23.13
yearlings	$23.08

APPENDIX II (continued)

BUILDING COST

LAMINATED OR HIP ROOF BARN	INsulated and finished interior, 32 x 50 x 20 12' loft, 1600sq. ft. cubical = 27,200 cu. ft. Length of exterior walls = 164 lin. ft.	1960 Cost
<u>Foundation</u>	footing - 24 x 9, wall 9 x 24, 164 x \$1.66 floor 6" slab 1600 x 29¢	\$ 272.00 464.00
<u>Walls</u>	spruce siding, 1 ply paper, 3/8 plywood, 2 x 6 studs @ 24 o.c. 3/8 plywood interior, vapour barrier, 2" insulation 1312 sq. ft @ 66^{72}¢	866.00
<u>Gable Ends</u>	2 x 6 studs @ 24 o.c., spruce siding, 770 sq. ft @ 24^{26}¢	185.00
<u>Loft</u>	2 x 10 joist @ 24 o.c., spruce floor, 1600 sq. ft. @ 30^{32}¢	480.00
<u>Beams & Posts</u>	2 beams 6 x 8 and 10 posts 4 x 6 = 560 BM	78.00
<u>Roof</u>	2 x 6 rafters @ 24 o.c., spruce shiplap, asphalt shingles, 2500 sq. ft. @ 40^{43}¢	1,000.00
<u>Paint</u>	2 coats 2246 sq. ft. @ 5^{6}¢	112.00
<u>Hardware</u>	2 tracks, hinges, latches, bolts, reinforcement	139.00
<u>Windows</u>	18 - 4 sq. ft. per window - 72 sq. ft at 60^{65}¢	43.00
<u>Electrical</u>	lights, plugs and switches	130.00
	Sub-total	\$ 3,769.00
	Labor approximately 33 1/3%	1,256.00
	Total	\$ 5,025.00

Cost per sq. ft. = \$3.14 Cost per cu. ft. = 18.50 ¢

APPENDIX II (continued)

BUILDING COST

LAMINATED OR HIP ROOF BARN – insulated and finished interior, 32 x 100 x 20, 12' loft, 3200 sq. ft. – cubical 54,400 cu.ft. length of exterior walls – 264 lin. ft.

		1962 Cost
Foundation	footings 24 x 9, wall 9 x 24 264 x$1.00	$ 438.00
Floor	6 inch slab, 3200 sq. ft. x 29¢	928.00
Walls	spruce siding, 1 ply paper, 3/8 plywood, 2 x 6 studs @ 24 o.c. 3/8 plywood interior, vapour barrier, 2" insulation 2112 sq. ft. @ 66^{72}¢	1,394.00
Gable Ends	2 x 6 studs @ 24 o.c., spruce siding, 770 sq. ft. @ 24^{26}¢	185.00
Loft	2 x 10 joist @ 24 o.c., spruce floor, 3200 sq. ft. @ 30^{32}¢	960.00
Beams & Posts	2 beams 6 x 8 and 20 posts 4 x 6 = 1020 BM	156.00
Roof	2 x 6 @ 24 o.c., spruce shiplap, asphalt shingles, 5000 @ 40^{43}¢	2,000.00
Paint	2 coats, 3046 sq. ft. @ 5^{6}¢	152.00
Hardware	2 tracks, hinges, latches, bolts, reinforcement	188.00
Windows	26 – 4 sq. ft. windows, 104 sq. ft @ 60^{65}¢	62.00
Electrical	lights, plugs & switches	190.00
	Sub-total	$ 6,653.00
	Labor 33 1/3%	2,218.00
	Total	$ 8,871.00

Cost per sq. ft. = $2.77

Cost per cu. ft. = 16.3¢

APPENDIX II (continued)

PORK GROWING & FINISHING BARN

PORK GROWING & FINISHING HOUSE 38' x 123' includes the following:

1. Curvet building c/w 1-1/2" Urethane insulation throughout.
2. 2 steel walk-in doors.
3. Epoxy-coated wainscoting
4. Pre wired control panel.
5. 3 roof ventilators 38" diam.
6. 4 side wall fans 38" diam. 2 H.P. c/w control.
7. Epoxy-coated slatted floor
8. Planum wall
9. Solid or mesh epoxy-coated partitions
10. 5" steel reinforced concrete floor throughout.
11. 2 rows of limited automatic feeders
12. Automatic waterers

Price complete as outlined above $35,275.00

APPENDIX II (continued)

STANDARD WEIGHTS OF FARM PRODUCTS PER BUSHEL

Crop	Pounds	Crop	Pounds
Wheat	60	Flax	56
Oats	34	Potatoes	60
Barley	48	Turnips	50
Rye	56	Sugar beets	50
Corn	56	Alfalfa	60
Peas	60	Clover	60
Soybeans	60	Timothy	48
Sunflowers	24	Brome grass	14

one ton = 2,000 pounds

one hundredweight (cwt) = 100 pounds.

