THE MANITOBA SUGAR BEET INDUSTRY - A GEOGRAPHICAL STUDY

A Thesis

Presented to

The Faculty of Graduate Studies and Research

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

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Winnipeg, Manitoba

April 1962

ACKNOWLEDGEMENTS

The writer acknowledges with gratitude the valuable suggestions and constructive criticism he has received from Dr. T.R. Weir, Chairman of the Department of Geography, University of Manitoba, and Dr. R.A. Hedlin, Chairman of the Department of Soil Science, University of Manitoba. The writer is indebted to the members of the Department of Agriculture, Manitoba Sugar Company; to the Soils and Crops Branch, Manitoba Department of Agriculture; to the staff of the Manitoba Soil Survey; to the sugar beet growers who willingly contributed information on their sugar beet enterprise; and to anyone who has directly or indirectly contributed to the writing of this report.

ABSTRACT

THE MANITOBA SUGAR BEET INDUSTRY -
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The purpose -

The purpose of this study is to analyse and describe the physical and cultural factors that have had an influence on the production of sugar beets; to determine how these factors have influenced sugar beet production and how the production process has adjusted to these factors; to trace the development of the industry from the experimental stage to the stage of stability; and to describe the activities that occur in the production and refining of the sugar beets.

Methods of Investigation -

In this study the writer endeavours to investigate the trends in: (1) the location and distribution of sugar beet acreage; (2) the requirements of hand labour in the production of sugar beets; (3) mechanization; (4) transportation; and (5) marketing of refined sugar. The physical conditions in Manitoba related to sugar beet production are compared with the more optimum conditions. Where possible the data has been tabulated and charts were drawn to show the data graphically.

Major Conclusions -

Some of the major conclusions were: (1) the sugar beet producing lands have shifted to areas with more suitable soil; (2) sugar beet production has concentrated in areas of relatively high rural population to help alleviate the labour shortage problem; (3) the climatic conditions in Manitoba set rigorous controls on the quantity and quality of beets produced; (4) the growing season in the Red River Valley is about forty-five days shorter than the optimum length; (5) the temperatures during

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CHAPTER I

INTRODUCTION

PURPOSE OF THE STUDY

This is a geographical study of the sugar beet industry in Manitoba. It is concerned chiefly with the relative importance of the physical controls such as soils, climate, and drainage underlying sugar beet production. In it the writer endeavours to describe and analyze some of the factors, including both physical and cultural, which affect the distribution of the sugar beet producing areas; to trace the development of the industry from the experimental stage through to the stage of stability; and to discuss the actual production and processing of the sugar beets.

Sugar beet production is playing a role of increasing importance in Manitoba's shift towards a more diversified agriculture. In the year 1960 over 800 farmers produced 258,500 tons of beets from 25,000 acres. The estimated value of the sugar beet crop was three million dollars. During 1960 Manitoba growers produced twenty-two per cent of the national production.

The industry has been in continuous operation for twenty-one years and has become part of the landscape. Some of the specific cultural forms of the landscape resulting from the production of sugar beets are the beet fields, loading stations, and the sugar factory. The beet fields form a conspicuous part of the landscape in certain parts of the Red River Valley. Yet very little information on the sugar beet industry has been published.

Officials of the Manitoba Sugar Company felt that a geographical study of the industry which would analyze some of the changes which have

occurred since the inception of the industry would be valuable. Also, the need for further geographical information on the production of sugar beets was stimulated by the increased attention being paid to special crops in Manitoba. They have recently become an important source of raw material for secondary industry. The development of secondary industry is receiving high priority by both local and provincial governments.

This study is concerned with sugar beet growing in the Red River Valley where its economical production reveals close integration with the physical factors of the environment, particularly soils, climate, and drainage. Here drought as well as excess moisture and both spring and fall frosts must be contended with.

Not alone, however, can the distribution of sugar beet producing lands be attributed to the physical aspects. The labour situation, too, had a part to play especially during the period of the second World War and prior to the mechanization of the harvest operation.

PREVIOUS WORK

Although the sugar beet industry was established over twenty years ago very little information about the interaction of physical and cultural factors has been correlated and published. A summation of some of the experimental data on sugar beets before the establishment of the refinery was made by the Department of Soils, University of Manitoba.[1]

Two economic studies under the auspices of the Department of Agricultural Economics and Farm Management, University of Manitoba,

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[1] "History of Sugar Beet Experiments in Manitoba." (Unpublished data, Department of Soils, University of Manitoba).

were carried out in 1956 and 1959. The first study entitled Economic Aspects of Sugar Beet Production in Manitoba was mainly concerned with "the nature of the costs involved in sugar beet production" and "the relationship between the sugar beet enterprise and other enterprises on the farm."[2] The more recent work was concerned with the different economic "aspects of hand and mechanical thinning of sugar beets in Manitoba."[3]

METHOD OF PROCEDURE

The activity of the production of sugar beets rests to a large extent on the physical base consequently the relationship of this activity to the elements of the natural environment must concern one in a geographical study of the industry. Therefore, in analyzing the activities of sugar beet production emphasis has been placed on the relation of the physical factors to the production of sugar beets and to the distribution of sugar beet growing lands. On the other hand if one is to understand and to explain the production and distribution of sugar beets one cannot ignore the cultural and economic aspects.

The physical factors - annual precipitation, seasonal distribution of precipitation, length of growing season, temperature of the growing season, winds, sunshine, soils, drainage, relief and pests and the cultural and economic conditions - labour supply, concentration of rural population,

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[2] J.C. Gilson, Economic Aspects of Sugar Beet Production in Manitoba, Research Report No. 1, (Winnipeg, Manitoba: Queen's Printer, 1956), p. 7

[3] J.C. Gilson, Comparison of Hand and Mechanical Thinning of Sugar Beets, Research Report No. 4, (Mimographed by Department of Agricultural Economics and Farm Management, University of Manitoba, 1959), p. 1.

mechanization, transportation, and the market situation must be considered. While the physical elements are fairly constant in any particular place but vary from area to area the production of sugar beets has shifted to areas where production is more economic or where the cultural features seem more favourable. There has been a tendency for sugar beet acreage to shift to certain predominant soil types. This shift is analyzed and discussed with the aid of maps and tables. The optimum conditions of climate and soils for the production of sugar beets are outlined and then the climate and soils as found in the areas of production in Manitoba are discussed with respect to their general suitability and to what extent they deviate from the optimum conditions.

The economic and cultural features are prone to change in time and these changescan act as strong forces on the sugar beet industry. The process of mechanization is decreasing the reliance of the industry upon hand labour. The labour requirements, the changes in labour requirements, the source of labour, and the impact of mechanization are discussed. This includes the effect of the labour shortage existing during the early years of the industry on the location of sugar beet producing lands as well as the trends in mechanization. The improvements of highway transportation have enlarged the areas served by truck transport and consequently have decreased the number of loading stations. The transportation picture and the market situation with respect to the sugar beet crop are discussed in this study. Methods of production, both on the farm and in the refinery are briefly described. This includes a section on the location factors of the refinery. The marketing of the finished product, sugar, is dealt with under three main headings: market area, the pricing of sugar, and the present and possible future demand for sugar.

Finally, the writer has attempted to summarize the study and to point out some of the more important findings and conclusions of the report.

SOURCES OF DATA

During the summer and fall of 1955 a reconnaissance was conducted by automobile in the various areas of sugar beet production. Information was obtained by means of personal interviews with present as well as past producers. The selection was based on the size of the sugar beet operation as well as the location in order to ensure as representative a sample as possible from all the parts of the sugar beet producing areas. Much valuable information was obtained through discussions with the seven Manitoba Sugar Company fieldmen who are stationed in their respective districts as well as with the officials of the agricultural department, Manitoba Sugar Company. Additional data were obtained from agronomists and soil specialists in the Manitoba Department of Agriculture and the Faculty of Agriculture, University of Manitoba.

The data on the development of the industry were gathered from various newspapers, including the Winnipeg Free Press, the Winnipeg Tribune, and Red River Valley Echo (formerly the Altona Echo), Dominion Experimental Farm records, agricultural periodicals, and government publications.

Information on the physical factors as they relate to the sugar beet production was obtained from various soils reports, Manitoba Soil Survey, United States Department of Agriculture Yearbooks, climatic records from the Meteorological Division, Department of Transport, and various federal and provincial government publications.

The statistical data on sugar beets were obtained from the Manitoba Sugar Company records and the Provincial Government files in Winnipeg.

EXPLANATION OF TERMS

Terms that are unique to the sugar beet industry or that are used in a restricted or unusual manner are explained when they appear in the body of the report.

CHAPTER II

ORIGIN AND DEVELOPMENT OF THE INDUSTRY

EARLY ATTEMPTS TO GROW SUGAR BEETS

Attempts to establish the sugar beet industry in Manitoba were made before the end of the 19th century. Sugar beets were first grown here before the turn of the century. They were utilized as feed for livestock and in the production of home made sugar beet syrup.

The experimental farm at Brandon was the first to experiment with the production of sugar beets. Their attempt in 1890 when the crop was destroyed by cut-worms[1] was a complete failure. From 1892 to 1900 the Brandon Experimental farm conducted variety tests. In 1900, at the request of the Winnipeg Board of Trade, sugar beets grown at Brandon and Winnipeg were analyzed for sugar content and purity by the Chemist of the Dominion Experimental Farm at Ottawa.[2] Due to extremely dry weather conditions in the early part of the growing season, followed by heavy precipitation in August and September, the sugar content and the coefficient of purity[3] were below average. Experiments were

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[1] S.A. Bedford, Report of Superintendent Experimental Farm, Brandon, Manitoba, Experimental Farms 1890 (Ottawa: Queen's Printer, 1891), p. 250.

[2] F.T. Shutt, Report of the Chemist, Ottawa, Experimental Farms, 1900, (Ottawa: Queen's Printer, 1901), p. 177.

[3] Coefficient of purity is determined by dividing the amount of sugar in a given quantity of beet juice by the total solids in the same quantity of beet juice. It should not be less than 80 per cent if the beets are mature. Within the American framework it is generally considered that a successful crop of sugar beets has the following criteria: (1) a yield of about 12 or more tons per acre; (2) purity of 80 per cent or more; and (3) a 15 to 20 per cent sugar content. See footnote 3 on page 26.

continued each year at the Brandon Experimental Farm, and occasionally beets with satisfactory sugar content were obtained, but as a rule, the data showed that high quality, either with respect to sugar or purity, was lacking.

In spite of the discouraging records at Brandon, an enterprising farmer and business man at Ninga, in 1899, erected a factory for the refining of sugar beets raised on his 640 acre farm. He placed on the local market a "very fair quality of syrup" selling at 50¢ per gallon as well as a considerable amount of brown, and a small amount of white sugar. It is believed, however, that financial losses in his grain buying ventures were likely the cause of his being unable to continue sugar and syrup manufacture beyond a three year trial.[4]

In the year 1903 experimental plots were conducted in numerous districts in the province which included such places as Boissevain, Pilot Mound, Morden and Gretna.[5] Satisfactory beets for profitable sugar manufacturing were produced only at Winnipeg, Ninga and Brandon. After 1903 up to 1917 the Brandon and Morden Experimental farms together with the Manitoba Agricultural College placed emphasis on variety testing, and limited their experiments to local areas only. At Morden the results of several years of testing showed that the tonnage and sugar content were good, but the purity index was not satisfactory.

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[4]Personal correspondence with Mr. W.J. Wade, Brandon Experimental Farm, Brandon, Manitoba.

[5]S.A. Bedford, Report of Superintendent Farm, Brandon, Manitoba, Experimental Farms 1903, (Ottawa: Queen's Printer, 1904), p. 330.

The rapid expansion of the sugar beet industry in the northern states of the United States provided the incentive to motivate the Agriculture College and the Department of Agriculture to expand their research program with respect to sugar beets. During 1917 the college, in conjunction with the Department of Agriculture, distributed seed to farmers in several districts of Manitoba. (Appendix B, Table 11, page 176.). Samples of the beets grown were collected and analyzed at the college. The analytical results showed that "the quality of the beets was below the average" the reasons being "the excessive growth made in the early months of summer, and the immaturity of the roots owing to the cool autumn".[6]

A date of seeding experiment was also conducted during 1917. The results secured, given in table form in Appendix B, Table 111, page 177, indicated that the coefficient of purity was largely dependent upon the stage of maturity.[7]

Large scale experimentation and investigation with the production of sugar beets suitable for the extraction of sugar was begun by Mr. C.J. McCullum in the year 1920. He distributed imported Kleinwanzleben seed to reliable farmers in the Winnipeg area, and in autumn samples from

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[6]W.F. Geddis, "The Sugar Beet Industry," Scientific Agriculture, V: 107, December 1924. p. 106

[7]"History of Sugar Beet Experiments in Manitoba," (unpublished data, Department of Soils, University of Manitoba). p. 22.

these farmers were obtained and sent to the Chemistry Department of the Manitoba Agricultural College, and to several beet factories in the United States for chemical analysis.[8] The results showed that the sugar content of the beets analyzed were satisfactory, however, the per cent coefficient of purity of the juice was low. (Appendix B, Table IV, page 178.)

In addition to the chemical analysis of the beets, the Manitoba Agriculture College carried out an experiment in plots at the college farm to determine the effect of maturity on the purity of the beet juice.[9] From a plot of beets seeded on May 31st, samples were taken in the fall at weekly intervals until the beets were harvested. The results obtained are tabulated in Appendix B, Table V, page 179. The results indicated that maturity is an important factor in purity.[10]

In the spring of 1922 Mr. McCullum again distributed imported seed to farmers with a 25 mile radius of Winnipeg. The season was not particularly favourable for the production of sugar beets. The seed was not planted until late in May and the precipitation was quite high and temperature low during the growing season. The analytical results obtained by the Manitoba Agriculture College are given in table form in Appendix B.[11]

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[8] Loc. cit.

[9] Ibid. P. 23

[10] Ibid. p. 23

[11] Geddes, op. cit. p. 109

In the spring of 1923, Mr. McCullum distributed seeds to farmers located in various parts of southern Manitoba. The seed was supplied by the Spreckles Sugar Company, San Francisco. Samples from these plots were analyzed by the Chemistry Department of the Manitoba Agriculture College. The location of the growers and the analytical results obtained are tabulated in Appendix G. The results showed that a much higher purity was obtained in 1923 than in any previous year. The average sugar content was also very satisfactory. The climatic conditions during the growing season were particularly favourable for the production of a mature beet. The seed obtained from the Spreckles Sugar Company might have been superior than that used previously. Further experimental work was carried on to show that similar results could again be obtained when using seed from the Spreckles Sugar Company.[12]

The Manitoba Agriculture College conducted experiments to determine whether or not satisfactory tonnage could be grown in Manitoba. Prior to 1919 the variety of seed used was Kleinwanzleben, but since that year the beets were grown from seed obtained from C.J. McCullum[13] The results of this experiment have been tabulated in Appendix B, Table VI, page 180. They showed that good average yields could be obtained, for the average yield for the six years was 12 tons per acre. This is higher than the average yield for the 1950-60 period (9.67 tons per acre).

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[12]Geddes, op. cit. p. 110

[13]"History of Sugar Beet Experiments in Manitoba," (Unpublished data, Department of Soils, University of Manitoba), p. 26.

A co-operative experiment between the Provincial Department of Agriculture, the Agricultural College and a number of farmers throughout the province of Manitoba was conducted during 1924 to obtain information as to the possibilities of growing sugar beets in the various parts of the province, and to determine, if possible, if there was any considerable variation in the sugar content of the beets grown in the various agricultural zones. The results of this experiment are given in Appendix B, Table VII, page 181.[14] The results indicated, though not conclusively on account of the limited number of plots and the lack of field supervision of distant plots, that the best beets were to be expected in the Red River Valley.

In 1925, the Manitoba Sugar Company was formed and commenced testing beets in plots in the Winnipeg area. Seed was distributed to 180 farmers within 100 miles of Winnipeg in an area bounded by Portage la Prairie, Teulon, Emerson and Whitemouth. At the end of the growing season the inspector of the plots collected samples from 141 farmers, which were analyzed at the Manitoba Agriculture College. It was impossible to find the results of this experiment.

The Industrial Development Board of Manitoba, formed in 1925, became interested in sugar beet experiments carried out by the Agriculture College and the Manitoba Sugar Beet Company and in 1926 they contributed to the installation of more modern testing equipment at the Manitoba

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[14] Ibid. p. 27.

Agriculture College laboratory.[15] That same year beets from 160 test plots were analyzed and satisfactory results were once more obtained. Further tests were carried out in 1927 from seed obtained from the Spreckles Company and plots were sown in different parts of the province under the supervision of the extension service of the Department of Agriculture.

The possibility of growing sugar beets in Manitoba was thus definitely established through experimental work. In the earlier years of the experiments the beets grown showed relatively low purity and sometimes low sugar content. It was suspected that this, probably, was due to the poor seed stock used, and to the methods of management, rather than to the soil or the climate. Subsequent work has proved this to be the case. Seed was obtained from the Dominion Sugar Company, Chatham, Ontario; Amalgamated Sugar Company, Ogden, Utah; Spreckles Sugar Company, Spreckles, California; and the Northern Sugar Company, Mason City, Iowa. The beets grown from this seed stock resulted in the production of beets on the College Farm having a sugar content varying from 16 to 21 per cent and with the juice purity ranging from 80 to 94 per cent. These variety trials definitely showed that excellent commercial sugar

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[15] Annual Report of the Industrial Development Board of Manitoba, 1926, p. 32.

beets could be produced under local conditions.[16] A general summary of the experimental data acquired by the Manitoba Agricultural College during the period from 1917 to 1931 is given in Appendix B, Table X, page 184.[17]

By this time the Spreckles Sugar Company of California had become interested in the possibility of establishing a sugar refinery in Manitoba, and in 1926 officials of the Company visited Winnipeg. In 1927, the general manager of the company advised that Manitoba had been recommended for the location of a beet sugar producing plant. However, following the death of the president of the Company no further action was taken.[18]

This closes what one might call the experimental stage. During this period sugar beets were raised on all grades of land in many parts of the Province largely as an experiment, and in most instances fed to livestock for want of a better outlet.

THE PERIOD OF ECONOMIC DEVELOPMENT AND EXPANSION

This period commenced in 1930 and lasted more than a decade. It is characterized by the development of a satisfactory market through the erection of factories, and by a rapid increase in production.

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[16] "History of Sugar Beets in Manitoba," (unpublished data, Department of Soils, University of Manitoba), P. 96-97.

[17] Ibid. p. 99

[18] Annual Report of the Industrial Development Board of Manitoba, 1927, p. 37.

In 1930, 150 acres of beet plots were planted to sugar beets in the Selkirk, Headingly, Stonewall and Lilyfield districts, and 516 tons of harvested sugar beets were shipped to the refinery at East Grand Forks, Minnesota. The American Sugar Beet Company supplied the necessary drills, cultivators and beet lifters.[19]

In 1931, the American Sugar Beet Company paying $4.50 a ton at shipping points had 425 acres under contract in Manitoba. Seed and special machinery, which were again sent to Manitoba, encountered considerable trouble clearing the customs. The government officials forced the company to resack the seed because of the possibility that it might be carrying foot and mouth disease.[20] The 425 acres under contract were distributed from Emerson and Gretna in the south to Stonewall and Selkirk in the north. The following year the American Company made contracts with 27 farmers in the Emerson, Gretna and Altona districts.[21] The beet sugar prices in the United States were the lowest in history, consequently, the cost of growing sugar beets indicated that it would be unprofitable to ship beets from the Winnipeg area to East Grand Forks, and that the growing area must necessarily be confined to districts close to the boundary. Approximately 3,500 tons of beets were produced in the Emerson, Gretna

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[19] Annual Report of the Industrial Development Board of Manitoba, 1930, p. 23.

[20] R.D. Colquit, "The Sugar Beet Takes A Step North," The Country Guide, Winnipeg, November 1931.

[21] Annual Report of the Industrial Development Board of Manitoba, 1932, p. 16.

and Altona areas and shipped to East Grand Forks, in 1933[22] (Table XI Appendix B.) A farmer from the Emerson district had received $1,000 after paying for the seed, fertilizer and duty for beets grown on a 25 acre field and refined at the East Grand Forks factory.[23] Again in 1934 sugar beets were raised in co-operation with the American Crystal Sugar Company in the Emerson and Gretna districts. Although the crop was somewhat below average in quality it was nevertheless satisfactory.[24]

By 1939, some 15,000 tons had been exported to the factory at East Grand Forks despite a duty of 80¢ per ton. No further information concerning the sugar beet production with the co-operation of the refinery at East Grand Forks was found. However, in 1939, 500 test plots were planted in difference parts of the Red River Valley to determine in what sections sugar beets would grow best.[25]

By this time it had been amply demonstrated that sugar beets for the manufacture of sugar could be commercially grown in Manitoba, and that farmers were anxious to have the opportunity of growing this crop.

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[22] The Winnipeg Free Press, August 11, 1934.

[23] The Winnipeg Free Press, May 14, 1934.

[24] The Annual Report of the Industrial Development Board of Manitoba, 1935, p. 26.

[25] The Winnipeg Free Press, July 19, 1939.

During the years following 1930 various groups endeavoured to secure the necessary capital to build a refinery, but as these were the depression years, all efforts were fruitless. The government in 1935 stimulated interest by introducing a bill called "an act authorizing a guarantee by the province of the securities of a corporation ...undertaking the building, equipping, and operating of a beet sugar refinery or factory."[26] This bill was passed by the provincial legislature.

Then, during 1940, a large modern beet sugar factory was erected in Fort Garry. The company operating the factory contracted with approximately 1,100 farmers in the Red River Valley within 60 miles of the factory to grow sugar beets.[27] During this year 15,700 acres were seeded down to sugar beets yielding 101,825 tons of beets in spite of encountering some difficulties from weeds, flooding, beet web worms and drought. In the period 1940 to 1949, the acreage in sugar beets remained between 9,000 and 15,000 acres, the average being 11,557 acres.

During the period 1950 to 1960 the average number of acres in sugar beets was 20,600. (Figure 1, page 20.) This increase over the 1940 - 1949 period was mainly due to the increased capacity of the plant. The oscillation of the production curve during the final period is due to geographic and economic circumstances such as weather, beet pests, and

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[26]The Winnipeg Free Press, June 17, 1939.

[27]Report on Crops, Livestock, etc., Crop Bulletin No. 119, (Winnipeg, Manitoba, Department of Agriculture and Immigration, December 31, 1940), p. 37.

sugar prices. For example the relatively low tonnage for 1959 was caused by unfavourable weather conditions during harvest.[28] Thirty per cent of the sugar beets remained unharvested and were a total loss. In 1952 some 8,000 acres of sugar beets were destroyed by drought, soil drifting, and cut worms.[29]

Manitoba now produces about 200,000 tons of beets annually and provides sugar for approximately sixty per cent of the population of the province. The annual consumption of sugar for Manitoba is approximately 700,000cwt, and consequently, it readily absorbs the yearly output of the industry which varies between 400,000 and 500,000 cwt.[30]

PRESENT LOCATION AND AREAL EXTENT

The present sugar beet producing areas in Manitoba correspond to the occurrence of certain factors favourable to the growing of the crop. First and foremost a market was provided in 1940 when a refinery was built at Fort Garry (Winnipeg) in the heart of the Red River Valley. Due to the high cost of transporting the beets from the producing areas to the refinery the sugar beet production is confined to an area within approximately 60

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[28] Report on Crops, Livestock, etc. Crop Bulletin No. 138, (Winnipeg, Manitoba, Department of Agriculture and Conservation, December 1959) p. 4.

[29] Report on Crops, Livestock, etc. Crop Bulletin No. 138, (Winnipeg, Manitoba, Department of Agriculture and Immigration, December 1952) Pp. 3-4.

[30] K. Schreiber, "Sugar Beets," Special Crops for Manitoba, (The Manitoba Department of Agriculture and Immigration, March 1954). p. 6.

mile radius of the factory.[31] Beyond this 60 mile radius of the plant transportation costs become excessive and so contracts with the farmers are made with this limiting factor in mind.[32] This definitely limits the sugar beet production to the Red River Valley. The Red River Valley with its level topography and large areas of suitable soil has also climatic conditions that are more favourable to sugar beet growing than other areas in Manitoba. Availability of an adequate labour supply within the territory or adjacent thereto is also an important factor.

The total number of acres utilized in the growing of sugar beets in Manitoba during 1960 was 25,068 which produced 258,452 tons of beets.[33] These beets were grown in five distinct major nodal areas in the Red River Valley (Figure 2, page 21).[34] The largest area is located just north of the international boundary and west of the Red River. Here 16,679 acres were utilized for sugar beets representing 62.3 per cent of the total. Next in importance is the Steinbach - Niverville area where a total acreage of 2,750 acres were seeded to sugar beets or 11.0 per cent of the total. A ribbon of land along the Assiniboine River from Portage la Prairie to Pigeon Lake had an acreage of 2,688 acres, 10.5 per cent of the total. Three minor nodal areas are located at Fort Garry, Homewood,

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[31] Report on Crops Livestock, etc., Crop Bulletin No. 133, (Department of Agriculture and Immigration, Province of Manitoba, (Winnipeg, Queens Printer, 1954), p. 37.

[32] L.D. Scott, "Some Requirements of the Beet Sugar Industry," (Report of the Annual Conference of Manitoba Agronomists, December, 1940). Pp 47-48.

[33] Report on Crops Livestock, etc. 1960, Department of Agriculture and Conservation, Province of Manitoba, (Winnipeg; Queens Printer, 1961), p. 37.

[34] This map shows areas of concentration only. A detailed map showing the precise location sugar beet lands is on page 81.

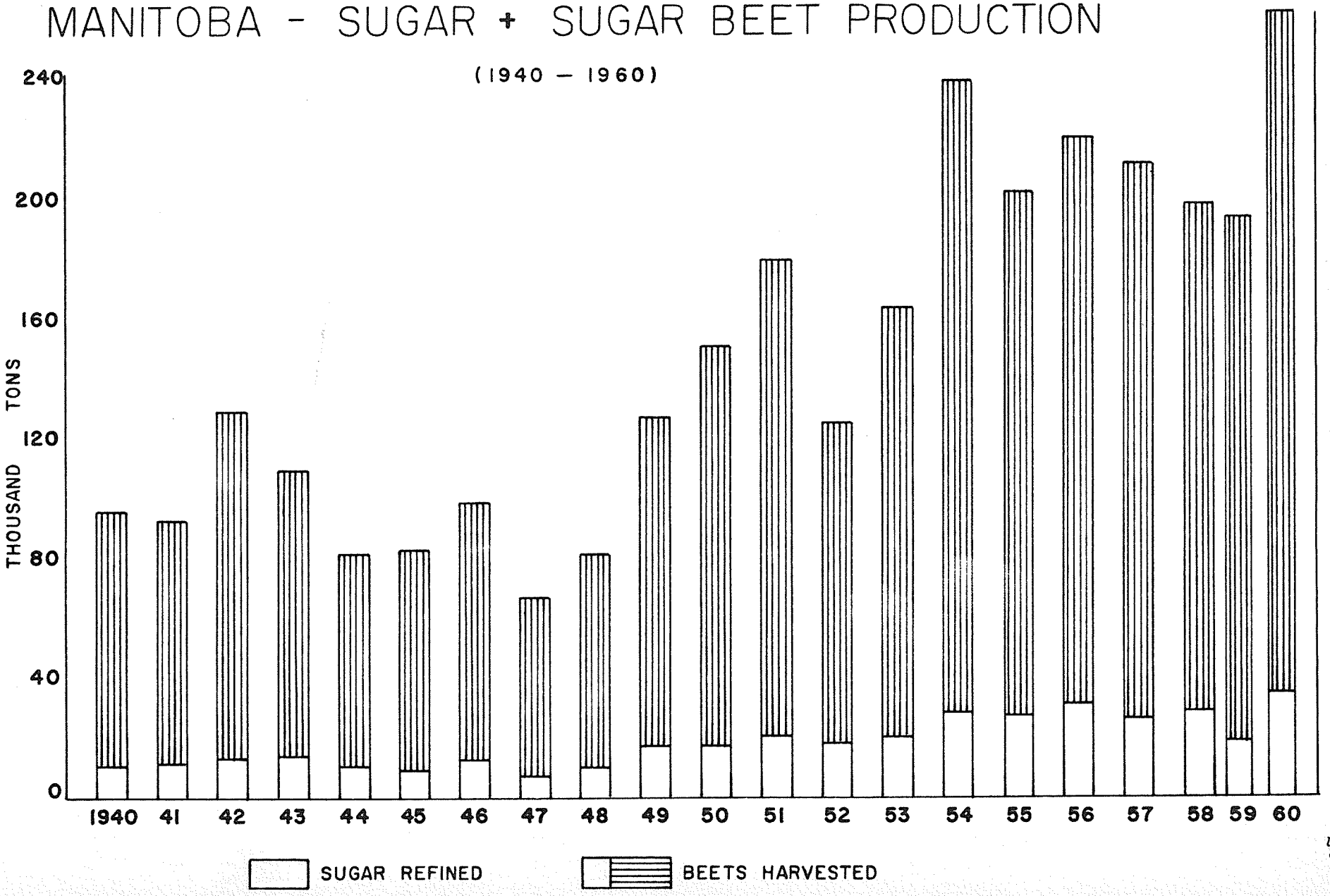
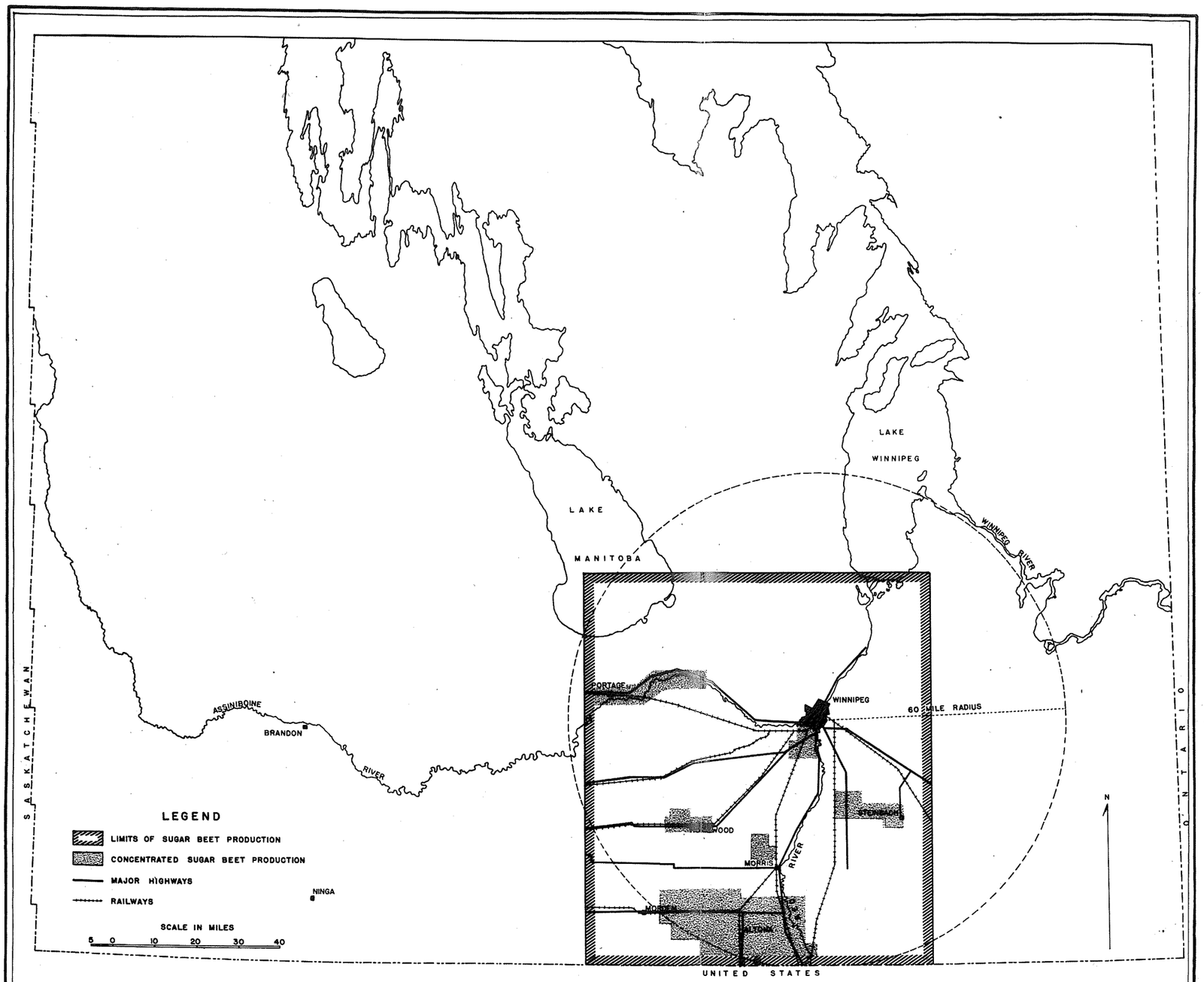

MANITOBA - SUGAR + SUGAR BEET PRODUCTION
(1940 – 1960)
THOUSAND TONS
240
200
160
120
80
40
0
1940
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
SUGAR REFINED
BEETS HARVESTED

Figure 1



SUGAR BEET PRODUCING AREAS - MANITOBA

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and Morris. At Fort Garry small market-gardeners as well as other farmers produce sugar beets with a minimum of transportation costs. The Homewood area has soils particularly suitable for the growing of a high yielding sugar beet crop. At Morris the 349 acres are located on the better drained clay textured soils adjacent to the Morris River. These three minor nodal areas contained a total of 3,099 acres of sugar beets, representing 16.2 per cent of the total.