APPENDIX III

NORMALIZED OR STANDARDIZED CROP YIELD IN BUSHELS, CDFBA 1957-1964*

	1957		1958		1959		1960		1961		1962		1963		1964		Average (1957-64)	
	A	N	A	N	A	N	A	N	A	N (.6113)	A	N (.9435)	A	N (.5053)	A	N (.9399)	A	N (.8304)
Wheat	24.5	24.5	27.9	27.9	24.9	24.9	28.3		17.3	17.3	26.7	26.7	14.3	14.3	26.6	26.6	23.5	23.5
Oats	37.5	34.9	43.7	39.7	37.8	35.5	40.3		25.7	24.6	46.6	38.1	35.9	20.4	46.4	37.9	39.8	33.5
Barley	24.5	27.9	36.4	31.7	28.1	28.4	32.2		16.5	19.7	35.2	30.4	13.8	16.3	34.4	30.3	26.4	26.7
Flax	5.3	8.9	10.8	10.2	7.8	9.1	10.3		7.3	6.3	10.7	9.7	12.1	5.2	11.4	9.7	8.9	8.6
Sunflowers	3.6	8.6	9.3	9.8	10.1	8.7	9.9		12.3	6.1	14.5	9.4	18.3	5.0	11.4	9.3	11.2	8.2
Peas	17.5	13.5	18.5	15.4	20.0	13.7	15.6		9.9	9.6	15.2	14.7	15.9	7.9	23.6	14.7	15.7	13.0
Sugar beets	406.7	380.9	320.1	433.9	270.1	387.3	440.1		306.7	269.1	360.1	415.3	430.1	222.4	303.4	413.7	354.7	365.5
Tame hay																		
Total without s'beets	118.3		134.7		120.3		136.6		83.6		129.0		69.1		128.5		113.5	
Total with s' beets	499.2		568.6		507.6		576.7		352.7		544.3		291.5		542.2		479.0	
AVerage N.W.Y./Ac.**	71.3		81.3		72.5		82.4		50.4		77.8		41.7		77.5		69.4	
N.W.Y./Ac. without s'beets	19.7		22.4		20.1		22.8		13.9		21.5		11.5		21.4		19.1	

* A = Actual, N = Normalized.

** N.W.Y./Ac. = Normalized Wheat Yield Per Acre.

APPENDIX IV

1. Net Worth: is the difference between the total amount of farm and personal assets and the total farm and personal liabilities. It is determined by subtracting liabilities from the assets.

2. Financial Progress: is calculated by subtracting the net worth in the beginning of the year from the net worth at the end of the year.

3. Work Units: number of 10 hour days of directly productive work usually associated with a crop or livestock program. This is also sometimes called productive man work units. The man equivalent (M.E.) is an adult male of average capacity fully employed for a 12 month period. Similarly, a month of labor means one man or man equivalent available for one month. Work units in crops are calculated* on a per acre basis; and in livestock on a per animal unit basis. Table 1 indicates the productive man work units for different crop and livestock programs. Time spent on repair work, construction and travelling is not considered as a part of the productive work.

TABLE 1

Work Units for Crop and Livestock Programs

Crops	Work Units	Livestock	Work Units
Cereals and small seeds	0.3	Milk cows	10.0
		Beef cows	2.0
		Bulls	4.0
Hay and hay silage	0.6	Young stock	1.5
		Sows & boars	10.5
		Market hogs	1.0
Corn silage	1.2	Ewes	3.5
		Lambs	2.8
		Hens	10.0
		Turkeys	5.0

4. Total Farm Receipts: include all product sales and miscellaneous income, income from custom work, decreases or increases in the crop or livestock inventory. Purchases of feed, seed and livestock are not included in total farm receipts.

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* The method of calculating work units in crops and livestock enterprises is similar to the procedure employed in the Carman District Farm Business Association Annual Report 1964 and the Western Manitoba Farm Business Association Report for 1963, Faculty of Agriculture & Home Economics, University of Manitoba.

5. Value of Crop Production: is the total yield of each crop valued at average prices.

6. Value of Livestock Production: includes the sale of livestock and livestock products, changes in the livestock inventory and the value of livestock products used in the home. Purchases of livestock are subtracted from the value of livestock production. The value of livestock production, therefore, equals the value of livestock sales minus the Livestock purchases plus home consumption plus the end of year inventory minus the start of year inventory.

7. Value of Total Farm Production: includes total product (crops and livestock) sales minus capital sales plus farm produce used in the home, plus or minus change in livestock inventory, minus livestock purchased, minus feed purchased, minus seed purchased.

8. Total Costs of Production: includes yearly operating expenses, depreciation on buildings and machinery, interest on debt and five percent interest charged for owned capital.

9. Fixed Costs Versus Cash or Variable Costs: fixed costs are the costs of owning a machine, that is, depreciation and interest. Cash costs or the variable costs are the costs of operating the machine, that is, fuel, grease and repairs.

10. Rate of Capital Turnover: is the number of years which it takes for the value of annual production to equal the total farm capital or the investment. It is determined by dividing the total farm capital by the total value of farm production.

11. Ratio of Farm Assets to Liabilities: indicates percentages of assets owned and is determined by dividing the total farm assets by the total farm liabilities.

12. Farmer's Liabilities: represents the debts or obligations of the farm and of the farmer's business. These debts include mortgages, farm improvement loans, credit union loans, notes, personal loans, liens, sales contracts and personal accounts payable.

13. Farm Income or Net Farm Income: is calculated by subtracting the operating cost of production from the total farm receipts.

14. Gross Expense Ratio: is the ratio of cost of farm production to the value of farm production, expressed as a percentage. It is determined by dividing the cost of farm production by the value of farm production multiplied by 100.

15. Operator's Equity in Business: is the value of total farm capital less total farm liabilities.

16. Ratio of Total Farm Capital to Liabilities: is determined by dividing the operator's farm equity by farm capital multiplied by 100.

17. Livestock Investment: is the sum of the livestock inventory and the purchase of livestock within one year. Thus the livestock investment is found by adding the beginning of the year value (inventory) and the purchase value of the livestock by the end of the year.

APPENDIX V

AGRICULTURAL INPUTS[a], PRODUCTION[b] AND DIVERGENCY[c] BETWEEN THEM FROM YEAR TO YEAR, MANITOBA, 1926-63[d]