However, sugar beet production has not always been concentrated on the nodal areas mentioned. Throughout the years that sugar beets have been grown in the Red River Valley there existed a trend for production to shift to the five districts.

CHANGES IN AREAS OF PRODUCTION

In the first two or three years that the factory was operating, contracts were made with producers in the Red River Valley regardless of whether the soil was particularly suitable or not for the production of sugar beets, and also irrespective of the labour situation in the different localities.[35] Production was scattered more or less uniformly within a 60 miles radius of the plant in the Red River Valley with heavy concentrations in the Dufrost - Dominion City area. During 1940, 15 per cent of the sugar beet acreage was located in this area.

In 1942 forty-two loading stations were scattered throughout the Red River Valley from the International Boundary in the south to Petersfield in the north, and from Portage la Prairie in the west to Ste. Anne in the east.

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[35] Scott, op. cit. p. 47

By 1943 there was already in evidence a very definite trend in the location of the acreage to particular areas.[36] This trend is readily discernible in Figure 2, page 21 where the actual location of the sugar beet acreage for the years 1941, 1945, 1950 and 1955 are plotted on four maps. In 1943 approximately one third of the acreage was located in the Emerson - Altona area; by 1945 this had increased to 51 per cent. Sugar beet acreage east of Winnipeg, and in the Red River Valley west of the river and north of Morris dropped considerably. The consolidation of sugar beet producing areas was reflected in a decline of loading station from 42 in 1942 to 23 in 1945.

An area of concentration, which has been built up in the past ten years, is the Niverville - Steinbach district. This concentration was non-existent up to 1945, but became quite dominant by 1950. (Figure 3, pocket). This area produced 22 per cent of the total production. Another area particularly important to the industry is the ribbon along the Assiniboine River, terminating at Portage la Prairie. Approximately 15 per cent of the acreage was grown here. Gravitation to the Altona - Emerson district continued for in 1950 there were 9,057 acres sown to sugar beets in this area representing 48 per cent of the total.

During the period from 1950 to 1955 the change in areas producing sugar beets was less pronounced. The Altona - Emerson district continued to grow for in 1955 it produced 68 per cent of the total production. It is developing into the most important sugar beet producing area in Manitoba. The Niverville - Steinbach area declined in total production during 1950 - 1955 to only 12.5 per cent. The ribbon along the Assiniboine River produced only 6.8 per cent of the total in 1955. The minor nodal areas

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[36] C.L. Taylor, "Sugar Beet Production, 1943," Report of the Annual Conference of Manitoba Agronomists, December 1943, p. 42.

at Fort Garry, Homewood and at Morris produced 11.7 per cent. The number of loading stations declined to 16 during this period.

From Figure 3 it is interesting to notice the diminishing importance of the Dufrost - Arnaud district. During the first years the Manitoba Sugar Company planted over 1,000 acres of sugar beets annually in this area. Shipping facilities were established at Dufrost, Arnaud, and at Dominion City which have been dismantled and moved to the expanding sugar beet producing districts west of the Red River. The Dufrost loader was moved to Horndean in 1955 and with this the Dufrost - Arnaud area completely ceased to produce sugar beets,, much to the chagrin of the farmers who had invested considerable capital in beet seeders, cultivators, and harvesters.

During the period 1955 to 1960 only minor changes in areas of production occurred. The Niverville - Steinbach area continued to decline in production of sugar beets (9.8 per cent in 1960). The ribbon along the Assiniboine River increased in total production to 11.0 per cent while the Altona - Emerson area remained close to its 1955 production.

Why has this shift taken place during the twenty years that sugar beets have been grown on a commercial scale? There are several factors contributing to this movement. The first and foremost factor is the suitability of the soil. The shift has been to the fertile, medium textured soils. This is discussed in some detail in the chapter on soils (Chapter V). The second factor is the supply of labour and ethnic background of the people. The availability of a source of labour was extremely important during World War II and prior to the mechanization of the harvest operations. This is further discussed in Chapter VI. Of minor importance is the climatic factor particularly the difference in the length of the growing season. This factor is discussed in Chapter III.

CONCLUSION

Experimentation and investigation with the production of sugar beets have shown that beets of a favourable quality (sugar content and purity) and quantity (tons per acre) could be grown in Manitoba. Although tests were conducted in different agricultural zones yet very little investigation was done to discover which soil types were most suitable for sugar beet production. The period from 1930 to 1939, when sugar beets were shipped to the factory at East Grand Forks, seemed to indicate that sugar beets could compete with the staple crops in the Red River Valley. With the erection of a refinery at Fort Garry in 1940 sugar beets became a regular crop in the valley. Since 1943 there has been a noticeable tendency for sugar beet production to gravitate to certain areas. The present location of the sugar beet producing lands has resulted from the interaction of several factors. Some of the factors are physical, some economic and cultural.

CHAPTER III

CLIMATE

CLIMATE IDEAL FOR SUGAR BEET PRODUCTION

The sugar beet is a crop grown in the temperate zone and, since it is a relatively hardy plant its production extends widely north and south. In the Northern Hemisphere the sugar beet is grown in an area bounded by the southern limit of about 35 degrees latitude to an extreme northern latitude of about 60 degrees. In general the sugar beet grows best within a zone lying between the mean summer temperature isotherm of 67 degrees and 72 degrees F. (Figure 4, page 27).[1] One American authority on sugar beets states that an average temperature of 70 degrees F. during the months of June, July, and August is considered essential for the successful production of sugar beets.[2,3] The sugar beet is grown

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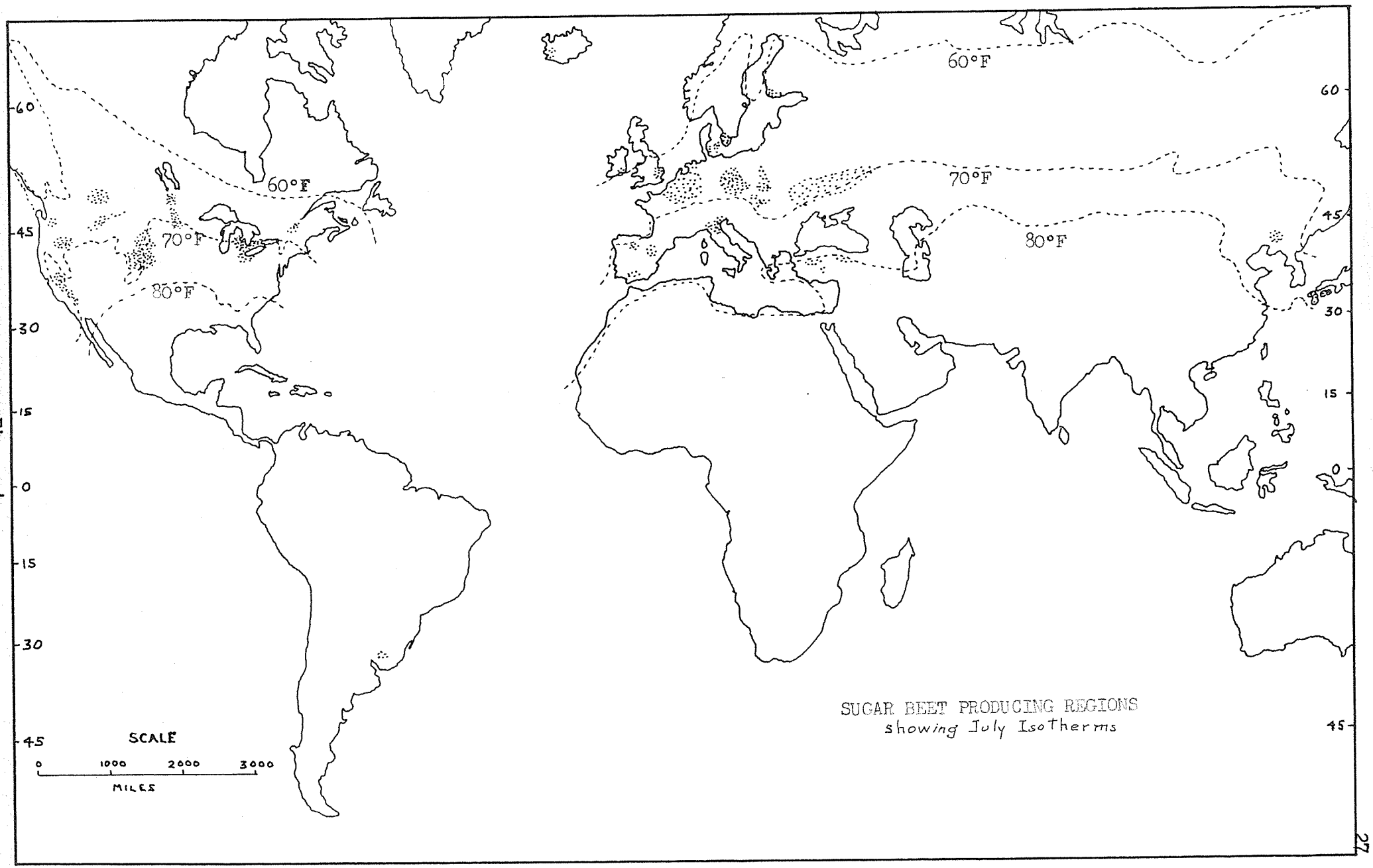
[1] C.F. Jones and G.G. Darkenwald, Economic Geography, (New York: MacMillan Company, 1954), p. 185.

[2] F.W. Geddes, "The Sugar Beet Industry," Scientific Agriculture, V:110, December, 1924. p. 110.

[3] What is generally considered as a successful crop of sugar beets? Some American authorities claim that a good tonnage is 12 tons per acres on non-irrigated land; a favourable coefficient of purity is 80 per cent or higher and a high percentage of sugar content is from 15 to 20 per cent or higher. The various elements of climate such as precipitation, temperature, length of growing season, amount of sunshine, and daily temperature variation influence the quantity as well as quality of sugar beets. The type of soil on which beets are grown can also influence the quantity and quality of beets. The management is another very important factor. This includes such items as fertilization, timeliness of operations, type



SUGAR BEET PRODUCING REGIONS
showing July Isotherms

successfully where the growing season has approximately 160 to 180 frost free days.[4] Ideal conditions are moist, sunny summers for growth, and dry, sunny, but not too warm, autumns for storage of sugar.[5] The precipitation requirement for an average crop production is two to four inches for each month of the growing season giving a total of eight to sixteen inches.[6] In irrigation experiments conducted at Montana State College it was discovered that 19 to 23 inches of water were required to grow sugar beets yielding 16.9 to 23 tons per acre.[7] The figures showing amount of water used include moisture received by natural rainfall, and loss due to evaporation from the soil as well as transpiration through the leaves. It has been claimed that the normal precipitation (19 to 21 inches) at Fargo, North Dakota is near the lower limit necessary for successful production of sugar beets without irrigation.[8] The moisture

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of operations, experience and intelligence of the operator, variety of seed used, and past history of land used for sugar beet production. Since the final product is the result of the interaction of climate, the soil and management it is difficult to correlate one factor with the quality and quantity of sugar beets produced and to determine the effect of one factor on yield.

[4]E.W. Brandes and G.H. Coons, "Climatic Relations of Sugar Cane and Sugar Beet," USDA Yearbook of Agriculture, 1941. p. 431.

[5]Jones, op. cit., p. 185.

[6]K. Schreiber, "Sugar Beets," Special Crops for Manitoba, (Winnipeg: Manitoba Department of Agriculture and Immigration, 1954), p. 7.

[7]W.E. Larson, Irrigation of Sugar Beets, Montana State College, Bozeman, Montana, June 1954, p. 3.

[8]R.M. Gilcreast, Sugar Beet Production in the Red River Valley, Agricultural Experimental Station, Fargo, N.D., December 1950, p. 7.

requirements will vary from area to area depending upon the type of precipitation, type of soil, precipitation effectiveness, humidity, and wind velocity. (See Table I, page30for comparison of yields).

Most of the sugar beet producing regions in the Northern Hemisphere lie between the 65 degree and 75 degree July isotherms (Figure 4, page27). In Europe the important and highly productive Magdeburg, Czechoslovakian, and Polish regions lie slightly north of the 70 degree isotherm. In the Western Hemisphere, culture of sugar beet is chiefly in the United States and Canada. In Canada, the only region producing sugar beets lying within the 70 degree July isotherm is Southern Ontario. The other three areas fall between the 70 degree and 65 degree July isotherms.

In Manitoba sugar beets have been grown on an experimental basis as far north as The Pas (54 degrees N. Latitude). The July average temperature is 64.5 degrees F. for The Pas while the frost free period is 119 days. The experimental plots produced 10.2 tons of sugar beets per acre having a sugar content of 15.8 per cent.[9]

CLIMATIC CONDITIONS IN MANITOBA'S AREA OF PRODUCTION

The area of commercial sugar beet production lies between 49 and 51 degrees latitude north. The entire area is located with-in Köppen's humid continental climatic zone with short, cool summers. The climate

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[9]J.H. Ellis, Field Crop Recommendations for 1960 based on Plot Experiments and Co-operative Field Demonstration in the Pasquia Area, 1955, Manuscript at Land Branch, Department of Mines and Natural Resources, Government of Manitoba. p. 9.

TABLE I

AVERAGE YIELD OF SUGAR BEETS IN TONS PER ACRE

Province	Years Observed	Average Acreage	Average Yield
Alberta	1955-1960	37,400	13.36[9]
Manitoba	1955-1960	22,000	9.72
Ontario	1955-1960	22,100	13.42
Minnesota	1949-1958	61,900	11.0
North Dakota	1949-1958	32,200	10.8
Nebraska	1949-1958	54,500	14.4
California	1949-1958	173,600	19.7 [9]

[9]In Alberta and California the sugar beets are produced under irrigation.

is characterized by a long and severe winter with an average snowfall of 65.8 inches and a summer which is short in duration and warm for the latitude. The transition seasons, autumn and spring, are brief.

Temperature. The optimum temperature for the successful production of sugar beets as stated on page 26 does not exist in Manitoba's producing area. At Winnipeg the average temperature for the three months June, July, and August is 64 degrees F., at Portage la Prairie it is 64.5 degrees F., at Morden 65 degrees F. while at Morris it is 67 degrees F. Moreover, in the East Grand Forks area in Minnesota, where beets for factory purposes have been successfully grown for a period of thirty-four years, we find temperatures for the three summer months below that of 70 degrees F. (68.3 degrees F.) Thus, the mean growing temperature in the Red River Valley is slightly below the optimum temperature for sugar-beet production, but it is believed that the long period of daylight during the growing season compensates in part for the lower temperature.[10]

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[10] K. Schreiber, op. cit. p. 7

TABLE II

MONTHLY AND ANNUAL AVERAGES

OF DAILY MEAN TEMPERATURES[11]

Station	Yrs. Obs.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Portage	32	- 2	1	16	37	51	62	68	64	55	42	22	7
Morden	32	1	5	21	39	52	62	68	65	56	42	27	10
Morris	22	0	4	19	38	54	64	70	67	55	41	24	8
Winnipeg	66	- 3	2	16	38	52	62	67	64	54	41	22	6
Average		-1	3	18	38	52	62	68	65	55	42	26	8

Since the sugar beet seed germinates slowly at temperatures just under about 50 degrees F., beets are usually planted near the beginning of May in the southern part of the province. In the vicinity of Winnipeg planting is usually done by the middle of May.[12] To assure a high percentage of emergence and prevent rotting in the soil the air temperature should be in the vicinity of 46 degrees F.[13] At Winnipeg the daily mean temperature

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[11] Climatic Summaries for Selected Meteorological Stations in the Dominion of Canada, Vol. 1; (Meteorological Division, Dept. of Transport, Toronto, Canada), p. 24.

[12] Sugar Beet, A Dependable Crop for Manitoba Farmers, Manitoba Sugar Company Limited, Winnipeg, Manitoba, p. 10.

[13] E.W. Brandes, op. cit. p. 432.

of 46 degrees is approached by the beginning of May while the daily mean temperature for the middle of May is 51 degrees F. (Table III, page 34) To avoid damage to the beet plants from low night-time temperatures, seeding operations are usually carried on in this area during the middle of May.

During the emergence stage, when the bent hypocotyls are pulling the seed leaves above the ground, the plant is most sensitive to freezing temperatures and will only tolerate five or six degrees of frost.[14] However, once the plant is well above the ground and somewhat conditioned it becomes very hardy and will withstand exposures to cold to the same degree as those withstood by small grains. It is not often that a drop in temperature to as low as 25 degrees F. will cause serious loss of stand.[15] The plant makes rapid growth when the daily mean temperature approaches 60 degrees F., and growth in late June, July, and August is speeded by mean daily temperatures of 65 degrees to 70 degrees F. At Winnipeg the daily mean temperature of 60 degrees F. is approached by the beginning of June and almost for the whole month of July the daily mean temperature remains at or near 67 degrees and begins to drop somewhat in August (Table III, page 34). For a period of at least 50 days the mean daily temperature is 65 degrees or more, however, by the end of September it has dropped to below 50 degrees F.

Cool temperatures in the latter part of August and during September check the growth of the plant while the photosynthetic activity and storage of sugar are augmented. Cool days combined with wide

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[14] Sugar Beet, A Dependable Crop for Manitoba Farmers, Manitoba Sugar Company Limited, Winnipeg, Manitoba, p. 10.

[15] S.B. Nuckols, Sugar Beet Culture in the Northern Great Plains Area, (Bulletin No. 2029, U.S. Dept. of Agriculture, Washington, D.C., October 1951), p. 5.

TABLE III

DAILY MAXIMUM, MEAN, MINIMUM TEMPERATURES FOR MAY, JUNE, JULY, AUGUST, AND SEPTEMBER AT WINNIPEG

Day	May			June			July			August			September		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1	57	34	45	71	46	58	77	54	66	78	54	66	72	49	60
2	58	34	46	71	46	58	77	55	66	78	54	66	72	48	60
3	58	34	46	71	46	59	78	55	66	78	54	66	71	48	60
4	59	35	47	71	46	59	78	55	66	78	54	66	71	48	59
5	60	35	48	71	47	59	78	55	67	78	54	66	70	47	59
6	60	36	48	71	47	59	78	56	67	78	54	66	70	47	58
7	61	36	48	71	47	59	78	56	67	78	54	66	69	47	58
8	61	37	49	72	48	60	78	56	67	78	54	66	69	46	57
9	61	37	49	72	48	60	79	56	67	78	54	66	68	46	57
10	62	37	49	72	49	61	79	56	67	78	53	66	68	45	57
11	62	38	50	73	49	61	79	56	67	78	53	65	67	45	56
12	62	38	50	73	50	61	79	56	67	77	53	65	67	44	56
13	63	38	50	73	50	62	79	56	67	77	53	65	66	44	55
14	63	39	51	74	50	62	79	56	67	77	53	65	66	44	55
15	64	39	51	74	51	62	79	55	67	77	53	65	65	43	54
16	64	39	52	74	51	63	79	55	67	77	53	65	65	43	54
17	65	40	52	74	51	63	79	55	67	77	52	65	65	43	54
18	65	40	53	74	52	63	79	55	67	76	52	64	64	42	53
19	66	41	53	75	52	63	79	55	67	76	52	64	64	42	53
20	66	41	54	75	52	64	79	55	67	76	52	64	63	41	52
21	67	42	54	75	53	64	79	55	67	75	51	63	63	41	52
22	67	42	55	75	53	64	79	55	67	75	51	63	62	40	51
23	68	43	55	75	53	64	79	55	67	75	51	63	62	40	51
24	68	43	56	76	53	64	79	55	67	74	51	62	61	39	50
25	69	44	56	76	53	64	79	55	67	74	50	62	61	39	50
26	69	44	57	76	53	65	79	55	67	74	50	62	61	38	49
27	70	44	57	76	54	65	79	55	67	73	50	62	60	38	49
28	70	45	57	76	54	65	79	55	67	73	50	61	60	38	49
29	70	45	58	77	54	65	79	54	67	73	50	61	60	38	48
30	71	45	58	77	54	65	79	54	67	73	49	61	59	37	48
31	71	46	58				79	54	66	72	49	61			

variations between day and night-time temperatures tend to produce beets with high sugar content.[16] According to experimental work conducted under artificial conditions in various localities where sugar beets are produced in the United States the sugar concentration formed an inverse pattern when plotted against the minimum night-time temperatures (above 32 degrees F.). for four weeks prior to harvest.[17] The variation between the daily maximum and minimum temperatures during August and September for Winnipeg (50° latitude) is 23.2 degrees F. The variation for Omaha, Nebraska (also located within the Great Plains Region at Latitude 41) is 21.7 degrees F. Since there are a number of factors which influence the sugar content of beets at harvest time such as variety, length of growing season, soil and fertility factors, rainfall, temperature and sunlight it would be unwise to compare sugar content of beets harvested at different latitudes. However, it may be interesting to note that the average sugar content of beets grown in the United States is 15.5 per cent[18] whereas the 21 year average for Manitoba is 16.26 per cent.

Growing Season. "The duration of the period with temperatures above 32 degrees F. is known as the frost free period or growing season."[19] The sugar beet is grown successfully where the growing season has approximately 160 to 180 frost free days. In the Red River Valley the

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[16]K. Schreiber, op. cit., p. 7.

[17]Personal correspondence with Dr. Albert Ulrich, Associate Plant Physiologist, Division of Plant Nutrition, University of California, Barkeley, California.

[18]E.W. Brandes, op. cit., p. 433.

[19]G.T. Trewartha, An Introduction to weather and Climate; (New York: McGraw-Hill Book Company, Inc., 1943), p. 62.

average length of the frost free period is about 115 days, varying from a minimum of 96 days at Graysville to a maximum of 120 days at Portage la Prairie. The average date of the last frost is about the 145th day (May 25th) of the year while the first frost can usually be expected about the 260th day (September 17th) (Table IV, page 38).[20] In that part of the region lying north of Winnipeg and Portage la Prairie the average length of the growing season varies from 100 to 114 days. The length of the growing period at Winnipeg calculated from a continuous 81 year record is 114 days, with a maximum of 158 days and a minimum of 76 days. In some areas the frost free period falls far short of the optimum for raising sugar beets. Most of the area around Winnipeg is thus below the optimum. It is believed that the long hours of sunlight and greater fluctuations between day and night-time temperatures, factors which improve the sugar content and speed up the maturing of the beets, compensate in part for the shorter growing period at this latitude.

It has been stated that sugar beet plants, during the emergence stage will tolerate five or six degrees of frost (page 33). For this reason the occurrence of 32 degrees F. in the thermometer screen is not regarded as significant for the growing of sugar beets, even though the temperature at the surface of the ground may be at least one or two degrees lower than in the screen. Rather a killing frost for sugar beets is denoted only if the temperature in the screen is below 29 or 30 degrees F. The following table sets forth the growing season based on a temperature of 29.5 degrees F. which is critical to sugar beets.

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[20] A.J. Conner, The Climate of Manitoba, (Winnipeg: Economic Survey Board, 1939), Pp. 9 - 10.

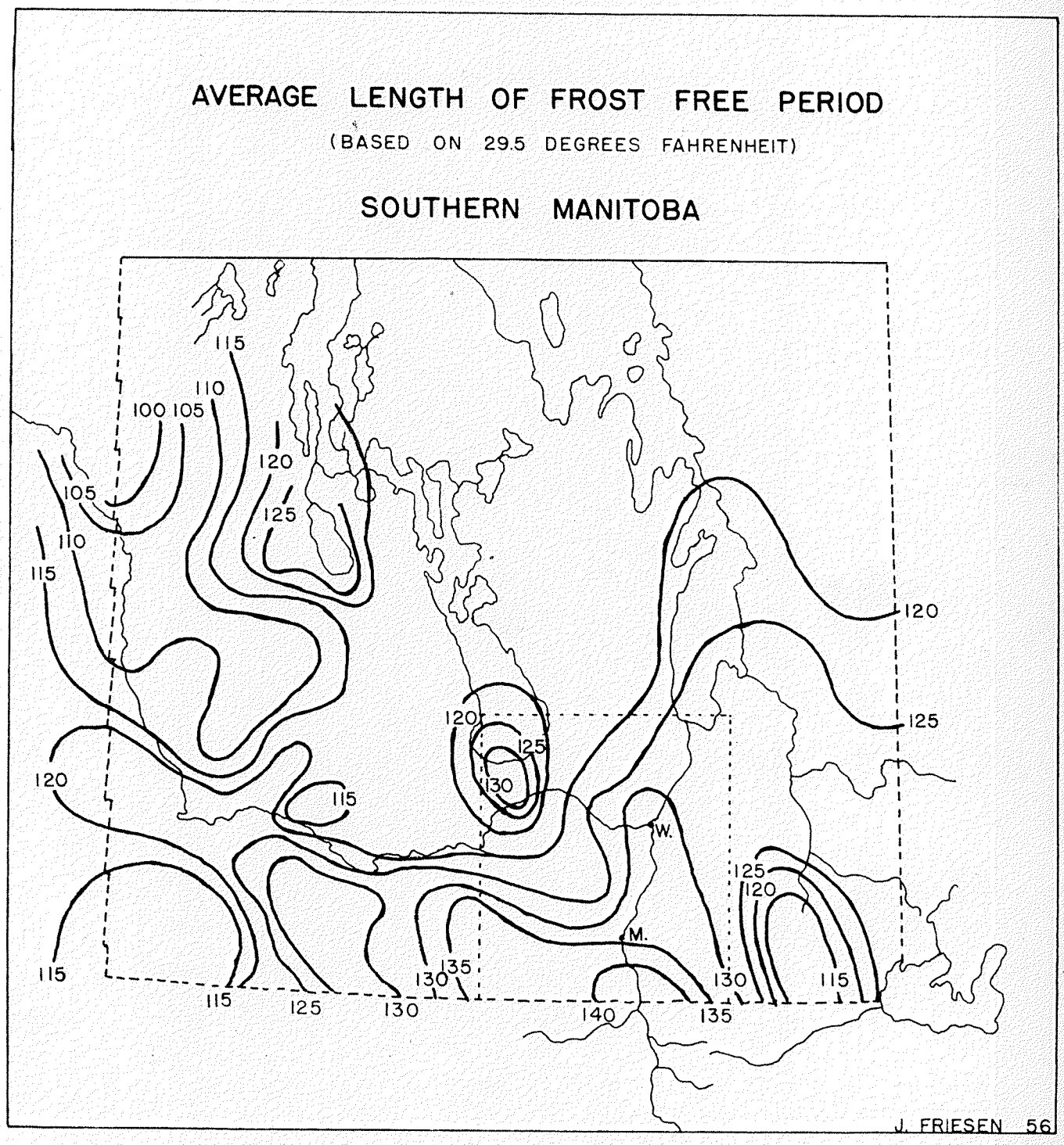
AVERAGE LENGTH OF FROST FREE PERIOD
(BASED ON 29.5 DEGREES FAHRENHEIT)
SOUTHERN MANITOBA
115
110
100 105
120
105
125
110
115
120
125
120
125
130
120
115
W.
125
120
M.
115
135
130
130
115
115
125
130
140
135
J. FRIESEN 56

Figure 5

TABLE IV

LENGTH OF THE GROWING SEASON BASED ON 29.5° FAHRENHEIT FOR STATIONS IN THE MANITOBA LOWLANDS[21]

Station	Length of Growing Season	LATE FROST				EARLY FROST			
		Av. date	Earliest date	Latest date	Yrs. Obs.	Av. date	Earliest date	Latest date	Yrs. Obs.
Portage	144	May 12	Apr.20	May 24	16	Oct.3	Sept.13	Oct.29	14
Emerson	143	May 13	Apr.18	June 12	18	Oct.3	Sept.12	Oct.28	17
Morden	136	May 17	Apr.24	June 8	30	Sept30	Aug.26	Nov.5	27
Morris	134	May 14	Apr.23	June 11	20	Sept26	Sept.9	Oct.12	20
Winnipeg	133	May 17	Apr.23	June 7	30	Sept27	Sept.6	Oct.31	31

Thus it will be seen that the growing season is lengthened by 25 to 30 days over the frost free season in the Red River Valley.