Year	Agri. Input		Agri. Prod.		Input-Output Divergency		Total crop Yield		Income from Crops		Income from Livestock		Total farm Income[e]	
	Index	% change from Yr. before	Index	% change from Yr. before	Index	% change from Yr. before	Index	% change from Yr. before	Index	% change from Yr. before	Index	% change from Yr. before	from live-stock (%)	from crops (%)
1926	100.0		100.0		100.0		100.0		100.0		100.0		25.9	74.1
27	95.7	-4.3	115.6	+15.6	120.7	+20.7	41.5	-58.5	78.3	-21.7	115.8	+15.8	34.1	65.9
28	104.4	+8.7	85.4	-30.2	81.8	-38.9	25.6	-15.9	83.7	+ 5.4	115.3	- 0.5	32.5	67.5
29	101.0	-3.4	116.4	+31.0	115.2	+33.4	42.7	+17.1	67.9	-15.8	118.5	+ 3.2	37.9	62.1
30	91.7	-9.3	75.2	-41.2	78.7	-36.5	25.9	-16.8	39.3	-28.6	91.4	-27.1	44.8	55.2
31	91.5	-20.2	104.7	+29.5	146.4	+67.7	39.0	+13.1	19.2	-20.1	78.8	-12.6	58.8	41.2
32	66.3	- 5.2	60.8	-43.9	91.7	-54.7	18.6	-20.1	20.0	+ 0.8	55.8	-23.0	44.8	55.2
33	64.1	- 2.2	82.5	+21.7	128.7	+37.0	27.0	+ 8.4	28.7	+ 8.7	57.0	+ 1.2	41.0	59.0
34	68.7	+ 4.6	68.4	-14.1	99.5	-29.2	21.2	- 5.8	40.4	+11.7	70.7	+13.7	38.0	62.0
35	33.3	-35.4	57.9	-10.5	173.8	+74.3	50.5	+29.3	10.9	-29.5	20.2	-50.5	53.2	46.8
36	34.0	+ 0.7	57.6	- 0.3	169.4	- 4.4	48.4	- 2.1	17.1	+ 6.2	22.0	+ 1.8	44.1	55.9
37	39.2	+ 5.2	93.5	+35.9	238.5	+69.1	40.8	- 7.6	32.2	+15.1	26.3	+ 4.3	33.5	66.5
38	38.2	- 1.0	90.6	- 2.9	237.1	- 1.4	77.1	+36.3	24.4	- 7.8	28.2	+ 1.9	41.5	58.5
39	39.5	+ 1.3	102.5	+11.9	259.4	+22.3	76.9	- 0.2	23.2	- 1.2	29.8	+ 1.6	44.1	55.9
40	40.1	+ 0.6	107.7	+ 4.6	267.0	+ 7.6	77.3	+ 0.4	19.4	- 3.8	34.6	+ 4.8	52.2	47.8
41	44.2	+ 4.1	102.6	- 4.5	232.1	-34.9	79.5	+ 2.2	26.2	+ 6.8	43.3	+ 8.7	50.3	49.7
42	52.4	+ 8.2	138.9	+36.3	265.0	+32.9	83.7	+ 4.2	27.9	+ 1.7	65.3	+22.0	59.0	41.0
43	57.3	- 4.9	115.6	-23.3	201.7	-63.3	121.5	+37.8	46.5	+18.6	77.1	+11.8	50.4	49.6
44	61.7	+ 4.4	112.2	- 3.4	181.8	-19.9	9917	-21.8	63.8	17.3	79.4	2.3	43.3	56.7
45	65.1	+ 3.4	91.0	-21.2	139.7	-42.1	96.9	- 2.8	52.0	-11.8	75.7	- 3.7	47.2	52.8
46	70.6	+ 5.5	111.9	+20.9	158.4	+18.7	86.8	-10.1	61.8	+ 9.8	76.2	+ 0.5	43.1	56.9
47	80.1	+ 9.5	102.8	- 9.1	128.3	-30.1	93.3	+ 6.5	71.6	+ 9.8	76.4	+ 0.2	39.6	60.4
48	92.8	+12.7	115.8	+13.0	124.7	- 3.6	72.9	-20.4	98.3	+26.7	101.4	+25.0	38.8	61.2
49	100.0	+ 7.2	100.0	-15.8	100.0	-24.7	100.0	+27.1	100.0	+ 1.7	100.0	- 1.4	38.0	62.0
50	110.4	+10.4	111.0	+11.0	100.5	+ 0.5	82.2	-11.8	67.9	-32.1	100.6	+ 0.6	47.6	52.4
51	119.2	+ 8.8	112.7	+ 1.7	94.5	- 6.0	107.9	+19.7	110.2	+43.3	115.8	+15.2	39.2	60.8
52	122.0	+ 2.8	124.0	+11.3	101.6	+ 7.1	106.0	- 1.9	100.2	-10.0	102.7	-13.1	38.6	61.4
53	121.5	- 0.5	110.0	-14.0	90.5	-11.1	122.3	+16.3	85.8	-14.4	96.8	- 5.9	40.9	59.1
54	118.5	- 3.0	91.0	-19.0	76.7	-23.8	104.1	-18.2	61.5	-24.3	101.9	+ 5.1	50.4	49.6
55	117.8	- 0.7	103.6	+12.6	87.9	+11.2	70.9	-33.2	52.5	- 9.0	101.2	- 0.7	54.2	45.8
56	127.7	+ 9.9	132.2	+28.6	103.5	+15.6	85.4	+14.5	75.0	+22.5	102.4	+ 1.2	45.6	54.4
57	121.6	- 6.1	106.8	-25.4	87.8	-15.7	121.3	+35.9	63.0	-12.0	109.5	+ 7.1	51.6	48.4
58	121.3	- 0.3	127.1	+20.3	104.7	+16.9	84.0	-37.3	65.0	+ 2.0	131.3	+21.8	55.4	44.6
59	127.9	+ 6.6	122.8	- 4.3	96.0	- 8.7	100.8	+16.8	73.6	- 8.6	125.6	- 5.7	51.2	48.8
60	132.8	+ 4.9	126.2	+ 3.4	95.0	- 1.0	95.1	- 5.7	72.8	- 0.8	117.9	- 7.7	49.9	50.1
61	132.7	- 0.1	87.7	-38.5	66.0	-29.0	96.9	+ 1.8	74.1	+ 1.3	138.5	+20.6	53.4	46.6
62	142.8	+10.1	155.7	+68.0	109.0	+43.0	46.2	-50.7	89.6	+15.5	125.4	-13.1	46.2	53.8
63							125.8	+79.6						
Total varia.		225.2		666.5		947.0		628.6						
Av. varia. in % per year		6.0		18.0		25.5		16.9						

Footnotes on following page.

APPENDIX V (continued)

AGRICULTURAL INPUTS[a], PRODUCTION[b] AND DIVERGENCY[c] BETWEEN THEM FROM YEAR TO YEAR, MANITOBA, 1926-63[d]

Footnotes:

[a]Agricultural inputs include total operating expenses for producing or raising various farm enterprises.

[b]Agricultural production is the index No. of physical volume of agricultural production including all farm enterprises.

[c]Input-output or production divergency index equals agricultural production. Index ÷ Input Index x 100. It is a measure of year to year changes in over all yield in agriculture.

[d]Year 1926 = 100 for calculating index numbers of production or income from 1926 to 1934 and year 1949 = 100 for the years 1935 to 1963.

[e]Total farm income includes only crop and livestock enterprises because here it is intended to see the impact of variability on these two major enterprises of the farm business.

APPENDIX VI

PRICE PER UNIT FOR EACH CROP*

	1957	1958	1959	1960	1961	1962	1963	1964
Wheat	1.48 bu	1.48 bu	1.40 bu	1.47 bu	1.65 bu	1.50 bu	1.50 bu	1.50 bu
Oats	.61 "	.47 "	.55 "	.61 "	.80 "	.50 "	.50 "	.50 "
Barley	.90 "	.80 "	.87 "	.87 "	1.00 "	.90 "	.90 "	.90 "
Rye	.90 "	.87 "	.95 "	1.00 "	1.25 "	1.00 "	1.00 "	1.00 "
Clover seed	.05 lb	.06 lb	.05 lb	.04 lb	.08 lb	.12 lb	.12 lb	.12 lb
Flax	2.70 bu	2,85 bu	3.00 bu	3.00bu	3.25 bu	2.75 bu	2.75 bu	2.75 bu
Sunflowers	.035lb	.035lb	.035lb	.04 lb	.035lb	.05 lb	.05 lb	.05 lb
Rapeseed	1.75 bu	.035lb	.035lb	.04 lb	.04 lb	2.50 bu	2.50 bu	2.50 bu
Alfalfa	-----Unbaled---		1957to1960	13.50 T.	20.00 T.	12.00 T.	12.00 T.	12.00 T.
Corn silage	"		"	"	5.00 T.	6.00 T.	6.00 T.	6.00 T. 6.00 T.
Sugar beets	16.50 T.	13.50 T.	12.00 T.	12.00 T.	12.00 T	15.00 T.	15.00 T.	15.00 T.

* Source: Farm Business Association Account Books, Department of Agricultural Economics, University of Manitoba.

APPENDIX VII

ANNUAL PRICES OF LIVESTOCK, DAIRY AND POULTRY PRODUCTS*

Year	Dollars Per Hundredweight				Fluid Milk Cents Per Hundred-weight	Creamery Butterfat cents per pound	Eggs, all grades, cents per dozen	Chickens cents per pound
	Choice Steers	Good Feeder Steers	Choice Fed Calves	Dressed Hogs				
1957	18.93	17.00	18.47	28.20	453	61.9	27.5	22.8
1958	22.93	21.60	22.86	25.20	441	62.4	26.2	22.3
1959	24.57	22.90	24.47	21.30	439	62.9	24.1	21.4
1960	22.60	21.00	21.53	21.65	442	63.4	23.4	20.3
1961	22.00	21.45	20.85	24.85	460	63.2	24.7	18.1
1962	25.70	24.40	24.25	25.65	462	63.1	24.4	19.2
1963	23.85	23.20	22.92	24.80	462	63.7	27.0	-

* Source: Principles and Practices of Commercial Farming, editors Gilson, J.C. et al, The Public Press Limited, Winnipeg 1965, pp. 404-405