The factors of illumination and humidity operate concomitantly wit h the factors of precipitation and temperature but their direct effects are difficult to assess. However, day-length may have rather far reaching effects. The International Potash Institute at Berne, Switzerland in their publication state that:

> Illumination is a highly important factor in obtaining yields of high quality. It is known to be the determining factor in the formation, in the green tissues, of the carbohydrate precursors which give rise to sugar in the leaves and roots. Without entering into details of the complex process of photosynthesis, the result may be summarized in the statement that CO_2 reacts, under the influence of light, with the water in the plant cells, giving rise to an indeterminate primary product, supposed by some authors to be formaldehyde; this polymerises to form glucose. In parallel with this photosynthetic process, an inverse effect occurs in the cells of the entire plant: this is respiration, or the oxidation of carbohydrate (glucose),

[21] Conner, op. cit., p. 10.

> CO_2 being liberated. Thus the growth of the plant is the resultant of the phenomina of photosynthesis (building up of reserves) and respiration (partial utilization of these reserves). It is clear then, that photosynthesis, and its consequence, sugar formation, will increase its activity as the quantity of light received by the plants becomes greater.[22]

Thus we see that the amount of sunlight received by the plants plays an important role in the growing of a beet high in sugar content. It is believed that there exists a relationship between the sugar content of the beets grown in a particular area and the amount of sunshine received by that area. Figure 6, page 40 shows that, in some years for beets grown in Manitoba, there is a direct correspondence between the two. For example in the last ten years of sugar-beet production the sugar content and the per cent sunshine in August bear a direct relationship one to the other. In the year 1951 the per cent sugar content was the second lowest while the per cent sunshine was at a minimum for the ten year period. The direct correlation continues through to 1959 when the sugar content reached an all time low of 13.8 per cent while the per cent sunshine for August was near normal. Although other factors such as freezing and thawing temperatures in the fall, the quality of the seed, the moisture conditions, type of soil, and the manner in which beets are grown and handled affect the sugar content of the beets, the amount of sunshine received by the plants is an important factor in obtaining beets high in sugar.

At Winnipeg (50° N.L.), the average length of day from sunrise to sunset on June 21st, is 16.22 hours; at 41° N.L. (Omaha, Nebraska), the day is 15.06 hours in length and at 30° N.L. (Houston, Texas) the average length of day is 14.05 hours.[23] There is a difference of 1.16 hours in

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[22] The Sugar Beet and Its Manuring, (International Potash Institute, Berne, Switzerland, 1955), p. 19.

[23] Trewartha, op. cit., p. 12

SUGAR CONTENT IN RELATION TO SUNSHINE

(1950-1960)

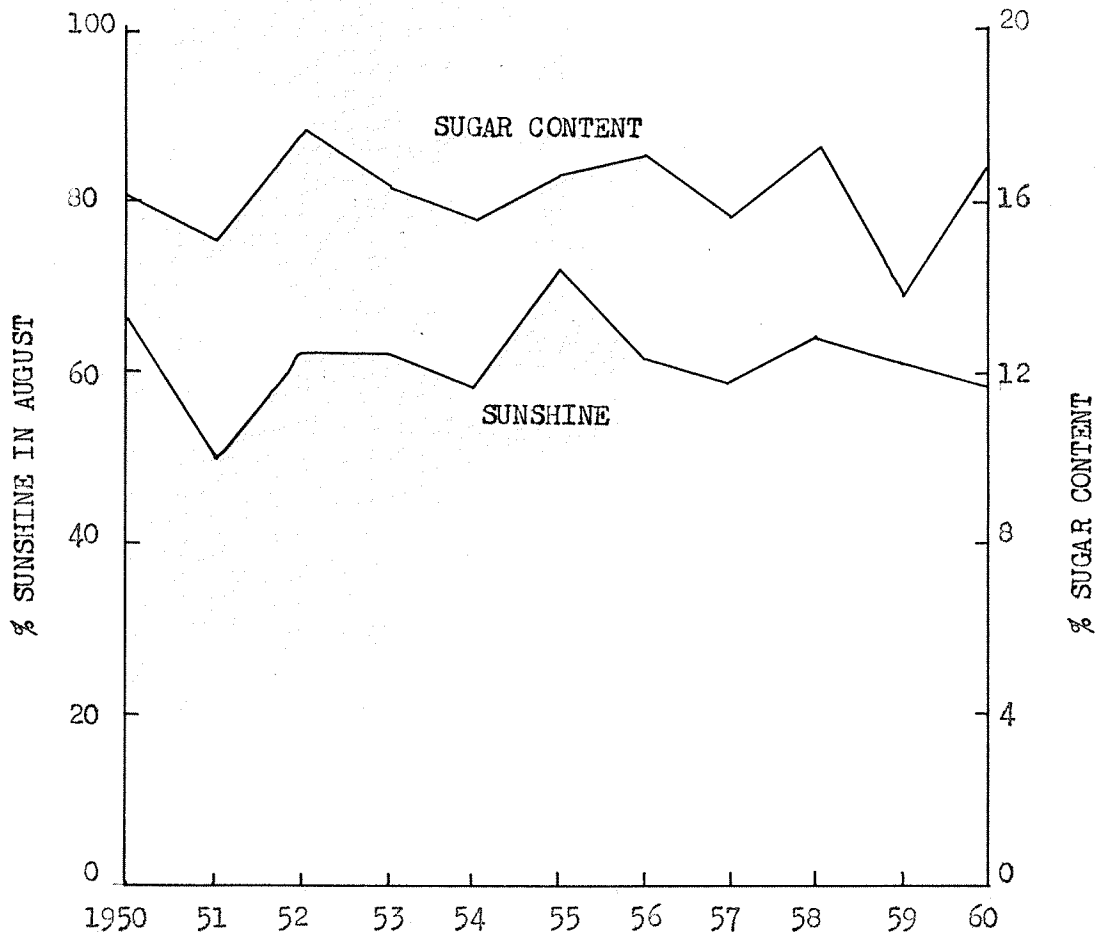

FIGURE 6

the length of day on June 21st between Winnipeg and Omaha, the total of which would be quite substantial for the summer months. However, in average number of sunshine hours for June, July, and August Omaha has 10.5 hours per day, Winnipeg has just under 10.5 while Houston has 10.3. The producing areas in Eastern Canada and Eastern United States have 10 to 8.5 average number of hours of sunshine per day from June to August. The producing areas in Alberta have 11.0 to 11.5 hours of sunshine.

Precipitation. The amount and distribution of rainfall is of great importance in the successful production of sugar beets. The sugar beet plant is particularly sensitive to the amount of precipitation during germination, stage of rapid growth, and during the maturing period.

The sugar beet growing lands of Manitoba are located in an area which receive from 18 to 21 inches of precipitation annually. The annual precipitation for the Winnipeg district, compiled from 78 years of continuous recording, is 20.49 inches. Oakbank, a point located fourteen miles northeast of Winnipeg, has a mean annual precipitation, calculated from 45 years of recording, of 20.82 inches. Portage la Prairie, located fifty miles west of Winnipeg, has a mean annual precipitation of 18.60 inches obtained from a 38 year record. The following table gives the average monthly and annual precipitation in inches for several stations in the Red River Valley.

The mean monthly precipitation and the highest and lowest monthly means for Winnipeg, compiled from a 78 year record is given in Table V, page 42 . The table shows that the yearly fluctuations in precipitation range from 13.83 to 29.70 inches. The annual precipitation increased sharply in May and the peak occurs usually towards the end of June. August and September receive less precipitation than the summer months with a sharp drop occurring in October. The winter minimum of precipitation then sets in and remains till the end of April. The average annual

TABLE V

AVERAGE MONTHLY AND ANNUAL PRECIPITATION IN INCHES[24]

Station	Yrs. Obs.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Portage	32				1.23	1.80	2.97	2.54	2.13	2.26	1.03			
Morden	32	0.72	0.67	0.95	1.25	1.92	3.10	2.44	1.76	1.84	1.16	0.89	0.84	17.54
Morris	22	0.77	0.73	0.96	1.03	1.63	2.84	2.49	2.05	2.28	1.37	1.08	0.67	17.90
Winnipeg	78	0.86	0.85	1.15	1.10	2.15	3.06	2.98	2.48	2.28	1.46	1.08	0.94	20.49
Grand Forks	40	0.54	0.54	0.73	1.59	2.58	3.16	2.75	2.57	1.88	1.36	0.86	0.62	19.18[25]
Omaha	40	0.75	0.90	1.21	1.98	3.04	3.95	3.09	3.17	3.36	1.89	1.29	0.86	25.49

snowfall for Winnipeg is 65.8 inches, which is equivalent to about six inches of moisture if ten inches of snow is considered equivalent to one inch of water. This is about 30 per cent of the total annual precipitation. Precipitation in the form of snow occurs generally during the period from November to March inclusive. The coincidence of the frost-free period with the period of maximum precipitation is of great importance to the production of sugar beets.

As a guide to the variation of the precipitation in the growing season, the difference from the average for each summer was tabulated for several points having a long record. These standard deviations are found in Table VII, page 44. Assuming an accumulation of soil moisture from winter precipitation, average moisture reserve within the soil profile, and normal distribution

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[24] Climatic Summaries for Selected Meteorological Stations in the Dominion of Canada, Vol. I, (Meteorological Division, Dept. of Transport, Toronto, Canada), p. 47.

[25] Climates of the United States, Climate and Man, Yearbook of Agriculture 1941, Washington D.C. Department of Agriculture, (Washington: Government Printing Office, 1942), p. 1045 and 968.

TABLE VI

MEAN MONTHLY PRECIPITATION AT WINNIPEG, MANITOBA AND THE HIGHEST AND LOWEST MONTHLY MEAN COMPILED FROM A 76 YEAR RECORD

Month	Mean Monthly Precipitation in inches	Monthly Precipitation Range	
		Highest Monthly Precipitation	Lowest Monthly Precipitation
January	0.86	3.36	0.12
February	0.85	3.34	0.10
March	1.15	3.00	0.06
April	1.10	5.64	0.08
May	2.15	5.88	0.03
June	3.06	10.07	0.45
July	2.98	7.77	0.61
August	2.43	9.42	0.13
September	2.28	8.09	0.05
October	1.46	5.67	0.21
November	1.08	3.55	0.06
December	0.94	3.99	0.10
	Yearly Mean	Highest Annual	Lowest Annual
Annual	20.49	29.70	13.83

of moisture throughout the growing season, the precipitation requirements for an average crop production is two to four inches for each month of the

TABLE VII

AVERAGE PRECIPITATION DURING THE GROWING SEASON AND DEVIATION FROM THE AVERAGE FOR SEVERAL STATIONS IN THE MANITOBA LOWLANDS[26]

Station	Years observed	Precipitation	Standard deviation
Winnipeg	62	9.62 in.	3.10 in.
Oakbank	46	9.61 in.	2.92 in.
Morden	51	8.53 in.	3.55 in.
Sprague	20	8.74 in.	3.10 in.
Portage	34	9.29 in.	2.93 in.

growing period.[27] This is a total of eight to sixteen inches. The average monthly precipitation for Portage la Prairie, Morden, Morris, Winnipeg, and Grand Forks is given in Table V, page 42. The total precipitation for May, June, July and August is: Portage la Prairie - 9.29 inches; Morden - 8.53 inches; Morris - 9.01 inches; Winnipeg 9.62 inches; and Grand Forks - 11.06 inches.[28] It will be seen that the total for the four months exceeds the minimum requirements of eight inches. However, it is felt that yields in Manitoba would be increased if additional moisture were available. The average yield for the past ten years was 9.67 tons per acre. Where sugar beets are irrigated the yield is substantially higher, for

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[26]Conner, op. cit., p. 12

[27]Schreiber, op. cit., p. 7

[28]Grand Forks represents a station in the sugar beet growing area in the Red River Valley in North Dakota where beets have been successfully grown since 1926.

example, crops in California often average 18 tons per acre, crops in Alberta during 1957 and 1958 averaged 14.5 tons per acre. In Ontario where the annual precipitation is 30 to 32 inches the sugar beet crop averaged 13.8 tons per acre for 1957 and 1958.[29, 30] In irrigation experiments conducted at the University of Manitoba it was discovered that during the "dry period several irrigations were warranted resulting in a 20 per cent increase in yield and 16 per cent increase of recoverable sugar over the non-irrigated plots.[31] There was a 0.6 per cent decrease in the sugar content due to the additional water.[32]

The sugar percentage is depressed for several days after heavy rains because of dilution of the plant juice. Dry weather during the ripening period increases the sugar percentage of the beet because the plant juice becomes more concentrated. Figure 7, page 46 shows that there is an inverse relationship between the sugar content and the amount of precipitation during August and September. In 1943 the precipitation

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[29] Canada Year Book 1960, Dominion Bureau of Statistics, (Ottawa: Queen's Printer, 1960), p. 475.

[30] See Table I, page 30 for yield data.

[31] K. Schreiber and P. Bergen, "Progress Report on Sugar Beets," Annual Conference of Manitoba Agronomists, 1955, p. 54.

[32] The sugar content and the yield in tons per acre determine the amount of sugar produced from one acre. Both are significant to the processor and both are affected by climatic conditions. In Manitoba the sugar content is given in an overall average figure representing all the beet producing lands. For the individual producer the yield in tons per acre is the more significant figure.

EFFECT of RAINFALL on PERCENTAGE of SUGAR in BEET

1940 - 1960

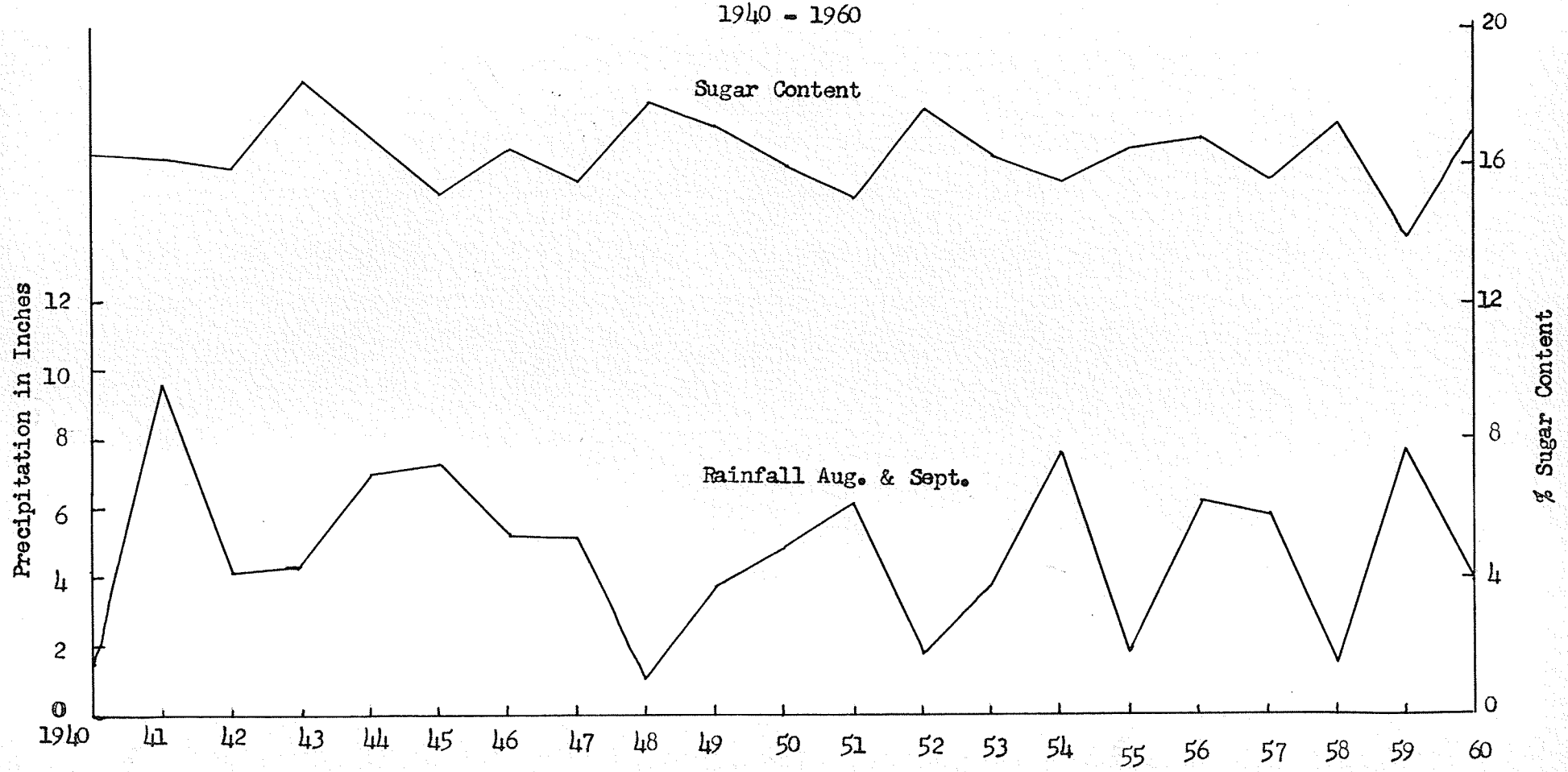

Figure 7

for the two months was just over four inches, the per cent sugar was over 18, similarly in 1948 the precipitation was only one inch while the sugar content was almost 18 per cent. The same was the case in the year 1952 and again in 1958 and 1960. When the precipitation for the two months is over six inches there is in most instances a decided fall in the sugar content of the sugar-beet crop (e.g. 1944, 45, 51, 54 and 59). Optimum moisture conditions seem to exist when the total rainfall for the two months, August and September is under four inches.

Precipitation during the season of growth usually results from the incursion of tropical air from the Gulf of Mexico.[33] The cold winds from the northeast and northwest encounter the warm moisture-laden air forcing it to rise. As it rises it cools rapidly until condensation of the water vapour occurs and it falls as rain. The greater the decrease in temperature of the warm air mass as it rises the more moisture it loses and the heavier the rainfall.

Precipitation also results from convectional activity within humid air masses. Precipitation in the form of heavy showers usually occurs on a hot summer afternoon when surface heating is intense. Because the disturbance is local in origin the area covered is relatively small and the duration of the precipitation is not long. Convectional precipitation comes at a most strategic time since it occurs in the warm season of the

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[33] Economic Atlas of Manitoba, Edited by T.R. Weir, Department of Industry and Commerce, Province of Manitoba, 1960, p. 16.

year when vegetation is active and moisture requirement of the crop is high. Moreover, it provides the maximum rainfall with the minimum amount of cloudiness.[34] However, some of the rainfall instead of entering the soil may be lost owing to surface run-off.

Frontal or cyclonic precipitation is characteristically less violent than thunderstorms and is inclined to be more widespread, steadier, and longer in duration. The dull, grey overcast skies and drizzly precipitation of the cooler months are usually associated with cyclones. In Manitoba during the growing season, rainfall originating from convectional activity is dominant, although the origin of the precipitation is frequently due to a combination of convectional and cyclonic or frontal activity.[35]

There is no doubt that for the growing season frequent and not heavy rainfalls contribute much more to the steady and vigorous growth of sugar beet plants than do a small number of heavy downpours which aggregate the same total of precipitated moisture.

Wind. Wind is a climatic factor which should be considered because spring winds that come during the planting season are sometimes serious. According to records kept at Winnipeg the percentage frequency of winds at speed causing damage to beet fields (15 miles per hour and over) is

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[34] Trewartha, op. cit. Pp. 179 - 180.

[35] Personal communication with Mr. Robertson, Meteorologist, Division of Meteorology, Department of Transport.

highest for the two spring months, April and May (Table VIII, page 49). This peak-frequency in the spring occurs when the far northern areas are still a source of wintry air masses while strongly heated air from the southern continental interior is beginning to reach higher latitudes on the Great Plains. Along the southern and eastern margin of the cold air

TABLE VIII

PERCENTAGE FREQUENCY OF WINDS AT SPEED INDICATED[36]

WINNIPEG

Miles per Hour	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Calms	9.1	10.5	8.5	6.7	6.5	8.2	9.7	9.6	6.6	7.1	7.4	10.7
4 - 15	71.8	71.0	70.5	68.2	70.7	73.6	75.6	76.5	73.5	70.7	71.5	72.5
15 - 31	18.7	18.1	20.4	24.3	22.3	18.0	14.5	13.7	19.7	21.8	20.8	16.5
31 - 47	0.4	0.4	0.5	0.8	0.5	0.2	0.2	0.2	0.2	0.4	0.3	0.3
47 +	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

masses violent, intermittent ascent of the heated air takes place, producing squall winds. Unfortunately, this is the period when, during spells, of bright quiet weather, the land is being seeded or during which the seedlings have already appeared. Since little rain is associated, as a rule, with cold fronts of early spring on the prairies, considerable movement of dry

[36]Conner, op. cit., p. 155.

top-soil occurs, interferring with the sowing of grain or "blowing out" the seedlings. Occasionally the seed is blown out of the ground or the cotyledons (seed leaves) and new leaves of small beets which are fragile and tender are injured by the cutting action of the fine soil particules. Moreover, injury may result from shifting soils on loose seedbeds. If the seedbed is not firm the seed furrow will be depressed an inch or more; drifting soil fills the furrow and may cover the seed too deeply.[37] Young beet plants also may be covered by drifting soil, and even a small amount of covering may destroy the stand.[38]

CONCLUSION

Optimum climatic conditions for the production of sugar beets do not exist in Manitoba. The average temperature in the sugar beet producing area (65 degrees F.) for June, July, and August is approximately five degrees below what is considered the optimum (70 degrees F.) temperature for the production of sugar beets. The length of the growing season is about 45 days below what is taken as the optimum length of the growing season (160 to 180 days). However, there are several advantages here which tend to compensate for the deviation from optimum climatic requirements.

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[37] S.B. Nuckels, Sugar Beet Culture in the Northern Great Plains Area, Farmer's Bulletin No. 2029, United States Department of Agriculture, Washington, D.C. 1951, Pp. 3-4.

[38] For discussion of wind damage to Manitoba crops see Chapter on Soils pages

The relatively short vegetative period is compensated for by:

1. the long hours of sunshine during which photosynthesis can take place thus improving the quality of the beet; and
2. greater fluctuations between day and night-time temperatures which accelerates the rate at which the sugar beet matures.

Uniformly distributed precipitation of from two to four inches during each month of the growing period is most advantageous. The normal rainfall is near the lower limits necessary for successful production of sugar beets. The low evaporation rate due to the lower temperatures in this region compensates, in part, for this deviation from optimum moisture conditions. However, growers and sugar company fieldmen point out that a lack of water is an important factor in limiting sugar beet yields during years of low precipitation. In spite of deficiencies in temperature and rainfall, profitable yields are obtained which compete successfully with other farm crops grown in this area.

CHAPTER IV

RELIEF AND DRAINAGE

TOPOGRAPHY AND SURFACE MATERIALS

The present topography of the area is influenced, to some extent, by the underlying rocks. These rocks in the Red River Valley of Manitoba range in age from the Precambrian to the Cretaceous periods.[1] During the Precambrian period there was a complicated sequence of volcanic activity, sedimentation, mountain building and denudation on a vast scale which may have occurred not once but several times. The final result was the planing down of the high relief to a near peneplain surface.[2] These rocks may be considered as ancestral rocks which form the base on which all the other rock formations rest. The rocks of the Paleozoic era include principally limestones, dolomites and associated shales. These sedimentary rocks were deposited in the second epoch, particularly in the Ordovician, Silurian, and the Devonian periods.[3] During the Mesozoic era the western plains, as a whole, were covered by muddy inland lakes in which thick layers of shales and sandstone were laid down. In the area concerned the regolith covers all these rock formations.

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[1] J. H. Ellis, et. al, The Report of the Reconnaissance Soil Survey of Winnipeg and Morris Map Sheet Area, (Winnipeg, Manitoba: Manitoba Department of Agriculture, 1953), p. 2.

[2] R. C. Wallace, The Geological Formations of Manitoba, (Natural History Society of Manitoba, 1925), p. 6.

[3] Ibid., p. 6.

The last stage in deposition was due to the southward progress of the ice sheets of the Pleistocene epoch. As the result of this glaciation the entire area was covered by glacial drift which ranges in thickness from less than twenty to over two hundred feet.[4] The composition of the drift is mainly of materials derived from igneous and limestone rocks. The igneous rocks become more prominent as the Precambrian Shield is approached resulting in a soil which contains more silicic material. The soils in the central and western portions are more dominant in calcareous material. This is significant because the soils ideal for sugar beet production are slightly alkaline in reaction. The calcareous material is in large part responsible for this reaction.

The glacial drift deposited by the ice in the Pleistocene period was modified by geological agencies other than the ice. These modifications have resulted in soil parent material of several distinct textural types. (Figure 8, page 54). In the basin of the glacial Lake Agassiz the drift was modified by the water of the lake and also by the deposition in the basin of particles of rocks and minerals transported by water from the higher lying cretaceous region and deposited as sediment.

The lake halted temporarily during its retreat and built up linear beach ridges of stratified sand and gravel. These beaches usually consist of sorted gravel and sand five to twenty-five or more feet in thickness overlying boulder till and are from about 10 to 800 yards in width with smooth concave tops. All the ridges located in this glacial basin were

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[4]Warren Upham, Report of Exploration of the Glacial Lake Agassiz In Manitoba, Geological and Natural History Survey of Canada, (Winnipeg: Wm. Foster Brown and Company, 1890), p. 28E.

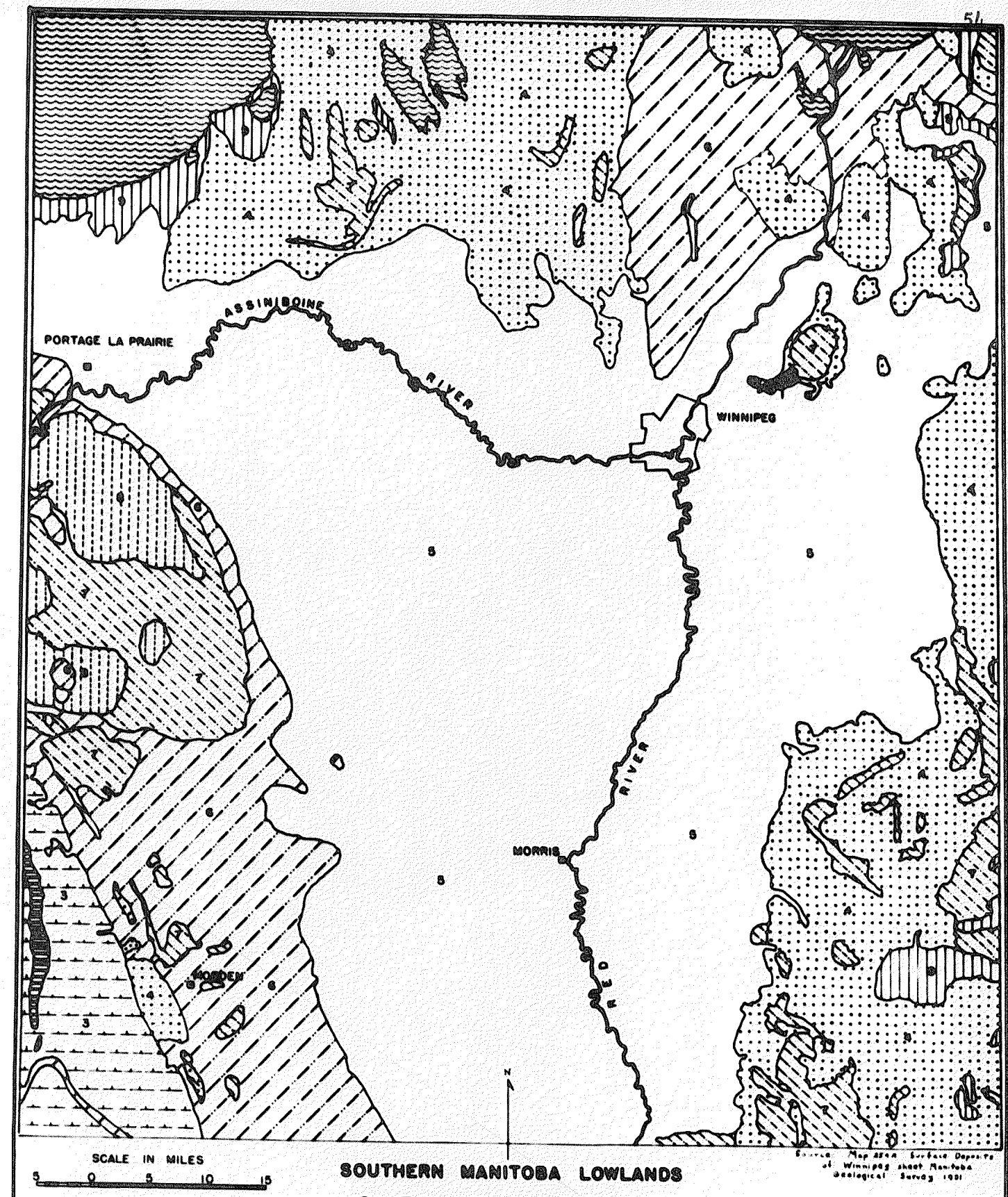
PORTAGE LA PRAIRIE
ASSINIBOINE
RIVER
WINNIPEG
MORRIS
RIVER
BOREDEN
N
SCALE IN MILES
5 0 5 10 15
SOUTHERN MANITOBA LOWLANDS
SURFACE DEPOSITS
Glacial Outwash, kames and eskers
Moraines, marginal deposits of ice sheet
Glacial Till or Boulder Clay, unmodified
Glacial Till or Boulder Clay, modified by wave action
Lake-bed & Flood-plain deposits, clayey
Lake-bed & Flood-plain deposits, silty
Lake-bed & Flood-plain deposits, sandy
Dune Sand
Muck and Peat

Figure 8

not formed on the shorelines. Numerous low ridges were one long-shore bars separated from the shoreline by shallow water which later in the formation of the bar formed a lagoon which gradually filled in with sediment deposited by the streams flowing into it. Where the water was shallow enough vegetation thrived and added its quota to the accumulating sediment. The bars were formed by waves dragging bottom well offshore, picking up sediment and depositing it at the line of breakers.[5] These bars generally consist of ridges having a thin covering of sand or gravel on the top and on the side which faces away from the lake.

As the lake receded to its last stages, the lower part of the lake basin was affected by alluvial sedimentation. It is probable that much of this low lying lake basin remained as shallow but broad bodies of water which were gradually being filled with fine alluvium transported by the waters of the Red River and its tributaries, the Pembina, the Assiniboine, the Boyne, the Roseau, the Rat, the Plum, the Morris, the La Salle, and the Seine rivers. Deltaic sedimentation has particularly influenced the texture of the Emerson, the Altona, the Portage, the Sperling, and Fort Garry soil associations.[6] These soils have all been formed from very fine sand and silty parent material.

The depth of sedimentation varies to a great extent. The major portion of the Red River plain has lacustrine clay (Figure 8, page 54) and alluvial deposits ranging in thickness from a few feet to 60 feet

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[5]C.R. Longwell, A. Knopf, R.F. Flint, C. Schuchert, and C.O. Dunbar, Outlines of Geology, Second edition, (New York; John Wiley and Sons, Inc., 1941), p. 178.

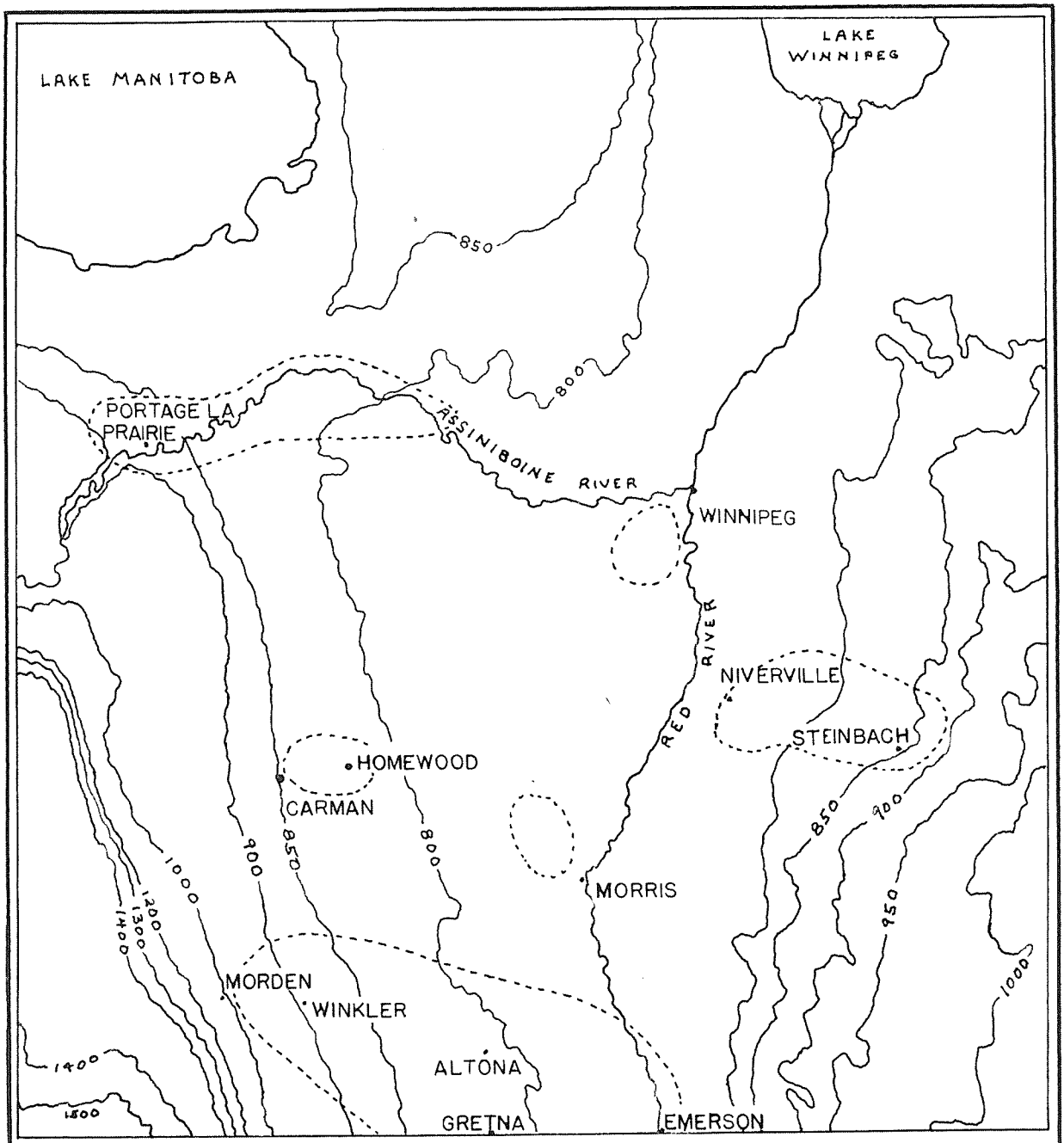
[6]W.A. Ehrlich, et. al., Report of Reconnaissance Soil Survey of Winnipeg and Morris Map Sheet Areas, (Winnipeg, Manitoba: Manitoba Department of Agriculture, 1953), p. 4.

or more. Near the margin of the central lowlands the fine sand and silty mantles range in thickness from several inches to ten feet or more.

The altitude of the general area where sugar beets are grown ranges from 725 feet to approximately 1,000 feet above sea level. (Figure 10, page 57). The area below the 850 foot contour is characterized by a broad flat expanse varying little in relief. Micro-relief exists in the form of low ridges running in a northwesterly to southeasterly direction. There is a gentle slope from the western and eastern margins of the area towards the Red River. From Morden to Winkler a distance of seven miles, the land falls approximately 100 feet. From Winkler to Altona the land falls six to eight feet per mile while from Altona to the Red River the fall is only around two feet per mile. The slope northward from the international boundary is less perceptible. The elevation at Emerson is 792 feet above sea level while Morris is 778 feet above sea level. Winnipeg is 757 feet above sea level and Lake Winnipeg is approximately 718 feet above sea level.

DRAINAGE

The nature of the surface deposits and the configuration of the surface combine to make the natural drainage, in many parts of the Red River Valley, sluggish and rudimentary. The drainage depends, to a large extent, on the man-made drainage channels which supplement, and discharge into the natural streams and rivers. (Figure 9, back pocket). The terrain of the Red River Valley which slopes almost imperceptibly from the margin to the river and from south to north, together with the low clay ridges running generally in a north northwesterly to south -



CONTOUR MAP

Scale: 1 inch - 16 miles

--- Limit of Sugar Beet Producing Areas

Source: Manitoba Soil Survey

Figure 10

southeasterly direction are two factors which have resulted in wide spread drainage problems.

The territory in which sugar beets are produced is drained exclusively by the Red River and its tributary streams, supplemented by artificial drainage channels that discharge into the natural stream channels. The Red River and its immediate valley has a uniform continuous descent northward averaging about one foot per mile.[7] The river channel occupies the lowest portion of the southern Manitoba Lowlands, somewhat east of its central line. It enters Manitoba at Emerson and flows northward in a quite direct course. At Winnipeg it is augmented by the Assiniboine River and then continues its course northward till it empties into Lake Winnipeg.

The natural tributaries other than the Assiniboine River, that flow into the Red River from the west are the La Salle, the Plum, and the Morris rivers. During a summer of abnormally low precipitation these tributaries may be dry. However, during spring break-up and following heavy rains these stream channels are filled with flood waters and at times they overflow their banks. Much of their water comes from the Pembina Hills on the west by creeks and seasonal streams which flow from the escarpment to the lowland plain (Figure 9, back pocket). On reaching the first prairie level the waters have been unable, in many cases, to cut continuous channels eastward to the Red River and, before artificial drainage was developed, these waters spread over the land creating what were known as the Boyne and Tobacco Creek marshes. North of the Assiniboine River the only two streams of any consequence that flow westward are the intermittent Sturgeon Creek, which discharges into the Assiniboine River near the city of

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[7] Upham, op. cit., p. 6E

Winnipeg and Netley Creek which flows into the Red River about seven miles north of Selkirk. This area, as a whole, is poorly drained; portions of it were referred to as the Frog plain and Clandeboyne marsh by the pioneers.

The Seine River, the Rat River with its tributaries, the Marsh and the Joubert, the Roseau River, the Joe River and Cook's Creek flow into the Red River from the east. Most of these tributaries originate in the eastern forested region and consequently they are more continuous and less erratic than those which flow in from the west.

Much of the drainage problem that exists west of the Red River is due to the flat topography of the lowland plain, the fine textured clay deposits covering much of the plain, plus the precipitation which is augmented by sheet run-off and intermittent streams which enter the lowlands from the highlands to the west. The intermittent streams from the escarpment, due to insufficient fall of the lowland plain, have been unable to cut adequate channels and were lost in marshes. However, as settlers pushed into these areas from the east and south these marshes were artificially drained by large open drains (double dykes and canals) which removed the water from these marshes and intermittent streams to the Red River or to one of its channels (Figure 9, back pocket). In the southern portion, the Buffalo Lake Double Dyke and the Hespeler Double Dyke carry much of the water from the Pembina Hills, in the vicinity of Morden, into the Plum River and thence into the Red River. The Shannon Double Dyke, the Tobacco Creek Drain and Double Dyke, the 4N channel and Double Dyke, the Boyne Double Dyke, and the Caster Drain with its extension are feeders of the Morris River carrying water from the Rosebank, Graysville, and Elm Creek areas. To the north but south of the Assiniboine River, a

maze of artifical drains have been constructed, many of which empty into the La Salle River. It will be noticed that not a few of these drains run in a south - southeasterly direction in the micro-depressions of that area. Some local systems of artifical drains have been installed north of the Assiniboine River and west of the Red River but an adequate and complete system of drainage has yet to be developed.[8]

East of the Red River fewer drains are used to supplement the natural drainage. In the south open drains are used to divert the waters from the streams, originating in the higher lands to the east, into the Roseau River. Artificial drains have also been constructed in the elongated depressions running north-northwest and south-southeast emptying into the Marsh and Rat rivers. The Maning Canal drains the area lying between the Rat and the Seine rivers. The Seine River itself has been deepened where the channel was not well developed. In the northeast area of the map (Figure 9 back pocket) the man-made drainage channels empty either into Cook's Creek or Devil's Creek the waters of which are discharged into the Red River.

To meet the general drainage problems existing in the Manitoba Lowlands, drainage districts under the Manitoba Drainage Maintenance Board have been formed. The Board consists of representatives of the municipalities concerned and of the Provincial Government. In these districts open drains and ditches have been installed to improve the drainage.

Excess water in the soil interferes with the growth of sugar beets and the timely performance of seed bed preparation, seeding, cultivation and harvesting. The removal of excess water is necessary to promote soil aeration, improve soil structure, prevent leaching losses of nutrients,

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[8]Ehrlich, op. cit., p. 86.

and increase the soil temperature as well as to regulate the chemical and biochemical changes in the soil. In the spring an inadequately drained surface soil may be five to fifteen degrees F. cooler than adjacent well drained soil.[9] The effect of excess moisture on soil temperature is particularly serious during the period when seeds germinate. Low soil temperatures restrict the development and branching of the fine roots. Excess water due to heavy rains should be drained from beet fields into drainage ditches. Where fields are flooded during the height of the growing season and the crop is submerged for two or three days the beets begin to rot.[10] Land selected to produce sugar beets, apart from desirable soil qualities, should be level or gently sloping and free from depressions that are likely to fill with water after heavy rains.[11]

The effect of drainage on a particular soil type and how it relates to the production of sugar beets and its distribution is discussed in Chapter V.

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[9]T.L. Lyon, et. al. The Nature and Properties of Soils, (New York: The MacMillian Company 1950), p. 254.

[10]R. McKay and G.H. McLean, Sugar Beet Diseases in Ireland, (Dublin, Ireland: Irish Sugar Company, Limited, 1952), p. 62.

[11]L.D. Scott, "Some Requirements of the Sugar Beet Industry," Proceedings of Annual Conference of Manitoba Agronomists, 1940, p. 47.

CHAPTER V

SOILS

SOILS IDEAL FOR SUGAR BEET PRODUCTION

Soils that are well adapted to the production of sugar beets are those which will yield a good tonnage with a high percentage of sugar having a favourable coefficient of purity.[1] There are several types of soil which, under proper management and favourable climatic conditions, will produce good sugar beets. Experience has shown that a well-drained clay loam free from hard pan and containing a sufficient supply of humus is one of the best sugar beet soils.[2] Likewise a loam and very fine sandy loam with the above prerequisites is usually satisfactory. Sandy soils are less favourable because of their low water-holding capacity and they are also more subject to wind erosion. Very little protective cover is left on the land by sugar beets. This can increase the erosion problem.[3] Heavy clay soils, while producing a fairly good yield of sugar beets, present a serious management problem when either wet or extremely dry. They interfere with the weed control operations as well as the harvesting operations. Neutral or slightly saline soils are the best for sugar beets, although, the beet is more resistant to salinity than most farm crops.[4] However, on acid soils, failures of the sugar beet brairds, in whole or in part, are common. The amount of acidity which the sugar beet can tolerate depends mainly on the texture and fertility of the soil.[5]

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[1]See footnote 3 on page 26.

[2]C.E. Saylor, "Progress of the Beet Sugar Industry," Year Book of Agriculture 1901, Department of Agriculture, (Washington, Government Printing Office, 1902), p. 487.

[3]W.S. Chepil, "Erosion of Soil By Wind" The Yearbook of Agriculture 1957, (Washington: Government Printing Office, 1957), p. 308.

[4]L. Winkle, "Soil Selection and Preparation For Sugar Beets," The Sugar Beet, Vol. 13, No. 5, p. 17.

[5]R. McKay and G.H. McLean, Sugar Beet Diseases in Ireland, (Dublin: Irish Sugar Company, Ltd., 1952), p. 47.

The nature of the subsoil is also an important factor in sugar beet production. If the subsoil is too hard the beets will not penetrate it readily, and as a result will be pushed out of the ground in the process of growth or the beet will develop a short, forked or sprangled root, to which earth and mud adhere tenaciously. The rather large lateral roots will break off in handling and represent an appreciable loss in tonnage (Figure 23, page 118). In order to produce long tapering roots the subsoil must be friable and well aerated to a depth beyond the plowed layer. The subsoil should not be impervious, as this prevents proper internal drainage; on the other hand it should not be too loose, as this allows the water to pass through too freely. Normally the sugar beet sends its tap root deep into the soil (Figure II, page 64). However, when the soil structure is poor, the water table high, or the profile shallow, root penetration is interfered with. This decreases the volume of soil upon which the tap root and its numerous small feeder roots may draw for the mineral elements and moisture used in growth.

SOILS IN MANITOBA'S AREA OF PRODUCTION

General description. The sugar beet producing lands of Manitoba, with the exception of a few marginal acres, lie within the black earth soil zone. The soils in this area are developed on heavy and medium textured lacustrine deposits under tall prairie-grass vegetation.[6] Typical black-earth soils in this region have a moderately deep and dark surface horizon, are high in organic matter, and are granular in structure. The heavy growth of the tall prairie grasses with the many divided root systems under the

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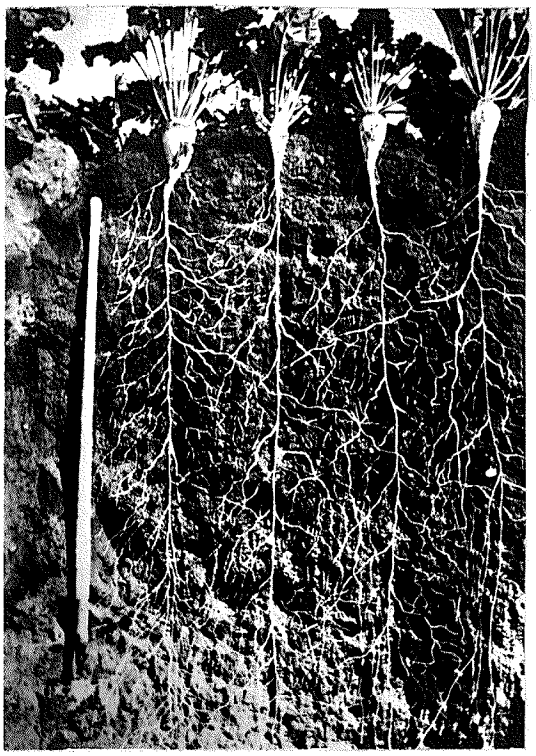
[6] J.H. Ellis, The Soils of Manitoba, (Published by the Manitoba Economic Survey Board, Winnipeg, Canada, 1938), p. 47. See also Economic Atlas of Manitoba, plate 6.



The normal growth of a sugar beet under ideal drainage and tillage conditions showing the hair-like roots which extends to a depth of four or five feet.

Figure 11

virgin soils has resulted in the high accumulation of organic matter deep in the soil profile.[7] In general the reaction of the soil ranges from neutral to slightly alkaline. This is the range most suitable for sugar beets.

The soils on which sugar beets are produced range in texture from clay to fine sandy loam. The fine textured soils have developed on the lacustrine clay deposits in the central basin of glacial Lake Agassiz. The coarser textured soils have developed on deltaic silt, flood-plain sediments, sediments transported by streams forming levees and overwash deposits. Soils adjacent to the Assiniboine River have developed on flood plain sediments.

Superior soils for sugar beet production. Experience has shown that a medium textured soil high in organic matter is one of the best sugar beet soils.[8] Approximately sixty per cent of the sugar beet acreage is on the medium textured soils. (Table X, page 67). These soils are more adaptable to sugar beet production for various reasons. They do not cause as much difficulty in harvesting during excessively wet or extremely dry fall seasons as do the fine textured clays. Soil drifting, is, as a rule, not as severe on these soils as it is on the coarser textured soils. Internal drainage is more satisfactory on the medium textured soils as compared to the fine textured soils where internal drainage is quite often retarded and the ponding of water after heavy rains is not infrequently the case. Good internal drainage has the advantage of: (1) warming of the seed bed by decreasing evaporation; (2) allowing for the early preparation of the seed bed; (3) increasing the feeding area of the plant by lowering

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[7]Ellis, op. cit., pp. 45-47.

[8]C.E. Saylor, op. cit. p. 487.

SUGAR BEET ACREAGE ON SOIL TYPES[1]

PERCENT

YEAR	FINE TEXTURED SOILS (CLAY)				MEDIUM TEXTURED SOILS (SILTY CLAY TO VERY FINE SANDY LOAM)								COARSE (FINE SANDY LOAMS)		
	RED RIVER SOILS		FT. GARRY SOILS	TOTAL	HORNDEAN SOILS	MORDEN SOILS	ALTONA SOILS (HEAVY)	EMERSON SOILS[3]	SPERLING SOILS	OAKVILLE SOILS[4]	PORTAGE SOILS	TOTAL	ALTONA SOILS (LIGHT)	STEIBACH SOILS	TOTAL
	RED RIVER[2]	OSBORNE													
1941	31.3	31.1	0.8	63.1	2.2	0.0	1.6	10.4	1.2	1.6	3.1	20.1	0.8	0.4	1.2
1945	24.4	14.3	1.1	39.5	5.8	0.0	5.1	14.5	2.2	6.7	1.2	34.0	2.1	1.5	3.6
1950	14.6	14.7	1.4	30.5	7.0	1.1	7.0	11.9	4.1	7.2	3.3	40.7	5.7	3.4	9.1
1955	15.7	7.9	1.4	25.1	11.2	1.8	12.2	17.0	1.7	3.3	0.9	42.0	9.1	1.3	10.6
1960	13.8	4.9	2.9	21.1	9.7	2.1	16.2	20.5	2.9	6.1	3.3	60.8	10.2	2.1	12.3

1 Percentage figures for acreage on the dominant soil types are given
2 Includes small acreage of sugar beets on St. Norbert and Marquette soils
3 Includes small acreage on Red River* Emerson transition soils
4 Includes small acreage on Riverdale soils

TABLE IX

TABLE X

SUGAR BEET ACREAGE ON SOIL TYPES
(in per cent)

Year	Soil Texture		
	Fine	Medium	Coarse
1941	63.1	20.1	1.2
1945	39.5	34.0	3.6
1950	30.5	40.7	9.1
1955	25.1	48.0	10.4
1960	21.1	60.8	12.3

SUGAR BEET ACREAGE ON SOIL TYPES

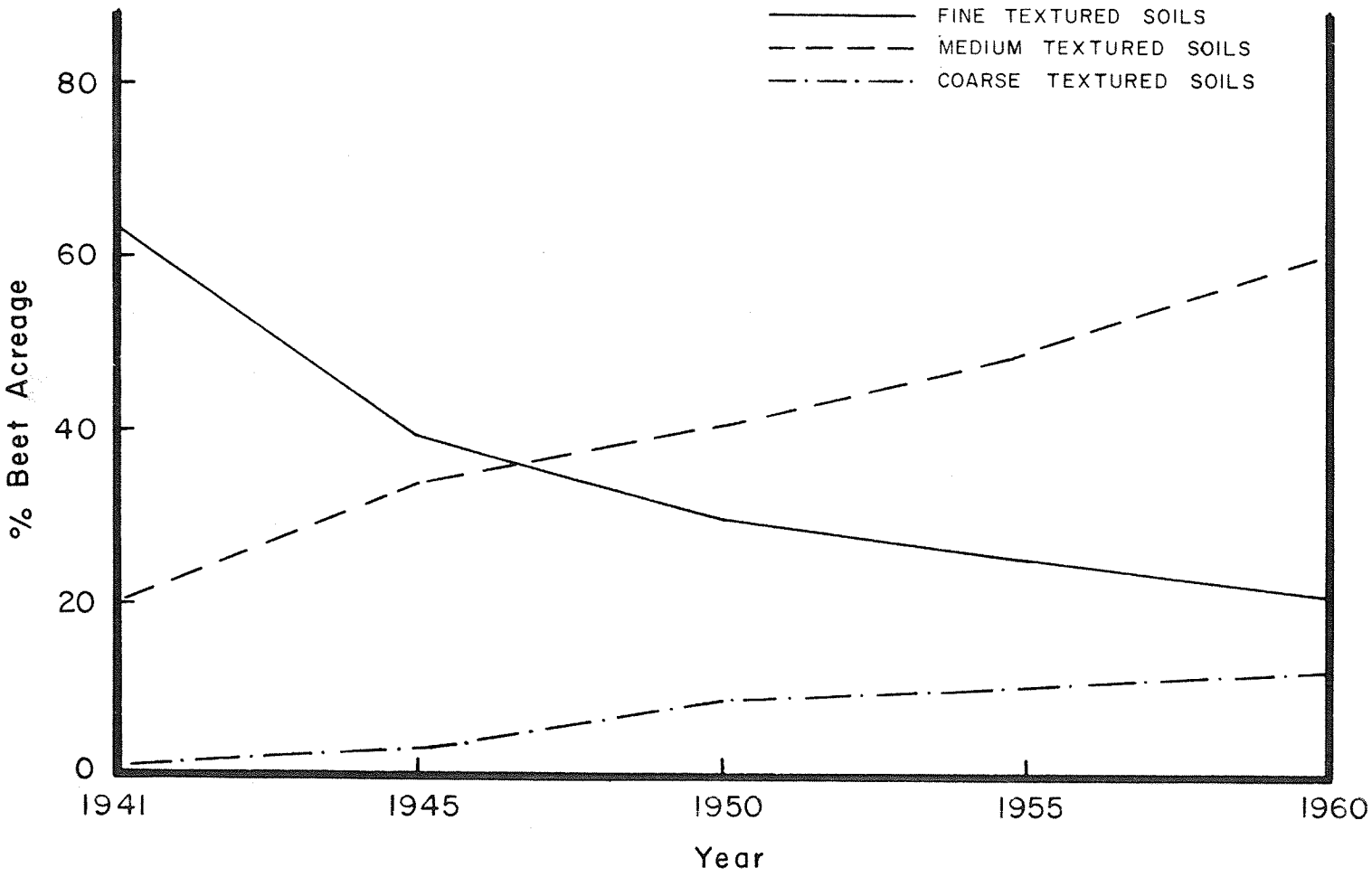

Figure 12

the water table which in turn ensures the beet against drought by stimulating deeper rooting; (4) permitting earlier cultivation and weeding after rains; and (5) preventing the destruction of the soil structure at harvest time. The medium textured soils have a higher water retention capacity than the coarse textured soils. For this reason beets grown on the former do not suffer as readily from drought and hot weather as beets grown on the coarser textured soils.

The soils in this group range in texture from silty clay to very fine sandy clay loams and have developed on deltaic and flood-plain sediments as well as sediments forming levees and over wash deposits. These soils are known as the Horndean, Morden, Emerson, Sperling, Oakville, Portage Associations, and the heavier soils of the Altona Association. The Portage, Sperling, Oakville, Altona (heavy) and Morden Associations have a high fertility rating while the Emerson and Horndean Associations are rated good to fairly good.[9] The average yield of sugar beets for the years 1955, 1956, 1957, and 1960 on these soils was 10.4 tons per acre.[10] The over-all average yield for the four years was 10.1 tons per acre.

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[9] As rated by the Manitoba Soil Survey. See Soils Report Numbers 4, 5 and 7.

[10] It was found that sugar beet yields varied from area to area and from soil type to soil type with certain types of soils yielding consistently low. It must be remembered that other factors also influence yield for example management, climate, variety, fertilization, and rate of fertilization. For purposes of comparing yield to soil type yield data for the years 1955, 1956, 1957, and 1960 were selected. The year 1958 was omitted because of the difficulty in obtaining the required field location information. The records for 1959 were omitted because only two-thirds of the crop was harvested. Two Tables showing this information are included in Appendix C pages 186 and 187 . Also included is an explanation of how the information was arrived.

The Portage Association has (1) an "A" horizon that is twelve to twenty inches thick; (2) a slightly alkaline reaction: (3) good friability and; (4) a fairly high moisture retention capacity.[11] This fades into a friable, moderately porous and slightly alkaline sub layer. The soils of the Portage Association had an average yield for the four years of 11.2 tons per acre. They are located to the north and east of Portage la Prairie well within the 60 mile radius of the plant (Figure 13, 81). While there are 89,037 acres of these soils only slightly more than three per cent of the sugar beet acreage is located on these soils. This is true because many of the farmers on the soils of the Portage Association are well established grain growers and a switch to sugar beet production would mean an investment in another line of implements. Also, the refinery is working at capacity and contracts to grow sugar beets are not easy to obtain.

The soil of the Sperling Association are located in a strip from Carman to Sperling that is no more than three or four miles in width containing 22,000 acres. The depth of "A" horizon on the dominant type of the Sperling soils ranges from ten to sixteen inches. They are very dark brown to black in colour indicating a high organic matter content. The textural range is from fine sandy loam to silty clay. The surface horizon is friable and slightly alkaline in reaction.[12] Approximately three per cent of the total acreage is located on these soils. The average yield is 12.7 tons per acre.

The soils of the Oakville Association occupy 25,499 acres and are located southeast of Portage la Prairie. They are immature soils with little profile development. The surface horizon of the better drained type is neutral to slightly alkaline in reaction, friable, and porous.[13]

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[11] W.A. Ehrlich, et. al., Soils Report No. 7, Manitoba Department of Agriculture, 1957, p. 46.

[12] W.A. Ehrlich, op. cit. p. 29.

[13] W.A. Ehrlich, et. al., Soils Report No. 5, p. 53.

Only the better drained soils located on the levees are well suited to sugar beet production. While the average yield was 11.7 tons per acre, only six per cent of the sugar beets are grown on these soils. The sugar beets have to compete with other special crops as well as grain crops on these excellent agricultural soils. The yields obtained from sugar beets grown on the soils of the Portage, Sperling, and Oakville Associations would verify the rating of the Soil Survey of "very good" to "excellent" for these soils for the production of sugar beets.

The heavier soils of the Altona Association are located in the Altona-Winkler-Roland area (Figure 13, page 81). The texture of these soils is fine sandy clay loam with a surface horizon that is very dark grey in colour, ten to twenty inches thick and neutral to slightly alkaline in reaction. The profile is friable and porous allowing easy penetration by the sugar beet root. Approximately sixteen per cent of the sugar beet acreage is on this soil yielding 11.1 tons per acre.

The soils of the Emerson Association occur south of Morris on both sides of the Red River and in an area west of Niverville. These soils are dominantly silty clay loam in texture but vary from fine sandy loam to silty clay and have satisfactory surface drainage. The "A" horizon, very dark grey in colour, is six to fifteen inches thick and grades into the "C" horizon. The dominant soil profile is friable, and granular in structure with favourable porosity. Internal drainage is retarded because of a clay substrate underlying the silty deposits. Water may accumulate above the clay substrate from a series of wet seasons. When the water moves upward soluble salts and lime will move with it to the upper part of the soil profile. This upward movement of

salts from the clay substrate results in areas having poorly drained soils which are usually salinized.[14] Their natural fertility rating is only good to fairly good. This is reflected in a corresponding lower average yield of only 9.3 tons per acre. No doubt the poor internal drainage and the salinized areas contribute to the lower yields. However, the acreage of sugar beets grown on the Emerson soils is increasing. This is due to: (1) the higher suitability of these soils to sugar beet production than the heavy textured, poorly drained soils; (2) the favorable location of these soils with respect to the refinery and the availability of spring labour.

The soils of the Horndean Complex, as the name suggests, are loc ated in an area around Horndean. They have been mapped as a complex indicating that there exists a wide variation within the area mapped as Horndean. The well drained soils, while having an "A" horizon which is six to fifteen inches in depth, are cloddy and tough. The less mature soils are clay in texture while the more mature soils are somewhat lighter. The heavier textured soils within this complex have poor surface and internal drainage. Moreover, salinization is most pronounced in these soils.[15] These characteristics are refle cted in a lower average yield. There is a wide variation in the yields on these soils ve rifying their complex nature. The four year average yield was 9.9 tons per acre.

The soils of the Morden Association are deve loped on alluvial clay deposited as overwash in the general vicinity of Morden. The typical soils have a surface horizon that is seven to sixteen inches in depth and heavy clay loam to silty clay in texture. The structure varies from finely granular on the furface to friable and crumbly in the lower horizons. The reaction ranges from neutral to slightly alkaline and the drainage is generally good. The natural fertility of these soils is rated as high.[16]

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[14] W. A. Ehrlich, et. al., Soils Report No. 5, Manitoba Department of Agriculture, Oct. 1953, p. 26-27.

[15] W. A. Ehrlich, op. c it. p. 23.

[16] J. H. Ellis, Wm. H. Shafer, Report of Reconnaissance Soil Survey of South-Central Manitoba; Report No. 4, Manitoba Soil Survey, 1943, p. 89.

The average yield for the four years was 11.5 tons per acre.

It will be seen that the soils just described have characteristics in common with the optimum soils for sugar beets. Their textural range is approximately the same as that outlined on page62 ; they all have a neutral to slightly alkaline reaction. Their surface horizon is of considerable depth and rich in organic matter. The organic matter serves both as a source of plant nutrient and as an absorbent for moisture. It improves the soil structure which in turn increases aeration and reduces power requirement for cultivation. The natural fertility ranges from high to moderately good. The profile of these soils is favourable for the penetration of the growing beet. The average yield for the years 1955, 1956, 1957 and 1960 for these soils was 10.4 tons per acre.

Soils less suitable for sugar beet production. These include the fine and the coarse textured soils.

1. Fine Textured Soils

There is considerable concentration of sugar beets on the heavy or fine textured soils. In 1960 one quarter of the total acreage seeded to sugar beets was located on these soils although the trend since 1941 has been to decrease the acreage grown on these soils. This trend is discussed on pages 78 & 79 . These soils are known as the Red River, Osborne, and Fort Garry Associations. They have developed on the fine clay deposits in the central basin of glacial Lake Agassiz on both sides of the Red River (Figure 13, page 81). The central basin has areas which are exceptionally flat while portions of it have a micro-relief of low flat ridges separated by poorly drained depressions.

The well drained soils of the Red River Association are the better soils in this category and 13.8 per cent of the sugar beet acreage is located on them. Its natural fertility is high to medium high. The surface horizon is black to very dark grey in colour, rich in organic

matter, and eight to twelve inches in depth. They have a columnar structure when dry which breaks down when wet.[17] Because these soils occupy the higher position and are better drained so that excess surface water can drain off they can be utilized for sugar beet production. The suitability of these soils for sugar beet production varies from locality to locality. The red River soils found south of Altona are somewhat lighter in texture having about a fifty per cent clay fraction and can be referred to as a light clay soil. The clay fraction of a representative Red River soil is about 67 per cent. The Red River soils south of Altona yield 10.5 tons to the acre while the average yield on the Red River soils is 10.0 tons per acre.

Approximately five per cent of the sugar beets are grown on the poorly drained Osborne soils. These soils have developed on flat or depressional topography and drainage is a serious problem. The dominant soil is alkaline in reaction, has a granular and friable structure when moist, and is lumpy and very hard when dry. It has an inadequate supply of organic matter for its surface horizon is only three to six inches in depth.[18] Its natural fertility is only moderate and the yield on these soils is 8.7 tons per acre.

The soils of the Fort Garry Association are located in the vicinity of Winnipeg (Figure 13, page 81). The dominant soil has a surface horizon seven to ten inches thick, clay to silty clay in texture and grades into a light grey, friable marly horizon. The surface is slightly alkaline in reaction, although, the subsoil is highly calcareous.[19] The fertility

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[17] W.A. Ehrlich, op. cit. p. 20-21.

[18] W.A. Ehrlich, op. cit. p. 21-22.

[19] W.A. Ehrlich, op. cit. p. 25.

rating of these soils is moderately high. The average yield is 10.4 tons per acre.

The fine textured soils are generally not as favourable to the production of sugar beets as the medium textured soils for several reasons. The clay soils are much more difficult to work when excessively moist which sometimes presents a problem during spring and fall operations. In the fall of 1941, when the rainfall for September reached an all time high (six inches at Winnipeg and Portage la Prairie and eight inches at Emerson) all the heavier soils were soaked beyond saturation and harvesting operations were only possible on the lighter soils. In that year some 3,000 acres remained unharvested because of the heavy rains.[20] During moist harvesting conditions the increase in per cent tare[21] on the clay soils, because of mud and dirt adhering to the main roots, becomes a serious problem. When the tare runs up to 50 per cent, as has been the case in heavy soils, the hauling costs are greatly increased while the pay load is substantially decreased. In the year 1944 excessive moisture conditions during the month of June retarded field operations and caused severe flooding in nearly all areas having clay soils. This condition and the delayed field operations resulted in a total loss of almost 4,000 acres which was almost entirely confined to the foregoing clay soils.[22]

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[20] The Winnipeg Tribune; October 1, 1942

[21] Tare is the deduction of weight made in allowance for the weight of any foreign matter adhering to the sugar beet as well as leaf matter remaining on the crown. At the weigh-stations an average sample is taken and weighed from every load delivered. The adhering soil is removed and the necks trimmed, removing all leaf scars. The clean beets are then weighed again and from the loss of weight the percentage tare is calculated.

[22] E.G. Minielly, "Sugar Beet Production - 1944", Proceedings of Annual Conference of Manitoba Agronomists 1944, (Mimeographed by Manitoba Department of Agriculture), p. 39.

The clay textured soils were saturated with moisture during the greater part of the growing season. This was due to poor internal drainage as well as inadequate external drainage. Not only did this hinder harvesting operations but also depressed the yields on these soils. The drainage conditions on the fine textured soils are highly important if these soils are to be used for sugar beet production. A small nucleus of sugar beet lands exists on the Red River soils along the Morris River (Figure 13, page 81). This area has soils which are better drained because of the gentle slope towards the Morris River and its tributary streamlets.

During extremely dry conditions sugar beets raised on the heavy textured soils suffer from root pruning or severing of roots caused by the cracks formed upon contraction of the clay particles in the soil. These soils are also more subject to crusting than lighter soils which may result in a poor stand when this occurs between seeding and emergence stage. The young plant seeking to push up through the soil hits the crusted soil and can emerge only by pushing through or around a block of the crusted soil.

In addition to the problems stated, the fine textured soils do not produce as high a tonnage per acre as the medium textured soils. The average yield on these soils is only 9.8 tons per acre. This can be attributed to their lower natural fertility, poorer structure allowing less root development and hindering field operations, shallower profile and lower organic matter content.

2. The Coarse Textured Soils

The coarse textured soils have developed on sandy to silty lacustrine and deltaic sediments and have a texture of fine sandy loam.

They are known as the Steinbach and Altona Associations (light phase) on which are located twelve per cent of the acreage. The soils of the Steinbach Association have a surface horizon that is six to twelve inches in depth, very friable, and only moderately alkaline. Internal drainage is retarded by a thin layer of lacustrine clay underneath the profile and, consequently, the subsoil is moist requiring drainage during wet years. During dry years this becomes a source of moisture for the plants. The soils of the Altona Association (light phase) have the same general characteristics as the heavier Altona soils (page 71) and differ only in texture. These soils are dominantly fine sandy loam in texture and their main drawback is soil drifting and low water retention capacity. Their productivity has been markedly reduced by the removal of organic matter by the wind.[23] The average yield of sugar beets on the soils of the Steinbach Association is 9.6 while the yield on the light Altona soils is 9.8 tons per acre. The heavy Altona soils which vary only in texture from the light Altona soils produce 11.1 tons of sugar beets per acre.

Sugar beets on these coarser textured soils are more susceptible to damage from soil drifting than on the finer textured soils. Dust storms in the spring of 1951 caused serious damage to sugar beets in the Winkler area on the light Altona soils. The Altona Echo stated that, "reports of beet fields being partially ruined by the high winds and drifting soils, have become common."[24] In 1952 nearly 600 acres of beets were ruined by a dry, windy spring.[25] It is significant that the textural

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[23]W.A. Ehrlich, op. cit. pp.29-32.

[24]The Altona Echo, May 30, 1951.

[25]The Winnipeg Free Press, May 25, 1952.

difference in the two Altona soil types gave a difference in yield of 1.3 tons per acre for the years 1955, 1956, 1957, and 1960. It is also important that on the lighter-textured Altona soils whole fields are destroyed by wind erosion and have to be replanted.

The sugar beet seed germinates earlier in sandy soils and produces a more vigorous growth for a few weeks in the early part of the growing season. However, during July and August when the demand for water is greatest, the beets on finer textured soils usually grow more rapidly.[26]

When sugar beets were first produced on a commercial scale, they were grown on a wide variety of soil types within the Red River Valley. The original contracts were alotted to producers with little regard to soil type.[27] In 1941, 63 per cent of the sugar beet acreage was located on the fine textured soils while the acreage on the medium textured soils was only 20 per cent. The acreage on the coarse textured soils was only 1.2 per cent (Figure 12, page 68). Since 1941 there has been a tendency for sugar beet production to gravitate to the medium textured soils. While other factors, such as labour supply and ethnic background may have influenced this shift, it is believed that the soil type was the prime factor. In 1945 the sugar beet acreage on the fine textured or clay soils dropped to 39 per cent with the most notable decrease on the Osborne soils, while the acreage on the medium textured soils rose to 34 per cent. This increase was caused by increased acreage on the Horndean, Altona and Oakville soils. In 1950 the acreage figures indicate a continuing trend to production on the medium and coarse textured soils. By 1955 only 25 per cent of the acreage was on fine textured soils and only 7.9 per cent was on the Osborne soils. During the period 1955 to 1960 the trend towards more

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[26]"History of Sugar Beet Experiments at Manitoba Agricultural College," (unpublished data, Soils Department, University of Manitoba) Pp. 16-17.

[27]L.D. Scott, "Some Requirements of the Beet Sugar Industry." Proceedings of Annual Conferance of Manitoba Agronomists 1940, p. 47.

production on the medium textured soils continued.

This movement of acreage towards soils ranging in texture from silty clay to very fine sandy clay loam indicates that these soils, over the years, are more adapted to the economical production of sugar beets. Not only are the average yields higher on these soils but also fewer acres are ruined from excessive moisture and drought than on the fine textured soils or soil drifting and drought on the coarse textured soils.

Accompanying this shift to more suitable soils is a gradual increase in average yield. During the first eleven years (1940 to 1950) the mean of the yearly average yield was 8.01 tons per acre. The tonnage during the following five years was 9.24 while the average yield for the past five years was 10.1 tons per acre. However, it must be recognized that the soil productivity is not dependent on soil fertility alone, rather it is a result of a summation of several influences which may be designated as soil fertility, seed variety, labour, capital, and climate. It is difficult to state precisely what portion of a ten ton crop of beets has been due to the soil itself and what proportion is a result of management practices. It is evident that the harvested crop is a result of the combined influences of the soil, including the natural environment and of man's techniques of management.

CONCLUSION

A well-drained deep and permeable soil of good moisture-holding capacity with a comparatively high fertility level and having a textural range from clay loam to very fine sandy loam constitutes the beet soils 'par excellence! It is on these soils where the more consistent and higher yields are obtained. The lighter loams will also produce successful crops but the expectancy of high yields cannot be constant mainly because of variation in annual precipitation and destruction of plants by drifting

soils. The fact that the sugar beet acreage has shifted to the well-drained medium textured soils substantiates the fact that these soils are more suitable to the commercial production of sugar beets. Soils with an unfavourably high water-table or soils high in clay content, shallow and poorly drained are being avoided for the production of sugar beets. As production of sugar beets evolved through the experimental period to the period of stability the acreage has shifted from the unfavourable soils and is becoming concentrated only on extensive bodies of the more suitable soil types. Along with this shift to areas of more suitable soils has accompanied a trend towards higher levels of yield of sugar beets.

The quantity of sugar beets produced per acre in Manitoba is lower than in the United States, Alberta, Ontario, and Quebec.[28] However, the general trend towards an increase in yield in Manitoba is significant. The 1951-1960 average yield was 9.67 tons per acre where as the 1940-1950 average yieldwas 8.01. As sugar beet production continues to shift to more suitable soils the average yield can be expected to increase.[29] One source predicts that the average yield will increase to ten tons per acre by 1980.[30] This appears to be a conservative estimate because the average yield for the seven-year period from 1954 to 1960 was 10.1 tons per acre.

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[28] See Tables XV and XVI, Appendix C for a comparison of yield of sugar beets grown in different areas.

[29] The factors of management and variety of seed used are also important and they, no doubt, will also contribute to any increase in yield.

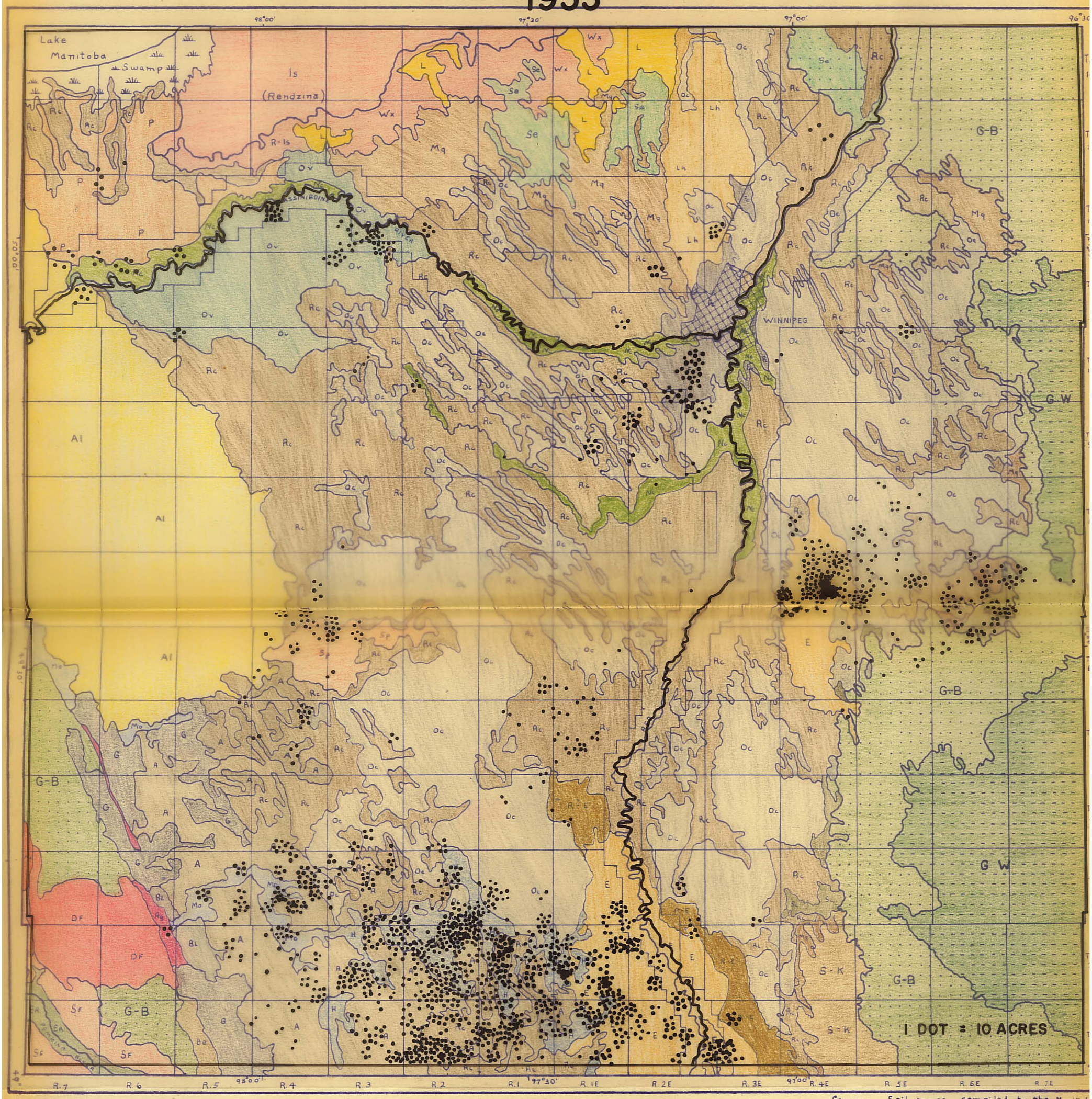
[30] , Prospects for Development in Manitoba. Submission to the Royal Commission on Canada's Economic Prospects by the Manitoba Government, p. 31.

SOIL MAP — SUGAR BEET GROWING AREA

SUGAR BEET ACREAGE

1955

MILES 5 0 10



Source Soil maps compiled by the Manitoba Soil Survey, Winnipeg, Manitoba.

KEY TO SOIL ASSOCIATIONS

SOILS DEVELOPED ON LACUSTRINE DEPOSITS

Fine Textured

Red River Association

Rc	Oc	Nc	Fc
Red River clay	Osborne clay	St. Norbert clay	Ft. Garry clay

Medium Textured

R-E	E	Lh
Red River-Emerson silty clay loam to clay	Emerson silt loam to silty clay	Lakeland clay loams to clay

H	G	Be	Mo
Horndean clay	Gretna clay	Benton clay	Morden silty clay to clay

Sp	Ov	P
Sperling fine sandy loam to silt loam	Oakville silty clay loam to clay	Portage very fine sandy loam to silty clay

Medium-Coarse Textured

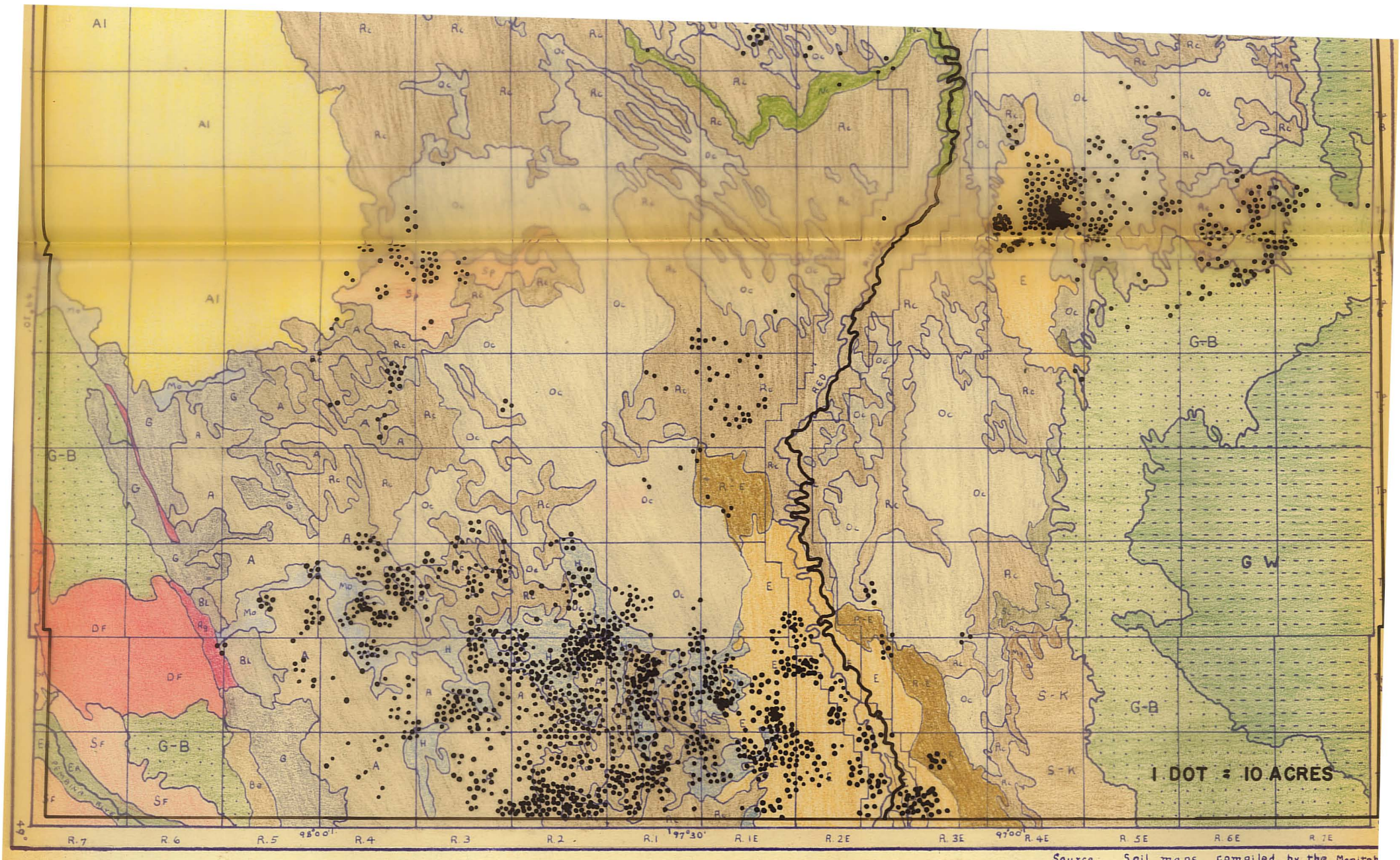
Coarse Textured

SOILS DEVELOPED ON LACUSTRO-TILL DEPOSITS

Mq	Se	Wx
Marquette clay to heavy clay loam	Semple clay loam to clay	Woodlands Complex fine sandy loam to heavy clay loam

SOILS DEVELOPED ON BOULDER TILL DEPOSITS

Ma	Sf
Manitou clay loam	Snowflake clay loam
Df	Is
Darlingford	Isafold



Source: Soil maps compiled by the Manitoba Soil Survey, Winnipeg, Manitoba.

KEY TO SOIL ASSOCIATIONS

SOILS DEVELOPED ON LACUSTRINE DEPOSITS

Fine Textured

Red River Association

- Rc — Red River clay
- Oc — Osborne clay
- Nc — St. Norbert clay
- Fc — Ft. Garry clay
- H — Horndean clay
- G — Gretna clay
- Be — Benton clay
- Mo — Morden silty clay to clay

Medium Textured

- R-E — Red River-Emerson silty clay loam to clay
- E — Emerson silt loam to silty clay
- Lh — Lakeland clay loams to clay
- Sp — Sperling fine sandy loam to silt loam
- Ov — Oakville silty clay loam to clay
- P — Portage very fine sandy loam to silty clay

Medium-Coarse Textured

- L — Lakeland fine sandy loam
- Sc — Steinbach fine sandy loam to fine sandy clay loam
- A — Altona fine sandy loam to fine sandy clay loam
- Al — Almasippi loamy fine sands to very fine sandy loams

Coarse Textured

- Ag — Agassiz loamy coarse sand to light sandy loam
- Bl — Blumenstein coarse loams
- S-K — Springbank-Kittson Complex

SOILS DEVELOPED ON LACUSTRO-TILL DEPOSITS

- Mq — Marquette clay to heavy clay loam
- Se — Semple clay loam to clay
- Wx — Woodlands Complex fine sandy loam to heavy clay loam

SOILS DEVELOPED ON BOULDER TILL DEPOSITS

- Ma — Manitou clay loam
- Sf — Snowflake clay loam
- Df — Darlingford clay loam
- Is — Isafold sandy loam to clay loam

MISCELLANEOUS SOILS

- Er — Eroded Slopes and Channels
- G-B — Soils in Grey-Black Sub-Zone
- G W — Soils in Grey Wooded Zone

CHAPTER VI

FARM LABOUR AND MECHANIZATION

At present the sugar beet industry is in a transition period between hand-labour and mechanization. While some phases of the farm operations have been completely mechanized hand-labour still remains an important feature in the production of sugar beets.

FARM LABOUR

Amount of labour required. Prior to the advent of mechanization sugar beet production was a large consumer of hand labour. An abundant supply of field workers within the territory where sugar beets were grown or adjacent thereto was very important.[1] Machines were used only in the preparation of the land, seeding, cultivation, and lifting of the beets at harvest time. As much as seventy to eighty hours of hand labour were required to produce one acre of sugar beets. The spring work, hoeing, thinning, and weeding used approximately 40 per cent of the hand-labour while the harvesting operations used the other 60 per cent.[2]

The reduction of hand-labour began with the introduction of the mechanical loader during the beginning of World War II. Instead of manually loading the windrowed beets into trucks or wagons they were elevated mechanically by machine. The first machines for loading windrows of hand-topped sugar beets were made by small manufacturing companies and local shops. The construction costs did not exceed 200 dollars if a large

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[1]L.D. Scott, "Some Requirements of the Beet Sugar Industry," Proceedings of the Annual Conference of Manitoba Agronomists, 1940, p. 47.

[2]J.C. Gilson, Economic Aspects of Sugar Beet Production in Manitoba, University of Manitoba, (Winnipeg: Queen's Printer, 1956), p.21.

part of the work was done in the home work shop.[3] During 1946 fourteen such machines were purchased by growers and eighty per cent of the crop was loaded mechanically.[4] The cost of mechanical loading was ten cents per ton while the cost of manual loading was fifty cents per ton.[5] While the loaders helped to speed up the harvest operations and decreased the costs, they were putting a lot of cloddy earth in with the beets in the heavier soil areas. The use of the mechanical loader for hand-topped beets was only a passing phase. The mechanization of the harvest operations by the introduction of mechanical harvesters further reduced the requirements of hand labour. This reduced the hand labour requirements by as much as fifty per cent. And by 1960 ninety-nine per cent of the crop was mechanically harvested.

Since 1950 mechanical thinners have been used in the thinning operations and where they are used successfully the hand labour requirements can be reduced by another fifteen to twenty per cent.[6] Thus the total reduction of hand labour contributable to mechanization is approximately 75 per cent.

During 1952 in the Morris and Rhineland Municipalities the hand labour requirements per acre of sugar beets averaged approximately 31.0 hours per acre. Of the 31 hours, 79 per cent was used in the weeding and thinning operations, while 21 per cent was used in the harvesting operations.[7]

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[3]E.G. Minielly, "Reducing Sugar Beet Production Costs," Proceedings of Annual Conference of Manitoba Agronomists, 1942, p. 39.

[4]E.G. Minielly, "The Manitoba Sugar Beet Industry, 1946" Proceedings of Annual Conference of Manitoba Agronomists, 1946, p. 54.

[5]Minielly, loc. cit.

[6]Ibid. p. 7

[7]J.G. MacKenzie and J.C. Brown, How Labour is Used on Red River Valley Farms, Economics Division, Canada Department of Agriculture, (Ottawa; Queen's Printer, 1954), p. 37.

Dr. J.C. Gilson in his study of 112 random selected sugar beet growers found that:

> In 1955, the hand labour requirements per acre of sugar beets averaged close to 29 hours. Of the 29 hours, 17 per cent was used in the harvesting operations, while 83 per cent was needed for the thinning and hoeing operations.[8]

The difference in the foregoing figures can, no doubt, in part be contributed to greater mechanization in 1955 than in 1952. In 1952 fifty-one per cent of the sugar beet acreage was mechanically harvested, while in 1955 seventy-six per cent was mechanically harvested.

According to the study carried out by J.G. MacKenzie and J.C. Brown the spring work (hoeing and thinning) required about 24 to 25 hours per acre.[9] Dr. Gilson's study revealed that 24 hours per acre was the average spring hand labour requirement for all farms studied.[10] The small sized grower required 23.6 hours per acre, the medium sized grower required 22.5 while the large grower used 25.3 hours per acre (Table XI, page 85). Another study carried out in 1956 when records from twenty-three beet producers from the Altona area were analyzed showed that approximately twenty-one hours per acre was required for hoeing and thinning.[11]

Sugar beet production was traditionally a high consumer of hand labour. However, the introduction of mechanical harvesters and thinners has caused a reduction in the hand labour requirements. This is especially the case in harvesting operations. Although the mechanical thinners were

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[8]Gilson, op. cit., p. 21.

[9]MacKenzie, loc. cit.

[10]Gilson, op. cit. p. 15.

[11]J.C. Gilson, Comparison of Hand and Mechanical Thinning of Sugar Beets, Department of Agricultural Economics and Farm Management, University of Manitoba, May 1959, p. 7.

TABLE XI

HAND LABOUR REQUIREMENT AND RELATIONSHIP BETWEEN FAMILY & CONTRACT LABOUR[26a]

Operation	10-10-20 acre group			21-50 acre group			51+ acre group			All farms		
	Family %	Contract %	Hours per acre	Family %	Contract %	Hours per acre	Family %	Contract %	Hours per acre	Family %	Contract %	Hours per acre
Post-seeding	34.7	65.2	23.6	9.8	90.2	22.5	5.8	94.2	25.3	9.8	90.2	24.0
Harvesting	44.3	55.7	5.6	20.7	79.3	2.0	0.6	99.4	6.9	9.0	91.7	4.8
Total	36.6	63.4	29.2	10.7	89.0	24.5	4.7	95.3	32.2	9.6	90.4	28.8

[26a] J. C. Gilson, Economic Aspects of Sugar Beet Production in Manitoba, Research Report No. 1, (Winnipeg: Queen's Printer, 1956), p.15.

introduced in 1950 yet the increase in the acreage thinned mechanically has not been as great as the increase in the mechanically harvested acreage. (See section on mechanization.) The mechanical thinners have not caused as dramatic a reduction of the hand labour requirements as the mechanical harvesters. And the prospects for complete mechanization of spring operations seem remote at the present.

Source of hand labour. During the first year that sugar beets were grown on a commercial scale in Manitoba there was sufficient labour available. However, in the following years regional shortages were experienced. The war conditions helped create an unstable labour supply. In the years 1940 to 1943 casual, inexperienced and inefficient labourers, among them University and High School students and city dwellers, were used. During the four years 1942 to 1945 Japanese from British Columbia aided beet growing farmers in various localities.[12] In 1943 the Japanese were largely used for spring and harvest work and while other labour was available, it was not as dependable nor as capable.[13] Also by 1943 there appeared a trend in the location of the sugar beet acreage towards areas where more family labour was available.[14] (This feature of the sugar beet production is discussed more fully on page 90). The report goes on to say that

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[12]Personal communication with Major Richardson, Dominion Provincial Farm Help Service, Winnipeg.

[13]News item in the Winnipeg Free Press, January 20, 1944.

[14]C.L. Taylor, "Sugar Beet Production, 1943," Proceedings of the Annual Conference of Manitoba Agronomists, 1943, p. 42.

"labour available for the necessary hand work was sufficient to handle the crop more efficiently than previously experienced."[15]

In 1944 German prisoners of war were used for hoeing, weeding and thinning the beet crop. Approximately 700 were divided into small groups and dispatched in small camps to the Curtis, La Rochelle, St. Eustache, Grassmere, Headingly and St. Jean areas. The following year 650 prisoners of war were used in addition to the local labour. They were operated from six hostels. While the quality of their work was quite satisfactory the volume was considerable less than that of regular contract labour. They thinned a total of 1,950 acres and harvested 2,400 acres.[16] During 1946 a total of 1,116 prisoners of war were allocated to Manitoba and were used on sugar beet farms.[17]

Displaced persons from Europe began arriving in Manitoba during 1947 and were used to replace the German prisoners of war. Stationary camps and mobile units for beet labour were used for the first time in 1947. These were located on farms with large acreage and were provided by the Manitoba Sugar Company.[18] In 1948 two hundred displaced persons were placed on the Portage plains to assist in harvest operations.[19]

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[15] Ibid.

[16] E.G. Minielly, "The Sugar Beet Industry, 1945," Proceedings of Annual Conference of Manitoba Agronomists, 1945, p. 48.

[17] News item in the Winnipeg Free Press, June 11, 1946.

[18] Manitoba Beet Growers' Bulletin, March 1947

[19] News item in the Winnipeg Free Press, September 23, 1948

During the same year most of the labour on the Mennonite farms in the Altona, Rosenfeld, Gretna, and Winkler districts was "self-contained". The balance was imported from adjacent surplus areas.[20]

From 1950 to 1954 the immigration of families from Europe continued to be an important source of labour for sugar beet growers. Whole families were placed on individual farms.[21] This source of labour was supplemented by labour moved in from the surrounding areas including the two Indian Reserves located in the vicinity of sugar beet growing lands. It was also during this period that mechanical harvesting came into its own (Table XII, page 97). In 1950 nineteen per cent of the acreage was mechanically harvested while in 1954 it had increased to seventy-five per cent. This substantially decreased the demand for labour during the harvesting operations.

In 1955 there was a sufficient supply of labour except in the

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[20]News item in the Altona Echo, September 27, 1948

[21]Sugar beet work assists in rounding out an agricultural worker's year for the heavy demand on labour in sugar beet fields occurs when the demand in grain farming is low. The heavy demand on labour during the spring operations in beet fields occurs in the latter part of May and during June after the grain seeding has been completed. The weeding is done during an "off-time" for grain farming. The beet harvest normally begins after the grain harvest has been completed. This makes it possible for the same labourers to put in a full year's work.

Homewood area.[23] Many of the workers were immigrants who had worked in beet fields in their native countries.[24] Some labourers were brought in temporarily from surplus labour areas in the Grunthal, St. Malo, St. Pierre and Ste. Claude districts. These areas have a high rural population density and since the spring labour requirements in sugar beet production occurs during a slack period in grain farming, farm workers move into the sugar beet fields (Figure 14, page 91). These people are available in greater numbers whenever hay crops are poor in their home area.

Labour from the Indian Reserves in the Red River Valley became an important source of workers. In 1956 over 375 Indians were used in the thinning process. The Long Plains Indian Reserve was the source of labour for the sugar beet fields in the Portage area while the Roseau Reserve supplied the Emerson district. In 1957 spring labour was much more plentiful than in previous years. The Indian labour supplied was about the same as in the previous year. The curtailment in pulpwood cutting released a considerable amount of labour. Also, the Mennonites who migrated from Mexico to Northern Ontario were used in Manitoba.[25] In the last three years the Indian labour continued to increase with

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[23] Annual Report of the Agricultural Department, Manitoba Sugar Company, Winnipeg, Manitoba, 1955.

[24] News item in the Winnipeg Free Press, October 1, 1955.

[25] Annual Report of the Agricultural Department, Manitoba Sugar Company, Winnipeg, Manitoba, 1957.

labour being supplied from the more northerly reserves (the Reguis Reserve, the Brokenhead Reserve, and the Sandy Bay Reserve). In 1959, 875 Indians hoed and thinned 3,300 acres and in 1960 some 1,200 were used to thin and hoe approximately 5,000 acres of sugar beets. The balance was hoed by local labour and labour brought in from surrounding surplus areas.

The number of acres sown to sugar beets on the farm influences the amount of contract labour requirements. It will be noted from Table XI that the amount of contract labour required by the small-sized, ten to twenty acre group was 63.4 per cent of the total. The group of farms having twenty-one to fifty acres of sugar beets required 24.5 hours per acre of hand labour, eighty-nine per cent consisting of contract labour. The large size group with fifty-one acres of sugar beets or more used 32.2 hours of hand labour for one acre of sugar beets of which 95.3 per cent was contracted labour.

The density of population is a significant cultural element favouring production of sugar beets. While the sugar beet production has gravitated to certain predominant soil types it has also had a tendency to shift to areas where more family labour was available and to areas where the rural population density is high (Figure 14, page 91). The Altona-Winkler area as well as the Steinbach-Niverville district has a rural population density which ranges from ten to fifty-nine persons per square mile. The Portage-Elie district also has a fairly high population density. The sugarbeet fields along the Morris River are

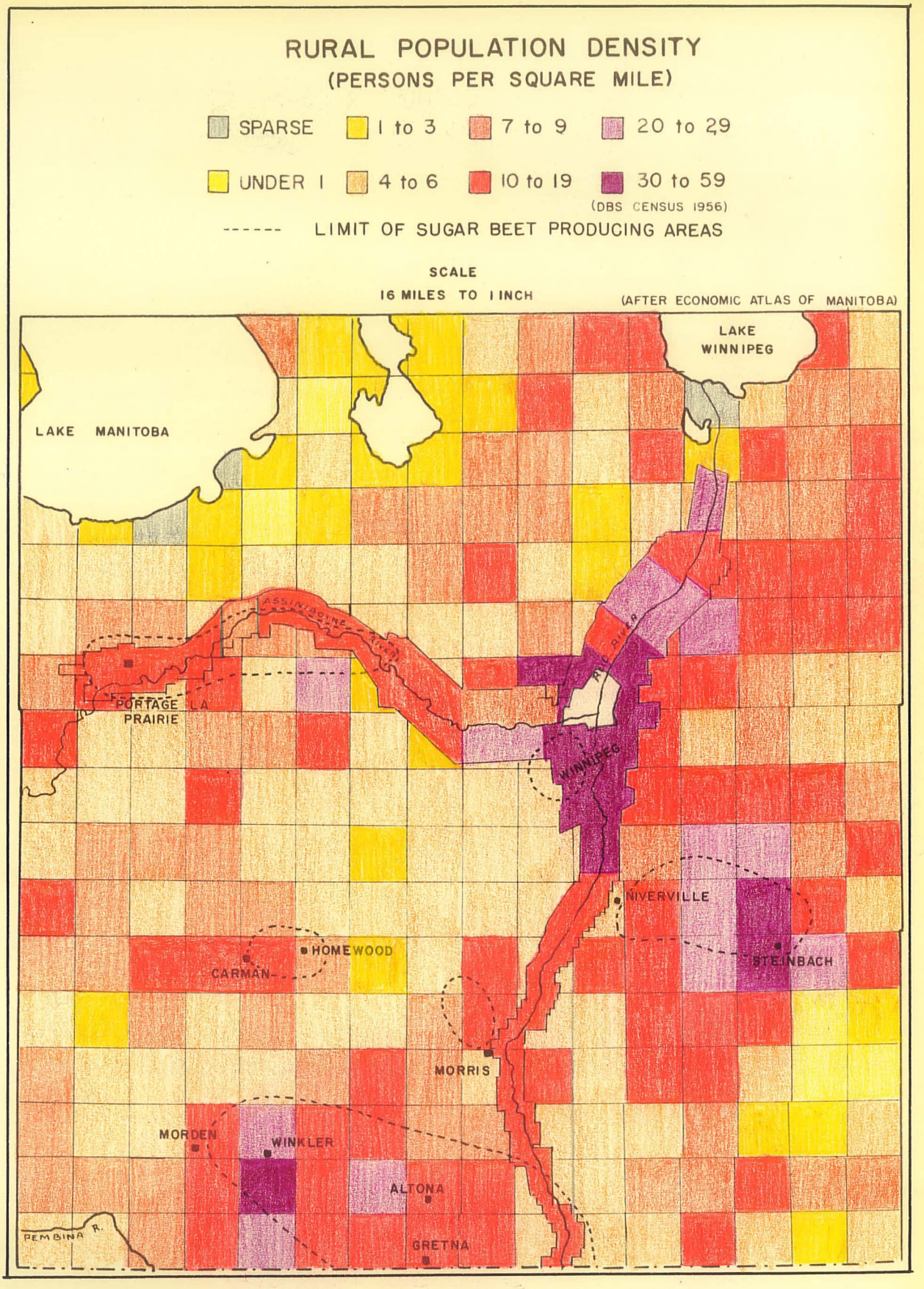
RURAL POPULATION DENSITY
(PERSONS PER SQUARE MILE)
SPARSE
UNDER 1
1 to 3
4 to 6
7 to 9
10 to 19
20 to 29
30 to 59
(DBS CENSUS 1956)
LIMIT OF SUGAR BEET PRODUCING AREAS
SCALE
16 MILES TO 1 INCH
(AFTER ECONOMIC ATLAS OF MANITOBA)
LAKE WINNIPEG
LAKE MANITOBA
ASSINIBOINE RIVER
RED RIVER
PORTAGE LA PRAIRIE
WINNIPEG
NIVERVILLE
STEINBACH
HOMEWOOD
CARMAN
MORRIS
MORDEN
WINKLER
ALTONA
PEMBINA R.
GRETNA

Figure 14

located in an area of relatively high population. The amount of local labour available became an important factor in the location of sugar beet acreage.[26] The trend to shift to areas of more available labour was noticeable in 1943.[27] The largest increase was in the areas settled by Mennonites. In that year approximately half the sugar beet acreage was sown by Mennonite farmers.[28] The concentration of the sugar beet acreage on Mennonite farms occurred first in the Altona-Winkler area and then in the Steinbach-Niverville district (Figure 3, pocket). In these areas the Dominion-Provincial Farm Help Service had very little activity. It is also here where the farm holdings are relatively small and the size of families is large resulting in a high density of population. The average size of farms in the areas occupied by Mennonite farmers is 160 to 240 acres[29] while the average number of people per farm is approximately 4.9.[30, 31] The increase of sugar beet production in areas occupied by

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[26]Gilson, op. cit., p. 8

[27]Taylor, op. cit. p. 42

[28]News item in The Altona Echo, May 19, 1943

[29]Economic Atlas of Manitoba, Edited by T.R. Weir, Department of Industry and Commerce, Province of Manitoba, 1960, p. 43.

[30]Census of Canada, 1956, Population Bulletin 1-7, Dominion Bureau of Statistics, (Ottawa: Queen's Printer, 1957), p. 11-4.

[31]Census of Canada, 1956, Agriculture, Manitoba, Bulletin 2-7, Dominion Bureau of Statistics, (Ottawa: Queen's Printer, 1957), Pp. 8-1, 8-2.

Mennonites is also reflected in the increase of percentage of Mennonite growers. In 1940 only twenty-four per cent of the growers were Mennonite farmers, however, by 1945 the number had increased to fifty-two per cent. The percentage of Mennonite farmers continued to increase until 1955 when it reached seventy-five per cent (Table XVII, Appendix C). This movement solved much of the labour shortage problem.[32]

Traditionally, sugar beet culture was a high consumer of labour, however, due to the introduction of modern machines there has been a marked reduction in the requirements of hand labour. At present the amount of hand labour required depends largely on the extent of mechanization.

MECHANIZATION

In recent years the trend in all phases of agriculture, and the sugar beet industry is no exception, is towards mechanization. Factors which are largely forcing beet growers to adopt mechanized methods are the shortage and the high cost of hand labour.[33] Also important is the uncertainty of a labour supply at the proper stage of growth of the sugar beets.

Efforts are now concentrated on the mechanization of the spring and summer work - thinning, blocking, weeding and hoeing. For many years the type of seed used was a serious obstacle to the mechanization

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[32]Personal communication with Major Richardson, Dominion-Provincial Farm Help Service, Winnipeg, Manitoba.

[33]G.W. Holmes, "Mechanical Harvesting of Sugar Beets and Potatoes," Proceedings of Annual Conference of Manitoba Agronomists, 1951, p. 41.

of these operations. A regular seed bulk contains up to four or five germs which will all sprout under favourable conditions, and may all emerge as a cluster, requiring stoop labour to leave the one desired plant. In 1943 segmented seed was introduced. The idea of segmentation was to reduce the large seed ball to one having one or two germs. This is accomplished by passing the whole seed between an emery wheel and a steel cutting bar (a shearing machine). The use of this seed allows for more efficient cross-blocking, thereby speeding up the thinning operation. The bulk of the thinning can then be performed with long-handled hoes. Later the decorticated seed was introduced which is an advanced step from the segmented seed. By decorticating the seed it is broken down perhaps to a single seed germ in each seed particle. Much of the material surrounding the seed germ is then removed by cleaning.[34] However, it is difficult to assure that only one seed germ will remain in the seed particles. Some seed particles contain two seed germs others may contain no seed germs. In recent years another type of seed is gradually making its appearance. This is the monogerm seed which is a seed bred to contain one single germ in each seed kernel. This new development has long been wished for by many growers in Manitoba.[35] In

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[34] Restrictive Trade Practices Commission Report Concerning the Sugar Industry in Western Canada, Department of Justice, Ottawa, (Ottawa: Queen's Printer, 1957), p. 33.

[35] Manitoba Sugar Beet Bulletin, Spring, 1960, p. 3.

1960 approximately half the seed used in Manitoba was the monogerm seed, the other half was decorticated seed.[36] Only half the seed was monogerm because of the experimental nature of this seed at the present. The Manitoba Sugar Company and growers want to be reasonably sure that the quantity and quality of beets from monogerm is superior to or the same as beets from decorticated seed.

At present the most serious obstacle to the mechanization of spring work is the difficulty of obtaining ample and uniform stands of single beet plants. Where the stand is 75 per cent or better crossblocking or down the row mechanical thinning is effe ctive. These two operations have reduced the hand labour expenses as much as two-thirds. However, poor germination and incomplete stands are limiting factors in the use of mechanical thinning.

Mechanical thinners were first used around 1950 in the spring operations in Manitoba. By 1955 eighty-two mechanical thinners were used on 3,700 acres of sugar beets. In 1956 the acreage mechanically thinned increased to 5,867.[37] It is claimed that the shortage of labour during that year was a major factor in the increase in mechanical thinning.[38] The total acreage mechanically thinned continued to increase in 1957, however, in 1958 the mechanically thinned acres dropped to 690 because of poor germination which was caused by low precipitation.[39] In

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[36]Personal communication with Dave Duerksen, Agronomist for Special Crops, Manitoba Department of Agriculture, Winnipeg.

[37]Annual Report of Agricultural Department, 1956, Manitoba Sugar Company, Winnipeg, Manitoba.

[38]Manitoba Sugar Beet Bulletin, Spring, 1958, Published by the Manitoba Sugar Company Limited, 1958, p. 5.

[39]Annual Report of Agricultural Department, 1958, Manitoba Sugar Company, Winnipeg, Manitoba.

1960 there was a drop in the number of mechanical thinners in use. The use of the spring tine harrows to remove weeds and beets increased considerably (Table XII, page 97).

In general, thinning is still done mainly by hand labour. The amount of mechanical thinning done is influenced by the availability of labour, weather conditions which delay thinning and the uniformity of stand. From one year to the next, mechanical thinning varies from practically none to over twenty-five per cent of the acreage (Table XII, page 97).

The prospects for complete mechanization of spring operations seem remote at the present time, however, mechanical thinning of sugar beets has been an important factor in reducing the amount of hand labour required. It is probable that hand labour during spring may be reduced to a single hoeing.

The first step in the mechanization of sugar beet harvest operations in Manitoba was the introduction of the beet loader. It doubled the daily hauling capacity of trucks and eliminated extra help for loading.

The Manitoba sugar beet growers have adopted the mechanical harvester which tops the beets on the ground, elevates them and drops them into a hopper or trailer from which they are elevated into trucks (Figures 29 and 30, page 127). During 1960 ninety-nine per cent of the sugar beet crop was harvested mechanically (Table XII, page 97). These machines were first introduced in 1946 but shortage of material for manufacturing was the limiting factor in the number of harvesters produced. For this reason only a few were alloted to Canada. Since 1946 the percentage of acres harvested mechanically has gradually increased. One reason why the sugar beet growers have adopted mechanical harvesting is because

TABLE XII

PERCENTAGE OF ACRES HARVESTED MECHANICALLY
AND NUMBER OF ACRES THINNED MECHANICALLY

Year	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Per cent harvested mechanically		3	10	12	19	37	51	66	75	76	85	92	95	97[a]	99
Number of harvesters	2	3	16	-	55	95	115	-	-	220	246	285	292	317	302[b]
Acres worked with mechanical thinners									5800	3700	5870	6085	6900	1634[c]	2000
No. of mechanical thinners										82	104	120	128	130	126[d]

[a]Approximately 500 acres harvested by hand in the heavy soil areas where the soil was too wet for the machines.

[b]The decrease in the number of harvesters is due to the trend towards multiple row harvesters. The number of single-row machines dropped by twenty-seven while the two-row machines increased by four and the number of three-row machines increased by eight.

[c]The drop in acreage was due to poor germination caused by abnormally low precipitation.

[d]The use of the spring tine harrows to remove weeds and beets increased considerably during 1960.

of its economic advantage.

A study carried out in 1951 showed that mechanical harvesting costs $1.65 to $2.25 per ton of beets harvested depending on the yield per acre as compared to $2.70 per ton for hand harvesting. Labour requirements are in the range of one to two man-hours per ton for hand harvesting as compared to approximately one-third to two-thirds man-hours per ton for mechanical harvesting.[40]

According to a recent survey conducted in the Red River Valley in North Dakota and Minnesota the loss of beets by mechanical harvesting was no greater than by hand topping. The producers were of the opinion that "any greater loss because of beets missed by the harvesters was offset by the more prompt delivery of beets and by less loss due to exposure of the beets to the sun and wind in the float row."[41]

To warrant the purchase of a sugar beet harvester the operator must harvest approximately 200 to 300 acres over a period of five years - a minimum of 40 to 60 acres per year, depending of course, on the initial cost of the unit. The price of the complete unit exclusive of the tractor is $3,500 to $5,500.[42] For many growers it is a crucial problem to decide

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[40] G.W. Holmes, "Mechanical Harvesting of Sugar Beets," Proceedings of the Annual Conference of Manitoba Agronomists, 1951, Manitoba Department of Agriculture, p. 41.

[41] R.M. Gilcreast, Sugar Beet Production in the Red River Valley, North Dakota, Agriculture Experimental Bulletin 363, 1950, p. 27.

[42] Various implement dealers selling beet harvesting equipment were questioned. The range in price is largely due to different sizes available. The annual capacity of harvesters varies from at least 100 acres for a one-row machine to 250 acres for a three-row machine.

whether to invest in a mechanical harvester or not. Many of the farms having small sugar beet acreage depend heavily on the custom hiring of machines for their harvest operations.[43]

Reducing hand labour by mechanization will make production of sugar beets a great deal more attractive to the individual grower. Also, by reducing costs it will improve the competitive position of beets relative to other crops. For these reasons mechanization may be expected to increase the demand by farmers for beet acreage. However, the present 1960 acreage was approximately equal to the present processing capacity, and any significant increase in future acreage depends upon additional plant capacity.

CONCLUSION

The amount of labour requirements in the production of sugar beets has decreased with the increase in mechanization. Prior to mechanization eighty hours of labour was required for every acre of sugar beets while in 1955 approximately twenty-nine hours was required. The problem of obtaining sufficient labour during the early years of the industry was often acute. Labour was supplied by Japanese from British Columbia, German prisoners of war, and later by immigrants from Europe. This was supplemented by the movement of labour from the nearby Indian Reserves. Also, the location of sugar beet acreages in areas

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[43] J.C. Gilson, Economic Aspects of Sugar Beet Production in Manitoba, (Winnipeg: Queen's Printer, 1956), p. 21.

where more local labour was available helped overcome the shortage. However, the demand for labour during the harvest period has been drastically reduced by the advent of the mechanical harvesters. No doubt the increased mechanization of the spring operations will continue and further reduce the labour requirements.

CHAPTER VII

TRANSPORTATION AND MARKETING

The transportation pattern throughout the area reflects the density of settlement characteristic of the Red River valley. An analysis of the pattern reveals four principal flow lines: a north-south route, a east-west route, a south-west-north-east route, and a south-east-north-west route. All the communication lines converge on Winnipeg, the location of the sugar refinery, thus making it the focal and pivotal point for all traffic from the sugar beet producing areas. (Figure 15, page 104). This makes Winnipeg the most logical location for the refinery from the stand point of transportation of raw material. Sugar factories using beets as raw material are generally located at the source or as close to the source of raw material for the transportation costs of the raw material is greater than that of the by-products, fuel, and refined sugar. The refinery, which is located in Fort Garry, a suburban municipality to the south of Winnipeg, is located approximately sixty miles from the Portage la Prairie area, seventy miles from the Altona and Winkler area, and about thirty-five miles from the Niverville - Steinbach area. The refinery is provided with adequate railway and highway connections.

ROADS

The main roads run in the direction of the principal flow lines. These in turn are fed by many tributary roads coming in at right angles and "draining" the farm lands of the Red River valley. The major highways may be termed "exotic" in the sense that they flow through the beet growing areas but neither begin nor terminate in it and carry much traffic that has no relation to the districts themselves.

The market roads form vital flow lines to the sugar beet loading stations many of which are located in or adjacent to a trading center. They also provide adequate access to the arterial highways and as such perform as collector roads, for they act as a link between the local roads and the highways. All the market roads are either improved dirt roads or gravel roads. The trend is towards more gravelled market roads.

Where farmsteads are located away from arterial highways or market roads they are served by local roads. In most parts of the Red River Valley improved dirt roads have been constructed around each square mile of land surface. On the whole the sugar beet producing lands are served by a fine network of graded, gravelled and paved roads linking them with the loading stations or the refinery.

Farmers within a distance of approximately forty miles of the refinery haul in their beets by truck. Beyond the forty miles it is more economical to transport the beets by rail. In the Niverville area, which is approximately twenty-five miles from the factory, only 491 tons of beets were hauled to the local loading station at Niverville during 1955; the balance (about 16,000 tons) was hauled directly to the factory by truck. In 1956-57 the loading stations at Niverville and at Ste. Anne were discontinued and all the beets from that district are delivered by truck. The better quality and faster highways linking Steinbach and Niverville with the refinery resulted in changing to truck transportation. No doubt the Greater Winnipeg perimeter road system strongly influenced this change for it decreased both the length of route as well as the length of the travel time to the refinery (Figure 15, page 104). Many of the producers at Morris haul in their beets by truck. All the sugar beets produced in the Fort Garry area are hauled by the farmer to the refinery. Table XIII gives the percentage of sugar beets hauled by

truck and rail to the refinery.

TABLE XIII

PERCENTAGE OF BEETS DELIVERED BY TRUCK AND RAIL[1]
(Net Tons)

Year	1942	1945	1950	1955	1956	1957	1958	1959	1960
Truck	22.5	13.3	13.6	18.2	19.5	21.0	15.6	13.7	16.2
Rail									
C.N.R.	35.7	40.4	36.3	26.5	27.9	26.9	27.1	29.3	28.6
C.P.R.	41.8	46.3	51.1	55.3	52.6	52.1	57.4	57.0	55.2

During 1960, sixteen per cent of the sugar beets produced was delivered to the factory by truck. Approximately ten percent was delivered by truck from the Niverville-Steinbach district while the balance came from the areas south and west of the factory. The fluctuation of the percent hauled by truck during the last three years was due mainly to the variations in acreage and yield from area to area. During this period there was no change in the number and location of loading stations neither was there a change in freight rates charged by the railroad companies.

RAILWAYS

Although a substantial volume of sugar beet tonnage is moved by truck, railways carry by far the larger tonnage from the areas of production. There are two railway systems serving the sugar beet industry, the Canadian Pacific Railway which carried 55.2 per cent of the total

[1]Manitoba Sugar Company, Winnipeg, Manitoba

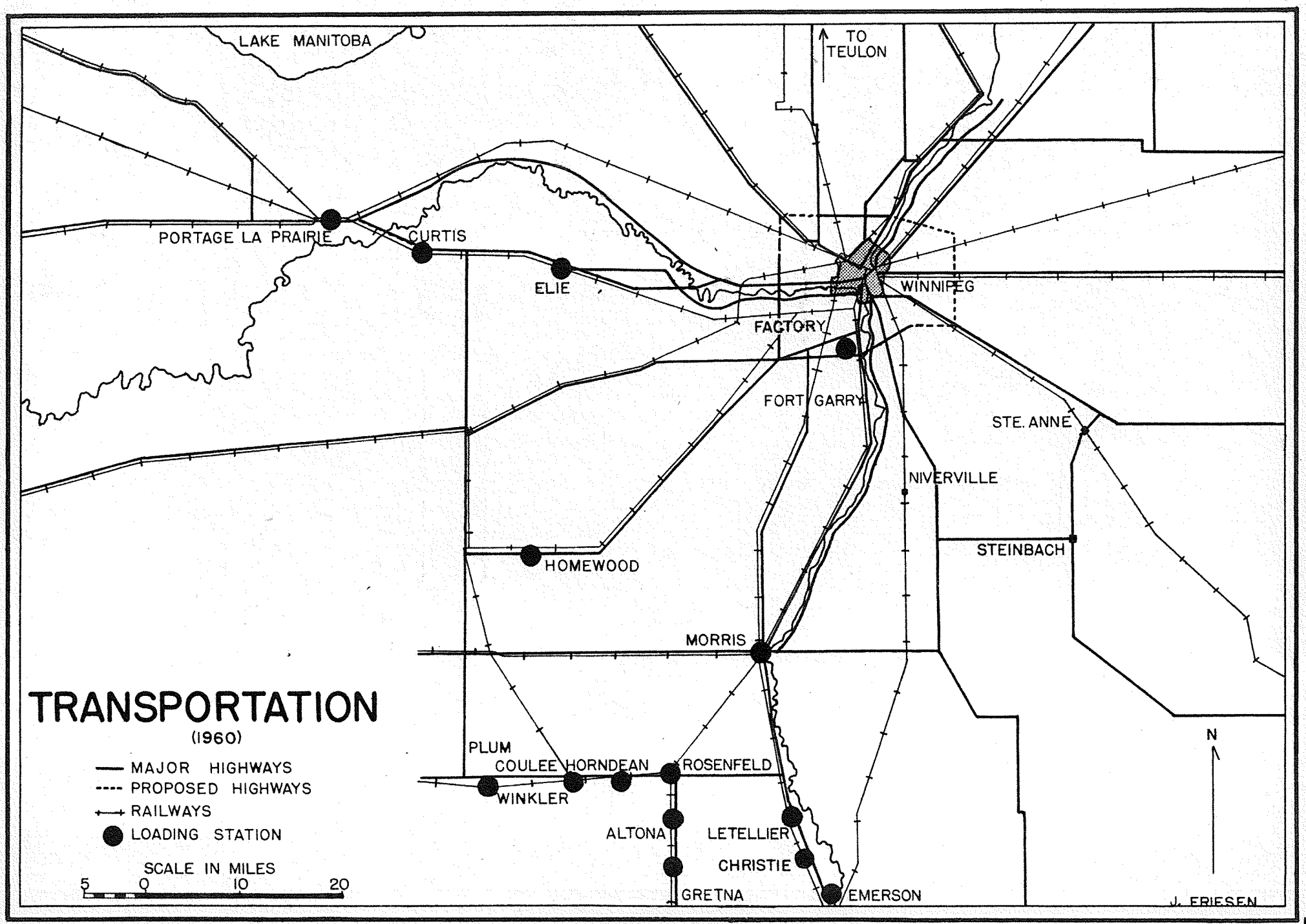
LAKE MANITOBA
TO TEULON
PORTAGE LA PRAIRIE
CURTIS
ELIE
WINNIPEG
FACTORY
FORT GARRY
STE. ANNE
NIVERVILLE
STEINBACH
HOMEWOOD
MORRIS
PLUM COULEE
HORNDEAN
ROSENFELD
WINKLER
ALTONA
LETELLIER
CHRISTIE
GRETNA
EMERSON
TRANSPORTATION
(1960)
MAJOR HIGHWAYS
PROPOSED HIGHWAYS
RAILWAYS
LOADING STATION
SCALE IN MILES
5 0 10 20
N
J. FRIESEN

Figure 15

tonnage in 1960 and the Canadian National Railway which handled 28.6 per cent. The Canadian Pacific Railway served eight local loading stations while the Canadian National served seven loading stations. Of the eight loading stations served by the Canadian Pacific Railway six are located in the Altona-Winkler districts. In 1960 these six loading stations handled 50.0 per cent of the total tonnage for that year. This railway line also served the loading stations at Portage and Teulon (5.2 per cent of the total tonnage). The Canadian National Railway served four loading stations in the Emerson-Letellier area. In 1960 these four stations handled 17.3 per cent of the total tonnage. The balance of the tonnage transported by this railway line came from the Homewood, Curtis, and North Elie loading stations (11.3 %). The total number of tons of sugar beets handled by each loading station is given in Table XVIII, Appendix C.

Prior to 1951 the freight on all beets delivered by rail was equalized so that each grower received the same price per ton at his nearest beet loading station, provided the shipment was in the established freight area.[2] Since 1951 all growers pay freight on the basis of their delivered raw weight and at the current rate in effect at their shipping point.[3] In other words the sugar beet company does not pay any freight charges on beets delivered to the factory. The cost of transportation from the loading station to the refinery varied from $1.39 per ton at North Elie to $1.78 per ton at Winkler. The freight rates for sugar beets have been stable since 1957 but between 1954 and 1957 they increased by

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[2] Sugar Beet, A Dependable Crop for Manitoba Farmers, Manitoba Sugar Company, Winnipeg, Manitoba, p. 5.

[3] Manitoba Beet Growers Bulletin, Winnipeg, September, 1951.

approximately fourteen to eighteen cents per ton.[4] Any increase in freight rates is reflected in an increase in the amount delivered to the refinery by truck.

LOADING STATIONS

Location. Since sugar beets are a heavy, bulky commodity loading stations are located at advantageous points along the railways. However, permanent loading stations are not provided until the acreage in the immediate territory has reached 1000 acres. The cost of the loading stations is in the neighborhood of 6000 dollars, consequently the acreage must be quite substantial at individual points to justify the cost of the installations. Where the acreage is much below the minimum and where there is little prospect for an increase in acreage a portable loader is installed. The sugar beet producing areas in Manitoba are serviced by fifteen loading stations including one portable loader (Figure 15, page 104). The loading stations at Curtis, North Elie and Portage la Prairie serve the Portage district. Receiving stations at Altona, Emerson, Rosenfeld, Christie, Letellier, Horndean, Plum Coulee, and Winkler serve the southern district. The sugar beets produced in the Homewood district are all handled by the loader located at Homewood. Teulon is equipped with a portable loader which adequately handled the sugar beets produced in that area in 1960. Prior to 1956 the Steinbach-Niverville area was served by two receiving stations, one at Niverville and the other at Ste. Anne, which served the area around Steinbach for Steinbach itself is not connected to Winnipeg by a rail line. The sugar

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[4] Annual Reports of Agricultural Division, Manitoba Sugar Company, Winnipeg, Manitoba, 1954 - 1960.

beets grown just east of Niverville were either hauled directly to the factory by truck or taken to the loading station at Niverville. The loading station facilities at Niverville were dismantled in 1956 while the facilities at Ste. Anne were discontinued in 1957.

The sugar beet flow diagram (Figure 16, page 108) shows the various districts from which the sugar beets originate and, by means of flow lines, the routes taken to market. The thickness of the flow lines is proportional to the number of tons of sugar beets shipped from the loading stations or by truck to the factory.

Sugar beet shipments from the Winkler-Altona district amounted to 130,200 tons in 1960. This represents fifty per cent of the total for the entire producing area. The Emerson-Letellier area shipped 42,600 tons in 1960 (sixteen per cent of the total). The Portage area shipped 28,495 tons of sugar beets by rail to the refinery (eleven per cent of the total). The sugar beet shipment form the Steinbach-Niverville area totalled 25,334 tons in 1960. This represents ten per cent of the total. The relative importance of the shipping points is apparent from Figure 16.[5]

As the sugar beet producing lands became more concentrated in certain areas the number of loading stations decreased. In 1942 there were 42 loading stations in the Red River Valley, by 1945 the number of loading stations had decreased to twenty-three. By 1950 the number had further decreased to nineteen while by 1960 the number had decreased to fifteen. As producing areas continue to consolidate and as the system of highways continue to improve together with a gradual increase in freight

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[5]Table XVII, Appendix C shows the actual tonnage handled by each loading station.

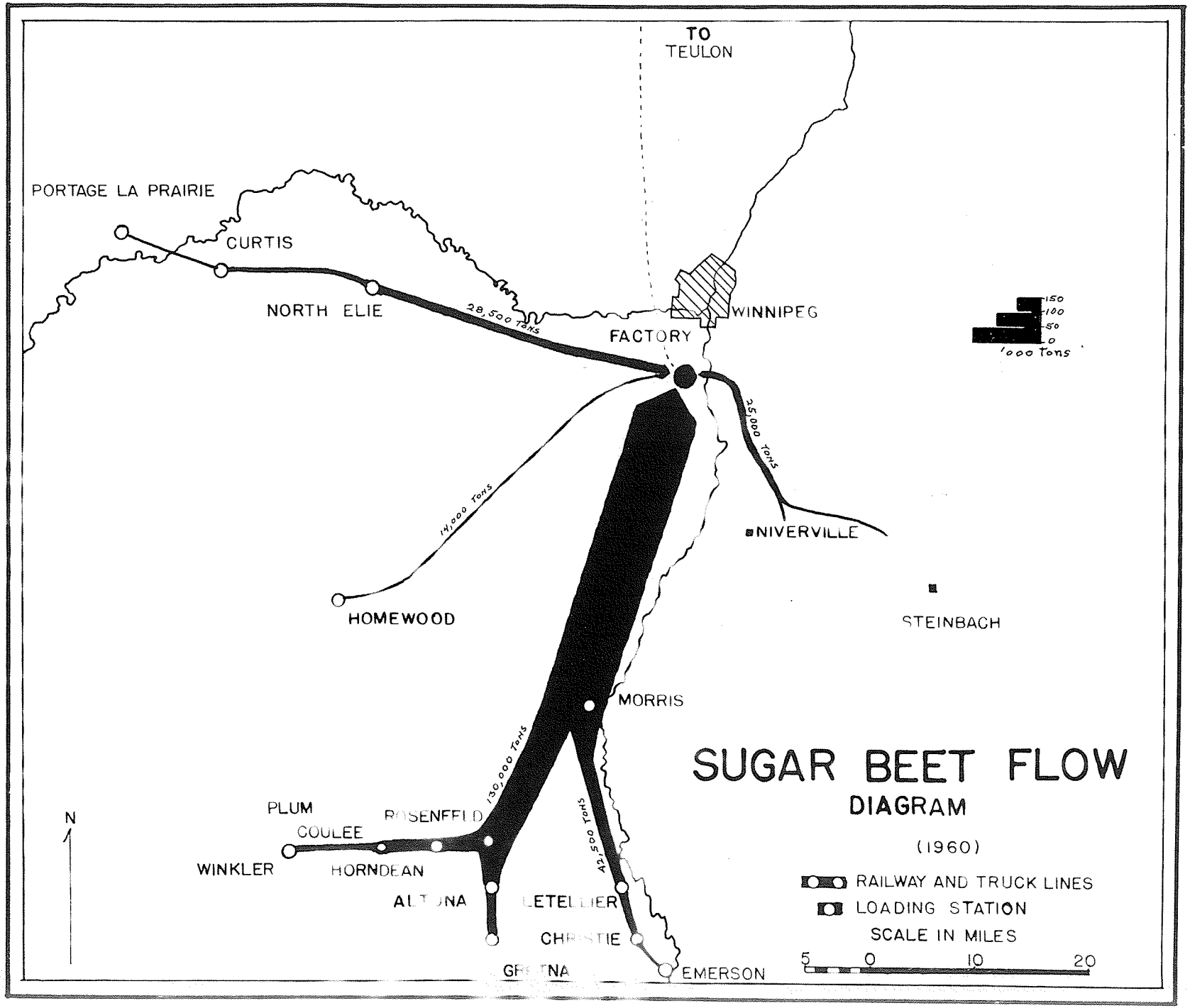
TO
TEULON
PORTAGE LA PRAIRIE
CURTIS
NORTH ELIE
28,500 Tons
FACTORY
WINNIPEG
150
100
50
0
1000 Tons
25,000 Tons
14,000 Tons
NIVERVILLE
HOMEWOOD
STEINBACH
MORRIS
130,000 Tons
42,500 Tons
PLUM
COULEE
ROSENFELD
WINKLER
HORNDEAN
ALTONA
LETELLIER
CHRISTIE
GRETNA
EMERSON
N
SUGAR BEET FLOW
DIAGRAM
(1960)
RAILWAY AND TRUCK LINES
LOADING STATION
SCALE IN MILES
5 0 10 20

Figure 16

rates a larger tonnage is being handled by fewer receiving stations and more sugar beets are being transported to the refinery by truck.

Function. The loading stations are located at points of transhipment where the sugar beet is transferred from the farmer's vehicle to the railroad. The receiving station consists of a small parcel of land on which a side track, weighing and unloading equipment is situated. The land is leased from the railroad company for an annual fee. As each load is received it is weighed and a sample taken to determine the amount of dockage or tare.[6] An accurate determination of the percent tare is essential in fixing the purchase price of a load of beets. The adhering dirt and soil is removed and the necks trimmed removing all leaf scars from the sample beets. The clean beets are then weighed again and from the loss of weight, the per cent tare is calculated and recorded on the weight slip accompanying each sample.[7] The truck load is dumped onto a conveyor belt which, in turn, lifts the beets to a spout where they fall into the open gondola-type railway cars (Figure 17, page 110). After the truck or wagon is emptied it is weighed out again over the scales and the farmer receives a ticket with the net weight of beets which he delivered. The dockage or tare is estimated by actual sample test of the amount of dirt, tops, or leaves remaining with the beets. Where the volume of beets is received faster than the railroad cars can be supplied the sugar beets are temporarily piled in huge piles (see Figures on page 111). In this case

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[6]Tare is the foreign matter and the crown and sprangly roots which adhere to the beet when delivered to the loading station. There are five items that influence tare, namely: the crown, feeder roots, clods of earth too large to screen out, mud and dirt adhering to the main root, and trash which includes weeds, leaves and grass.

[7]Werner Moeller Krause, Practical Handbook For Beet Sugar Chemists, (Easton, P.A.:The Chemical Publishing Co., 1914), P. 15.

Figure 17

At the loading station beets are transferred from the trucks to the railway cars. The truck box is tipped so that the beets roll into a hopper from which they are carried by an endless apron to the open gondola rail-car. The above loading station is located in Horndean, September, 1961.

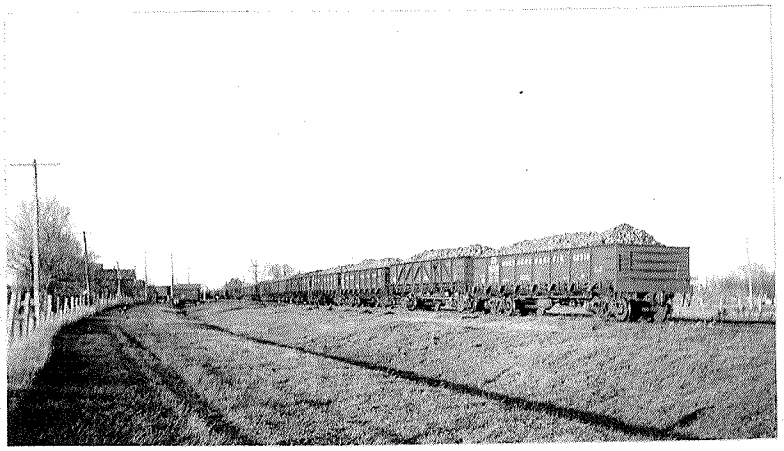

Figure 18

After a sufficient number of cars have been filled they are moved directly to the factory. In Manitoba about 80 per cent of the beets are moved to the refinery by rail. The above scene is near Altona, September, 1955.

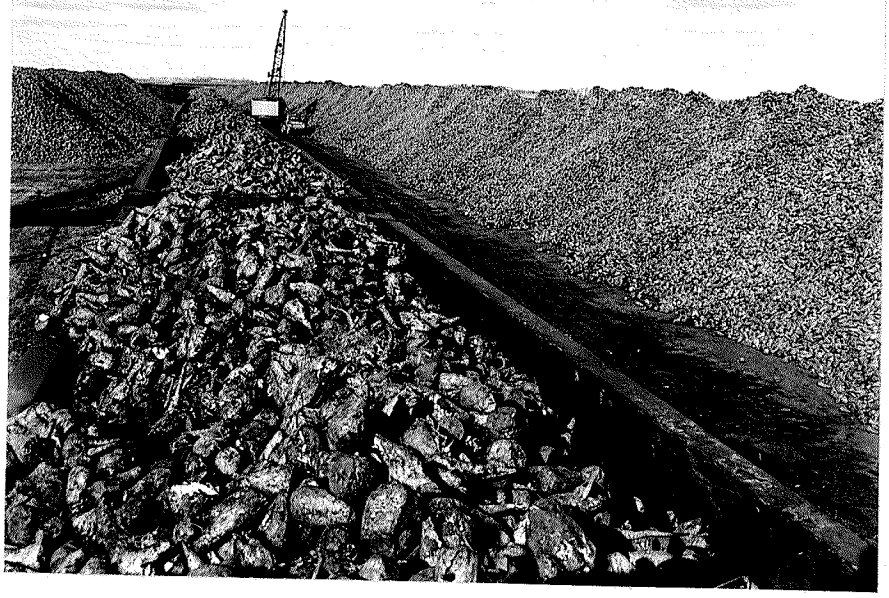

Figure 19

Sugar beet piles located north of Gretna, October, 1953.

Figure 20

Vast storage piles, often covering several acres, accumulate at loading stations when insufficient railway cars are available. Later in the season freight cars are filled for shipment to the factory. A piling machine will unload a farmer's truck in about half a minute and then throw the beets into a pile that may contain 20,000 tons.The piler above is located in Altona, October,1954.

a piling machine will unload the farmer's truck and determine the amount of tare. Later in the season freight cars are filled by draglines for shipment to the factory. There are three piling machines in use, one just north of Gretna and another at Altona. Both these stations are located in areas of heavy concentration of sugar beet production and both handle sugar beet tonnage in excess of 30,000 tons (Table XVIII, Appendix C). The other beet piler is located at the factory (Figure 21, page 114).

Sugar beets in good condition are essential for the proper extraction of sugar and it is to the farmer's advantage to see that his beets are delivered properly topped and in good condition. Beets are comprised of seventy-five or eighty per cent water and if exposed to the weather for any length of time shrinkage is unavoidable. That is one reason why sugar beets are delivered as soon as possible after removing them from the ground. This directly affects the tonnage of the beets and the returns the grower receives for the beets.

SUGAR BEET CONTRACTS

Sugar beets are grown under contract between the grower and the Manitoba Sugar Company. In this way the processor is assured of an adequate supply of beets and the production is limited to the capacity of the plant. The contract sets out the number of acres which the grower agrees to devote to beet growing. The grower agrees to deliver the entire crop from the contracted acreage to the factory while the company agrees to receive all of the crop. Contracts are made during the winter months with the prospective growers by company fieldmen. In the contract is set out a sliding scale of payments to the producer based on the over all sugar content of the beets and the net sales return on sugar. The Manitoba sugar beet growers get sixty per cent of the net returns from the sale of sugar

while the processor keeps the remaining forty percent. In the pricing arrangement there is also a bonus given based on the purity of the sugar beets.[8]

Sugar beet production in Canada has been supported by the Federal Government. Prior to 1962 but after 1958 assistance to the producers has been provided under the Agriculture Stabilization Act. A certain support price was declared by the Government and it would then make up the difference between the price the producer received under his contract with the processor and the declared support price. For 1962 the financial assistance to be given by the Federal Government will be based on the world price for sugar.[9] The imported raw sugar will be given an arbitrary value of 4.5 cents per pound. This is the actual average value during the last ten years. If the average value of imported raw sugar for 1962 drops below 4.5 cents the Canadian growers will get a deficiency payment of 1.22 cents per pound for each cent of the difference.[10] Under the new plan all growers in Canada will get the same deficiency payment.

This new plan of support is not likely to increase the acreage of sugar beets because the processors are not likely to contract for new sugar beet acreage in the face of falling world sugar prices. (Just before Christmas, 1961, the price for sugar hit a 20-year low of 2.26 cents per pound at London). Processors probably will contract for sufficient beets to keep their present processing equipment operating and then rely on imported cane sugar for any additional needs.

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[8] Restrictive Trade Practices Commission Report Concerning the Sugar Industry in Western Canada, Department of Justice, Ottawa, (Ottawa: Queen's Printer, 1957), Pp. 172-173.

[9] News item in The Financial Post, Toronto, December 30, 1961.

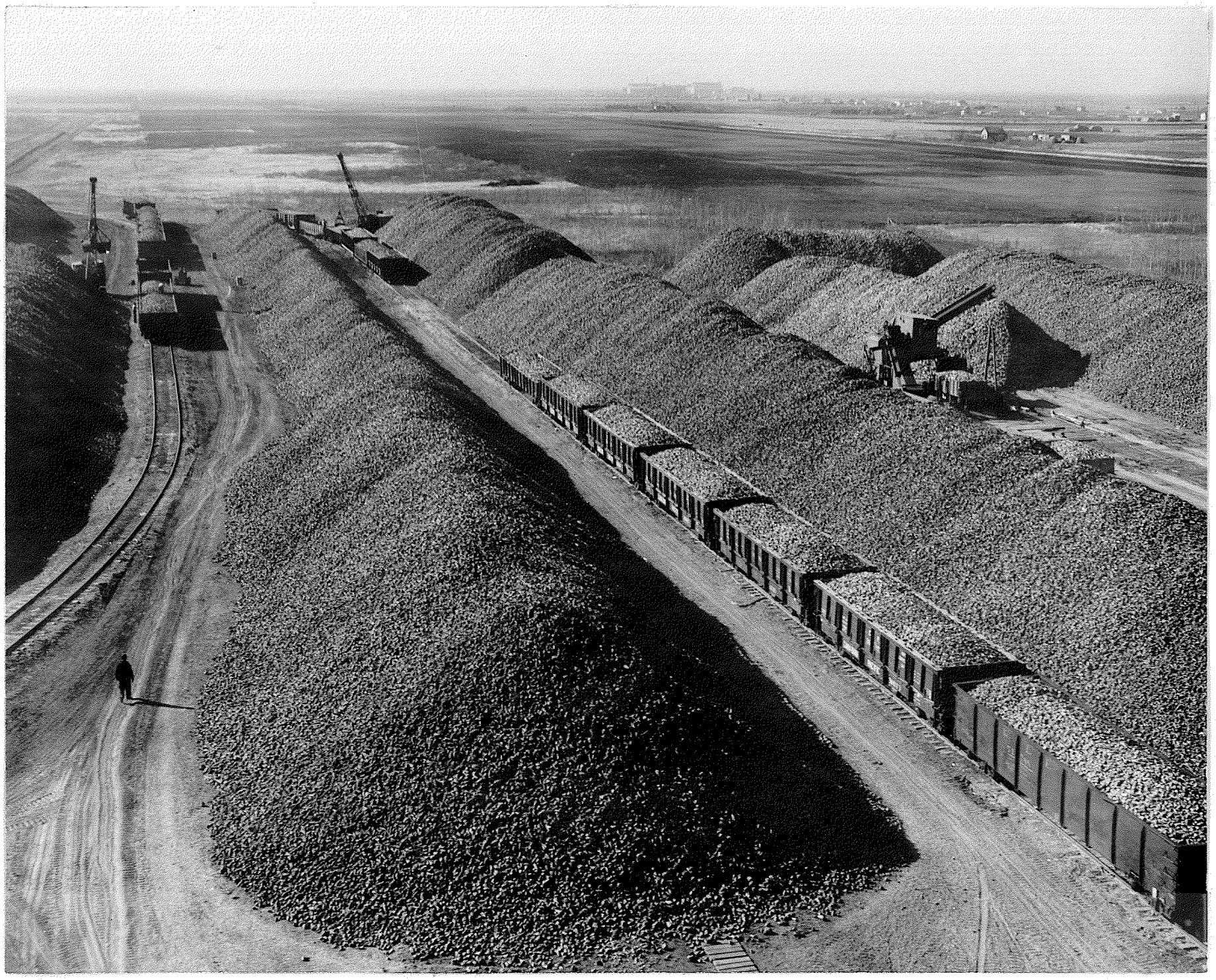
[10] News item in The Winnipeg Free Press, December 16, 1961.


J. BRANDT

Figure 22

At the factory freight cars filled at the loading stations in the country are received and unloaded with the aid of two draglines to the beet piling yard at Fort Garry.

(Courtesy of Manitoba Government, Department of Industry and Commerce)



CHAPTER VIII

METHODS OF PRODUCTION

FARM PRODUCTION

Methods of growing sugar beets as described in this chapter apply to Manitoba where some of the practices in growing sugar beets have become standardized. Thus, methods of land preparation and cultivation generally follow certain patterns. Other practices have been revised or discarded. New developments in planting and harvesting equipment, for instance have brought about radical changes in practice. No doubt more changes will be made which will lead to more economical production of sugar beets.

Preparation of the seed bed. In order to produce profitable crops, careful attention is given to the preparation of a suitable seed bed. The preparation begins the previous summer since the best selection of land for sugar beets is well prepared summerfallow or summerfallowed land on which green manure has been plowed under. Land which has been used for the production of grain, providing it is reasonably clean and fall plowed, is generally suitable.[1] The reasons why the use of summerfallow is so highly recommended by the Manitoba Sugar Company Agricultural officials are threefold:

(1) protection against seasons of subnormal moisture conditions;

(2) its value in weed control and;

(3) its a soil builder when a green manure crop is used.[2]

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[1] Manitoba Beet Growers Bulletin, May, 1945

[2] Manitoba Beet Growers Bulletin, January, 1953

In the spring the first operation usually is a light harrowing to promote the growth of any weeds that may be in the soil. It is recommended that after a lapse of two or three weeks the field should be disked, harrowed, and packed as rapidly as possible .[3] One of the main essentials in preparing a good seed bed for sugar beets is not only to have the soil well worked and clean but to have it reasonably firm and not so fine as to encourage drifting of the soil. It is a generally accepted rule that the finished seed bed should be firm enough so that a man will not sink in deeper than one half to three quarters of an inch while walking across the field.[4] The seed bed is prepared with the least possible loss of surface moisture which is necessary for early germination of the seed. In contrast, seed bed preparation on summer-fallow for spring wheat requires generally only one cultivation or spring tooth harrow prior to seeding. The type and nature of operation will depend on soil structure, degree of weed infestation, and weather conditions.

The preparation of the seed bed is usually timed in such a way that it is completed and ready for planting just as soon as the danger of heavy frosts is over.

Seeding and planting. As soon as the soil is sufficiently warm and dry enough to ensure quick germination of the seed, planting is begun. The first two weeks in May are the safest dates for planting in southern Manitoba because at this time sufficient moisture supports a quick and complete germination of the seed. Furthermore, the emerging seedlings can make rapid growth in a usually frost-free period. It is possible for beets planted in the last two weeks of May and even the first week of June to produce an average yield, but usually with somewhat reduced quality.

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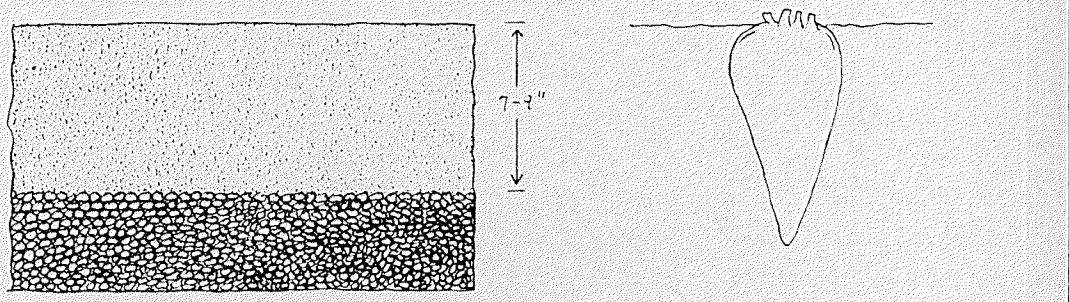
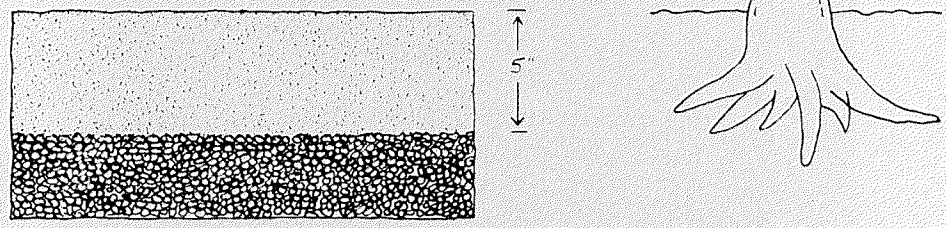
[3] Sugar Beet, A Dependable Crop for Manitoba Farmers, Unpublished material prepared by the Manitoba Sugar Company, Winnipeg, Manitoba, p. 7.

[4] J. O. Culbertson, Sugar Beet Culture in Minnesota, Bulletin 349, University of Minnesota, Minneapolis, Minnesota, June, 1940, p. 9.

ROOT DEVELOPMENT of SUGAR BEETS

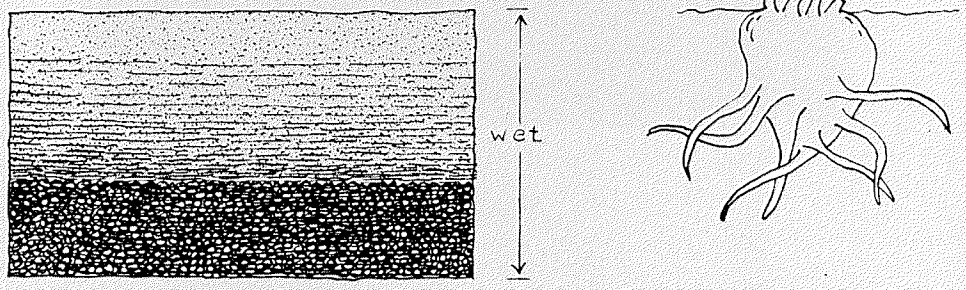


Proper seed bed. Well fitted, perfect beet



Improper seed bed

Distorted beet



Poor drainage

Abnormal beet

The importance of proper soil and drainage conditions in the production of sugar beets is shown by the nature of the root development. Distorted or abnormal root development results in excessive tare, lower tonnage, and a lower sugar content.

Figure 23

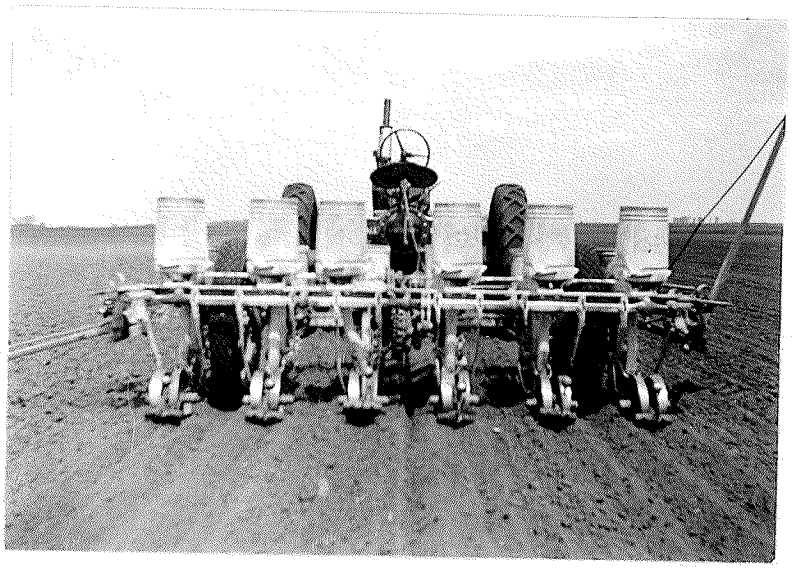


Figure 24

After a firm, smooth seed bed has been prepared, the farmer plants his beet seed, using a tractor drawn drill that can seed four to six rows at a time. It has attachments for applying commercial fertilizer with the seed. Seed drill and tractor in the picture are located just north of Altona, May, 1956.

In Manitoba the optimum recommended seeding rate is five pounds of processed seed[5] per acre. The depth of planting varies from three-quarters to one and one-half inches depending on the condition of the seed bed and the amount of moisture in the soil. Experience has indicated that row width of twenty to twenty-four inches have produced maximum yields.

The Manitoba Sugar Company recommends that approximately 60 pounds of ammonium phosphate (11-48-0) per acre be applied at planting time.[6] The main requirement of sugar beets is phosphorus; it improves the yield as well as the sugar content. According to experiments conducted in Manitoba the most effective response was obtained by the application of a fertilizer high in phosphorus. This element is deficient in almost all localities. It was also discovered that, early in the spring, Manitoba soils do not have sufficient nitrogen for a rapid growth of the crop. These factors have lead the company to make the foregoing recommendations.[7] In the light Altona soils where sugar beets follow grain crops 145 pounds of 16-20-0 fertilizer is recommended instead of the standard 11-48-0 fertilizer.[8]

Blocking and thinning. Blocking implies cutting out a block of beets while thinning implies reducing the remaining clump of beets to a single beet. Any weeds that may exist are removed in the two operations.

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[5]Regular or unprocessed seed balls contain up to four or five germs which will all sprout under favourable conditions and may all emerge as a cluster, requiring hand or finger thinning to leave the one desired plant. This work is most tedious and expensive. The idea of processed seed is to reduce the large seed ball to one having only one germ. This seed, when planted with a slight spacing from its neighbour, enables the thinning to be performed much faster and almost entirely with a long handled hoe thus eliminating the so-called "stoop-labour".

[6]Manitoba Sugar Beet Bulletin, Spring, 1960

[7]Manitoba Beet Growers Bulletin, February, 1945

[8]Manitoba Sugar Beet Bulletin, Spring, 1960

Thinning or singling of the plants is done to provide adequate space in which the plant may grow and reach its normal development. Blocking and thinning is performed in one operation by a person using a long-handled hoe. This operation is started and performed as rapdily as possible, when the small beets have two to four true leaves. The spacing of single plants in the row may vary from eleven to thirteen inches according to the row width or approximately 23,700 plants per acre. The importance of a complete stand cannot be over-emphasized as it not only increases tonnage per acre but also results in higher sugar content. Successful production of sugar beets requires careful attention at thinning time.

For mechanical operations, the so-called "down-the-row-blockers" can be used when the beets are in the four-leaf stage. All power driven blockers work on the same principal of making several small blocks per foot of row. All of them have eight, or more knives on rotating cutter-heads. Gearing establishes the speed of the rotating head which is timed according to the number of knives, giving as a rule three cuts per foot of row. The sizes of the cutting blades vary, the larger the blade the greater the removal. After taking a stand count the appropriate size of blade for that stand is employed, which will allow just a few more than the desired number of thinned beets to remain in the rows. Two or three days later labour finishes the thinning.

The "Windsor" system makes use of a twice-over operation with the same type of machine, followed by long-handled hoeing where necessary to remove the few remaining weeds and excess beets.

Another method, "cross blocking" is employed whereby a cultivator is set up so that it cuts out portions of the row and leaves a block of approximately four inches in which the plants are undisturbed. The space

between these clumps may vary from eight to twelve inches depending upon the interval desired between plants. The blocker is operated across the rows, and the blocks are then thinned to a single plant. Cross-blocking has two distinct advantages in that it results in a saving of hand labour and it also provides for cross-cultivation which helps in the control of weeds.

Cultivation. In general weed destruction is the primary purpose of cultivation. It is also of importance in breaking the soil crust, preventing wind damage and aerating the soil. Cultivating down the row is done with tools on a tractor-mounted cultivator bar.

The first cultivation is usually done soon after the plants have emerged from the ground. This not only destroys weeds but it also helps break up any crust that may have formed. The depth of cultivation usually is about two inches in ordinary soils. This is most effective because it destroys the weeds while at the same time it does not injure the feeding roots. It also leaves a good surface mulch to catch and hold the moisture when precipitation occurs.

The frequency of cultivation depends upon the rate of weed growth and the general condition of the soil. If successive crops of weeds follow each other closely, cultivation of necessity is equally frequent. Usually three to four cultivations are satisfactory to keep down weed growth. Prolonged cultivation, after the leaves begin to cover the row, may be harmful since many leaves may be broken off. If the soils becomes hard or crusted, it should be cultivated to break up the crust and allow rain to soak into the soil more readily. The last cultivation should be accompanied by slight hilling of the beets to permit the more efficient use of the mechanical harvester.

It is sometimes necessary to hand hoe the crop once or twice during the summer. In clean fields where the preparation of the soil and the first cultivations have been done carefully, one hoeing to remove the large weeds is ordinarily sufficient (Figure 26, page 124).

Harvesting. Harvesting operations include lifting, topping, loading, hauling, and delivering the beets to the receiving station. Many of the operations, as well as time of harvest, affect the weight and sucrose percentage of the beets. The sucrose stored in the root of the sugar beet is reserve food which the plant normally uses for the next year's seed production. While some of the plant food produced during the summer is transferred to the root as it is formed, there is an appreciable increase in the storage rate as cooler weather begins in the fall. The root also keeps increasing in weight until frost kills back the tops. Since the farmer is paid on a basis of the weight of the roots produced and also on the average sugar content of the beets from the entire producing area, it is important that harvesting be delayed as long as there is not too great a risk of the soil's freezing so hard that harvesting cannot be completed.

Harvest operations usually start about the fourth week of September and should be completed by the end of October because of the frost hazard.

In Manitoba there are two systems of harvesting sugar beets, hand-harvesting and complete mechanical harvesting. Prior to the advent of the mechanical harvester hand labour was used to harvest the crop. Hand harvest consists of first lifting the beets with tractor-drawn plows or beet lifters

Figure 25

Sugar beet fields should, and usually are, kept free of weeds. Weeds close to the plants are hoed or pulled out. Here a field worker east of Plum Coulee is removing weeds close to the plants. June 1954

Figure 26

Later in the season tall weeds are removed. Field labourer east of Horndean, July, 1955.

so that they may be pulled easily from the soil.[9]

The field workers follow the lifter closely and pull up the roots by the tops. If the stand is thin or the beets small in size, they are thrown together in piles. Usually twelve rows are thrown together in a windrow across the field, and the beets are then topped from these windrows. By first piling or windrowing the beets, much of the soil which interfers with the topping and loading is knocked off, the labourers do not have to walk so far to perform the topping, and the roots naturally fall into convenient piles or rows for loading. The leaves and part of the crown are removed by cutting at right angles to the axis of the beet at the lowest leaf scar. It is often the practice to drag a weighted V-shaped sled across the field to smooth down a place on which to pile the topped beets, which then are picked up by a mechanical beet loader and placed directly into a truck for delivery to the receiving station.

By 1960 mechanical means of harvesting sugar beets had almost completely replaced the use of hand labour. During 1960 ninety-nine per cent of the acreage was harvested by machines. The mechanical harvesters now in commercial use can be classified into two general groups:

(1) harvesters which top the beets while still in the ground, then lift them either by plows or rotating wheels elevating them directly into trucks or carts (Figure 31, page 128);

(2) harvesters which lift the beets with foliage, then guide them, either by spiking the crown or holding the tops to the topping unit from where the topped beets fall into an elevator for transport to trucks or carts.

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[9]As soon as they are lifted the beets begin to lose weight as the moisture in the root dries out. This loss becomes appreciable after a period of a few hours. It is desirable to finish the harvest operations and have the beets delivered as soon as possible once they are lifted.

Figure 27

Prior to the mechanization of the harvesting operations the beets were loosened by beet lifters after which the toppers pulled the roots by the tops and threw them in piles. Usually twelve rows were thrown together in a windrow across the field. The beets were then topped. By first piling the beets, much of the soil was knocked off. (Field workers near Rosenfeld, October 1951).

Figure 28

Much hand labour was used to top the beets. A long knife which had a curved hook at the end with which they spiked the beets from the ground was used. The top growth was removed at the lowest leaf scar. (High school students near Horndean, October, 1955).

Figure 29

Fall harvesting after early snowfall near Niverville, October, 1959.

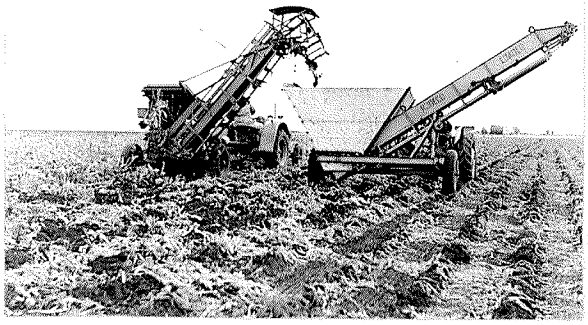

Figure 30

When the beets are ready for harvest mechanical harvesters cut off the tops and dig up the beets and throw them into hoppers from where they are elevated into the farmer's truck. Various types of harvesters are in use; two types are shown in figures 29 and 30. In Figure 30 harvesting done south of Plum Coulee, October, 1955.

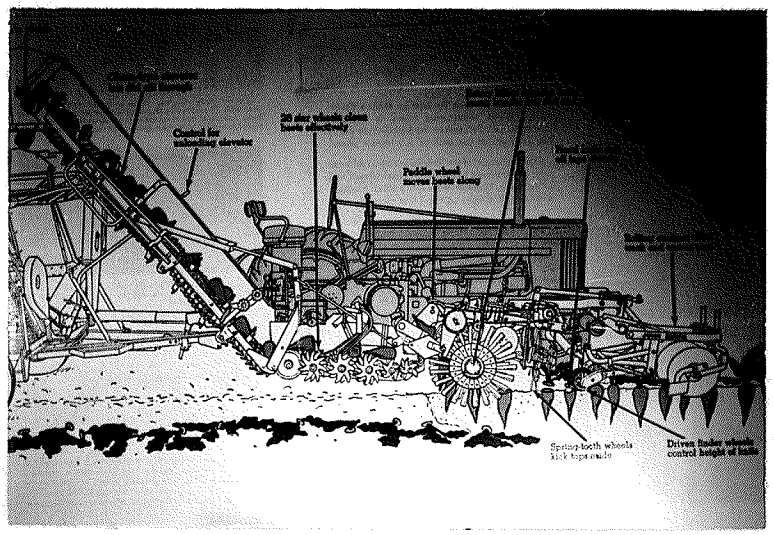

Figure 31

The mechanical harvester shown tops the sugar beets as they stand in the ground, after which the rotary lifters lift the roots and discharge them onto a carrier to be elevated into the farmer's truck. This type was developed in 1955.

Most of the harvesters will cover a minimum of three acres per day; two-row machines will cover approximately one acre per hour. Recently a trend has developed towards multiple row machines. In 1960 the number of single row machines dropped by twenty-seven while the two-row machines increased by four and the number of three-row harvesters increased by eight. It is expected that the multiple row harvesters will increase in numbers in the future.[10]

The most important advantage gained from the use of mechanical harvesters other than the saving of hand labour is that they lend themselves to the immediate delivery of freshly lifted beets to the storage piles. Weathered or wilted beets, being subject to substantial loss in weight, reduce the income of the grower and create serious storage problems. In hand-harvesting, lifting and topping should be restricted to an amount that can be delivered the same day to the receiving station or piling yard.

Crop rotation. A well planned farming system includes an orderly scheme of crop rotation, which is employed to provide definite beneficial results not only to a given crop but also to all crops grown. The major benefits to be derived from a good system include:

1. conservation of soil fertility,
2. less damage by diseases and insects,
3. better weed control,
4. more even distribution of the labour load in crop production throughout the season,
5. abundant feed for livestock, encouraging the inclusion of livestock in the farm program,
6. a more varied source of farm income,
7. distribution of risk from weather, diseases and insects.

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[10] Manitoba Sugar Beet Bulletin, Spring, 1960.

In the Red River Valley the most common rotation on a farm producing sugar beets begins with bare summerfallow, followed by a crop of sugar beets. Of the 112 sugar beet growing farms studied by Dr. J.C. Gilson 77 per cent of the total acreage of sugar beets was grown on summerfallow while only 8.8 per cent was grown on fields which in the previous year grew sugar beets.[11] Beets require a considerable amount of moisture and this is one reason why, in Manitoba, sugar beets follow summerfallow in the rotation.[12] Two or three crops of grain usually follow the sugar beets. The two or three crops of grain usually consist of wheat, barley, or oats, with wheat following sugar beets.[13] A few farmers drill in sweet clover with the last crop before summerfallow which is plowed down as a green manure crop the following year. According to Dr. J.C. Gilson's study only 1.6 per cent of the total acreage of sugar beets grown on the farms under study followed sweet clover.[14] The farmers who use both sugar beets and sunflowers include the sunflowers in the third or fourth year of the rotation.

The agricultural officials of the Manitoba Sugar Company recommend that sweet clover used as a green manure crop be included in the crop rotation which includes sugar beets.[15] It helps to maintain and increase soil fertility. More specifically it increases the organic matter and nitrogen content in the soil as well as increasing soil tilth.[16]

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[11] J.C. Gilson, Economic Aspects of Sugar Beet Production in Manitoba, Research Report No. 1, (Winnipeg: Queen's Printer, 1956), p. 12.

[12] The Country Guide, Winnipeg, October, 1947

[13] Sugar Beets, A Dependable Crop for Manitoba Farmers, Manitoba Sugar Company, Winnipeg, Manitoba, p. 21.

[14] J.C. Gilson, op. cit. p. 12.

[15] Manitoba Beet Growers Bulletin, Winnipeg, May 1945

[16] J.O. Culbertson, Sugar Beet Culture in Minnesota, Minnesota Bulletin 349, University of Minnesota, Agricultural Experiment Station, Pp. 6-7.

Figure 32

A poor stand of sugar beets on Osborne soils four miles north of Morris. This was caused by inadequate drainage of excess water. All operations have to cease and weeds grow unmolested. This is one of the reasons why the yields on Osborne soils are lower. The flooding occurred in July, 1956.

Figure 33

Many farmers in the Altona district include sugar beets together with sunflowers in their crop rotation. Notice the sunflowers back of the farmstead south of Plum Coulee, August, 1955.

There are several reasons why a rotation which includes sugar beets is beneficial to farming. First, the beet root system penetrates the ground to a depth of four or five feet (Figure 11, page 64). The greater part of the root system must remain in the ground. After decomposition the supply of the organic matter is increased and the aeration of the soil is improved together with the drainage. An average crop of beets will leave over one ton of roots per acre in the soil. Second, by including sugar beets in the rotation the plant nutrients in the different soil levels are made use of because the sugar beets are a deep rooted plant which is alternated with shallow rooted crops.[17] Third, a sugar beet crop, since it is a row crop, aids in weed control.[18]

Crop pests. Flea beetles, cutworms, sugar beet root maggot, grasshoppers, and beet webworms are the most common insects attacking sugar beets but fortunately those that are liable to cause the most trouble can be readily destroyed if steps are taken to control them when first noticed.

Flea beetles are active little insects appearing in swarms on sugar beet crops during spring and early summer. Species occurring in Manitoba are about 1/12 of an inch in length and are black in colour with a metallic sheen. They eat holes into the leaves of the plants; leaves of young plants are sometimes completely destroyed and in some cases seedlings maybe killed. Beets are generally attacked while still quite small. The best method of control is to spray the crops infested with flea beetles with dichlorodiphenyl trichloroethane (commonly called D D T).[19] The flea

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[17] Manitoba Beet Grower's Bulle tin, Winnipeg, January 1954. See also Sugar-Beet Culture in the Intermountain Area, Bulletin No. 1903, U. S. Department of Agriculture, Washington, D.C., 1942; p. 32.

[18] K. Schreiber, "Sugar Beets," Special Crops for Manitoba, Manitoba Department of Agriculture and Immigration, Winnipeg, Canada, p. 7.

[19] Personal communication with Dave Smith, Manitoba Department of Agriculture Entemologist.

beetles feed on many of our common weeds. Therefore keeping down all our weeds along the fence rows and ditch banks will effectively check the multiplication of this pest.[20] In Manitoba the number of acres affected is limited and the amount of damage done is negligible.

Cutworms cause some crop losses every year. They are about one and one-quarter inches long when fully grown, have soft dull coloured bodies, and curl up when disturbed. They are nocturnal in habit and lie hidden just below the surface of the soil during the day, coming out to feed at dusk and night. In infested fields the worm can usually be found buried in soil near a plant which has just been cut off. They are effectively controlled in small fields by using poisoned bait which is spread as soon as worms in the fields are observed.[21] In large fields cutworm control is achieved by spraying the plants and soil with a solution of toxaphene or chlordane.[22]

Webworm is one of the few insects that has as yet proved serious. It appears first as a little grey-backed diamond shaped moth which lays its eggs in clusters on the under side of the leaves.[23] In Manitoba the eggs will hatch into worms in July and that is when the damage occurs as these worms are voracious eaters and if not poisoned will strip the leaf entirely. Control can be very effective if done at the proper time, before the crop is completely denuded of foliage. Prompt action is necessary to destroy them because they can strip a whole field in a few days.

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[20] Manitoba Beet Growers Bulletin, June, 1946

[21] Manitoba Beet Growers Bulletin, January, 1948

[22] L.A. Jacobson, "Cutworms," Silver Sunshine, Vol. XV, 1956 p. 29.

[23] Manitoba Beet Growers Bulletin, May 1945.

The grasshopper appears in the latter part of July and in August and as a rule migrates to the beet fields after the grain is harvested. By growing beets on summerfallow no hoppers will hatch in the field so the only danger lies along the edges if the adjoining fields are grassy or in stubble.[24] By August beets are so large that damage is slight but if grasshoppers are very numerous some damage may result.

In recent years the sugar beet root maggot has appeared in Manitoba sugar beet fields. This insect feeds on the root causing "bleeding" and wilting which causes a reduction in yield and sugar content. The severest injury occurs in July and August in dry sandy area. The control for this pest is fertilizer treated with heptachlor. The chemical is mixed with the fertilizer which is applied at the time of seeding.[25] It is difficult to state the amount of damage being done by the maggot for the control is very effective, however, the area where this control is recommended is increasing in size.

There is a long list of beet diseases caused by fungi, bacteria, and viruses as well as the dreaded nematodes, round worms, which feed on beet roots. So far Manitoba has been free from nematodes and many of the diseases, the possible reasons being:

(1) that beet growing has only recently been introduced, and

(2) that our severe winters prevent their development.

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[24] Sugar Beet, A Dependable Crop for Manitoba Farmers, Published by Manitoba Sugar Company, Winnipeg, p. 11.

[25] Personal communication with Dave Durksen, Agronomist for Special Crops, Manitoba Department of Agriclture.

Irrigation possibilities. The only sugar beets produced under irrigation in Manitoba at the present are grown by Mr. Kuhl of Morden. The processed sewage from the town of Morden flows, in an open sewer, across his farm and whenever there is a deficiency in the natural water supply he diverts the water from the open sewer onto his sixty acre sugar beet field. Mr. Kuhl's farm is located on soils of the Morden Soil Association which ranges in texture from heavy clay loam to silty clay.[26]

The only area where sugar beets could be produced under irrigation is in the area west of Winkler where the Altona fine sandy loam soils predominate.[27] The "Pembina Project"[28] could possibly supply the water required. However, an increased cost of production would have to be considered. According to Agricultural Officials of the Manitoba Sugar Company, the increase in yield would not compensate for the increase in the cost of production. Furthermore, the precipitation for this region for the period April to October is 15.7 inches which is slightly below the maximum moisture given to sugar beets grown under irrigation. Consequently only in periods of drought is irrigation necessary. There is no further increase in yield if more than eighteen inches of water is added to the fields.[29] These two factors will, no doubt, discourage producers from growing sugar beets under irrigation.

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[26]J.H. Ellis, et. al., Report of Reconnaissance Soil Survey of South Central Manitoba, (Winnipeg: Manitoba Department of Agriculture, 1943), p. 87.

[27]Personal communication from K. Schreiber, Manitoba Sugar Company, Winnipeg, Manitoba.

[28]The "Pembina Project" is a proposed dam on the Pembina River near the International boundary. The reservoir could supply water for irrigation, industrial and municipal use.

[29]Personal communication with J.W. Hall, Manitoba Sugar Company, Winnipeg, Manitoba.

The foregoing was a description of the farm practices related to sugar beet production. When the sugar beets leave the farm they are shipped to the factory where they are stored in huge piles on the factory storage grounds. From there they gradually enter the factory where the final stage of production takes place.

FACTORY PRODUCTION

Location factors of the refinery. The factory which processes the beets was built in 1940 and is located on twelve acres of land in the Municipality of Fort Garry, adjacent to the city of Winnipeg. Fort Garry is endowed with several essential assets which make it favourable for the location of the sugar refinery. It is located close to the source of the raw material, the sugar beet. The refinery is provided with adequate railway and highway connections (See Chapter VII). Another important factor in the localization of sugar factories is the source of water supply. A good supply of water must be readily available. The promoters for the construction of a sugar beet factory at Morris abandoned their enthusiastic plans because of the inadequate supply of water there. To provide an adequate water supply a dam would have to be built.[30] At Fort Garry the Lockport locks back up water in the Red River providing a sufficient supply. The huge quantities of water required (180,000 gallons per hour) are obtained from the Red River, one-half mile east of the plant, through a 14-inch pipe.[31] Furthermore, the proximity of the factory to the city of Winnipeg is of great importance. The reasons for this are discussed in the following paragraphs.

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[30] News item The Morris Harald, July 20, 1939.

[31] New item The Winnipeg Free Press, October 5, 1940.

The mill is in full operation for about 100 days[32] every year and during that period it employs 300 to 400 men in addition to the regular permanently employed staff of 70 to 90 men. These are made up of technicians, highly skilled and trained workers, the shipping groups, and office staff. Much of the temporary labour is drawn from the city where the workers can go to and from their homes each day. Bus service makes the labour market of Winnipeg readily available. It is also significant that the period of highest employment at the refinery coincides with an off-season labour period.

Winnipeg provides a ready market for much of the sugar produced with a minimum of freight rates and transportation costs.[33] Minor factors involved in the location of the sugar refinery are, the provision of facilities for waste and water disposal, adequate room for expansion, and the availability of hydro-electric power without lengthy overhead wires.

During the first year of operation the plant had a daily slicing capacity of 1,500 tons of beets;[34] at the present it has an enlarged capacity of approximately 2,400 tons of beets.[35]

The refinery requires, during 24 hours of operation 400 to 450 tons of coal obtained from the Saskatchewan lignite coal mines at Estevan, 80 to 90 tons of limerock, and eight to nine tons of coke which is purchased

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[32]The perishability of sugar beets once they are harvested makes it necessary to complete the processing of the beets within a relatively short period. This means that the factory is operated only for about 100 days during the fall and early winter. For the remainder of the year the factory is idle.

[33]See Chapter IX Marketing of Refined Sugar (page 149).

[34]News item in The Winnipeg Free Press, October 5, 1940.

[35]Phamphlet prepared by the Manitoba Sugar Company. Improvement in the operations of the plant are made from year to year which have increased the capacity somewhat. In 1960 the capacity was 2,700 tons of beets per day.

in Winnipeg. During the same period of operation it produces 4,000 to 7,000 - 100 pound units of sugar, 2,000 to 2,500 - 100 pound units of dried beet pulp and 85 to 95 tons of molasses.[36] During a season of operation the plant consumes about 40,000 tons of coal, 1,750,000 gallons of fuel oil to generate power, 1,000 tons of coke to burn the limerock, 8,000 tons of limerock. The limerock is brought in from Moosehorn, Manitoba and then processed in a kiln at the local plant.

Factory ownership. Source of raw material, marketing of finished product, transportation facilities, labour, and materials required in the processing are all important in the successful operations of the factory. Also of importance is the ownership of the factory. The Manitoba Sugar Company was incorporated on November 8, 1939 and by March 31, 1941 all the preferred and common shares had been sold and issued to persons in Manitoba, and elsewhere in Canada as well as to persons in New York. Among the shareholders were Baron C. Neuman de Vegvar of New York and Baron P.G. Kronacker of Brussels. Apparently Baron Kronacker had been connected with the sugar industry in other parts of the world. The iversity of interests of the many shareholders appeared to create some difficulties at times in arriving at commonly shared goals as to the management and direction of the company.[37]

Just prior to the time when the British Columbia Sugar Refinery Company gained control of the company the ownership of the common stock

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[36] Ibid.

[37] Restrictive Trade Practices Commission Report Concerning the Sugar Industry in Western Canada, Department of Justice, (Ottawa: Queen's Printer, 1957), p. 49.

was in three groups, the "Winnipeg group," Baron Neuman, and Baron Kronacker. In 1955 the B.C.S.R. Company gained control of the company when the "Winnipeg group" agreed to support the B.C.S.R. Company's bid for control. Later the balance of the shares were offered to B.C.S.R. Company. However, since the Restrictive Trade Practices Commission, Department of Justice in Ottawa began its inquiry the B.C.S.R. Company decided not to buy more shares until the result of the inquiry was known.[38]

On August 8, 1960 Chief Justice Williams handed down the judgment declaring that the B.C.S.R. Company was not guilty of attempting to form a combine. He further declared that the existing situation was not harmful to public interest in Manitoba nor to the interests of the consumers or the beet producers. The chief justice found no evidence that:

1. the price of sugar was inflated in Western Canada;
2. the productive capacity of the refineries was reduced;
3. the merger had stifled competition in the western provinces; and
4. there existed attempts to control the price at which the companies buy the beets grown by the farmers.[39]

W.R. Hetherington, General Manager of the Manitoba Sugar Company in his statement to the Manitoba Beet Growers Association, January 1962 said that "the successful conclusion of the case has now permitted us to proceed with long planned modernization projects."[40, 41] He goes on to say that

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[38]Editorial in the Winnipeg Free Press, February 6, 1957.

[39]News item in the Winnipeg Free Press, August 9, 1960.

[40]W.R. Hetherington, "Manitoba Sugar Company Comment, "Proceedings of the 22nd Annual Meeting of the Manitoba Beet Growers Association, (Winnipeg 1962), p. 17.

[41]Since the conclusion of the 'combine case' the Manitoba Sugar Company has begun the expansion of their warehouse facilities.

"we are grateful for the Growers' assistance and support through the trying years that this affair covered."[42] He stated that "although our industry is faced with important and difficult problems we believe that the future can be viewed with confidence."[43]

Operations. From the huge piles the beets are loaded by dragline into railway cars (gondola type) from which they are dumped into a flume and a stream of water carries them into the plant. Since the specific gravity of sugar beets is only a little greater than that of water, they move along with the current. Before the beets enter the beet washer and slicer a trash catcher is employed to remove foreign material such as soil, trash, weeds, and stones. The beet washer thoroughly washes the beets before they are elevated by the beet elevator to the slicers. The beet slicers cut the beets, by revolving knives, into long, slender V-shaped slices known as "cossettes" which are then discharged into automatic beet scales after which they are conveyed to the "diffusion battery". The diffusion battery consists of fourteen "cells" or tanks which are filled in rotation with cossettes. By bringing the sliced beets into contact with warm water and circulating the solution from one cell to the other the juice from the cossettes is by diffusion efficiently extracted and a dark purple colored solution is obtained which is called "raw Juice". After the juice is removed the cossettes are called pulp, and are dumped out of the bottom and pumped to the pulp presses. The purification of the juice is the most difficult and at the same time the most interesting step in the process of preparing sugar for the market. First, the juice enters the

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[42] W.R. Hetherington, op. cit. p. 17.

[43] W.R. Hetherington, op.cit. p. 17.

carbonation tank where the "milk of lime" and carbon dioxide are introduced. The lime is partially soluble in solutions of sugar; hence part of the lime goes into solution and reacts with some of the impurities present in the juice. The CO_2 gas is used to remove the lime more readily. The carbonated juice then flows to the "Dorr" settling tank where the lime sludge settles to the bottom and the juice overflows to the second carbonation tank. Here additional impurities in the juice are removed. The juice is then filtered after which sulphur dioxide is blown through the juice for clarification purposes. After the juice has been boiled it is again filtered; the juice then goes to the evaporators where it is concentrated to a syrup containing from 50 to 60 per cent sugar. The syrup is than boiled under vacuum until sugar crystals form. As the process continues, the crystals increase in size. This operation continues until the sugar crystals are the desired size. After the crystalization is complete the crystals are separated from the surrounding syrup by centrifugal action. The sugar from the centrifuges is dried by hot air after which the sugar is put over screens to separate the various sized crystals and is then sacked and stored in the sugar warehouse for future shipments.

BY-PRODUCTS

Three by-products of value to livestock feeders result from the beet-sugar industry - beet tops, pulp, and molasses. These by-products have a considerable content of elements of animal nutrition such as protein, carbohydrates, and fats, besides being an excellent bulk-feed, stimulating to the appetite and digestion. The complete utilization of the sugar beet by-products is not yet fully recognized in Manitoba. From year to year the

number of farmers taking advantage of beet tops is increasing but on the whole, pulp and molasses are sold chiefly in the United States and in Eastern Canada. Only a very small percentage is sold to farmers in Manitoba.[44]

Sugar beet tops. Sugar beet tops include not only the leaves, but also an appreciable portion of the crown which adds considerably to the weight and feeding value of the tops. Beet tops are relatively high in protein and their highest feeding value lies in their use for growing and fattening animals. However, in contrast to many of the sugar beet producing areas in Eastern Canada, Alberta, and the United States where beet tops are a more important item in livestock feeding, only a small proportion of the tops are utilized for feed in Manitoba.

Despite efforts of the Manitoba Sugar Company to promote the feeding of beet tops, little progress has been made in this direction.[45] There are several reasons for this apparent lack of interest on the part of the producer:

1. most of the beet producing farms are organized on a cash crop basis and considerable reorganization and investment in shelter and equipment would be required to carry a feeding enterprise;
2. relatively few growers have a background feeding experience;
3. growers are not convinced that the additional returns would be sufficient to compensate for the extra expense and effort;
4. the harvest season in this area is relatively short, consequently growers are anxious to get their beets harvested ahead of snow and freezing weather, leaving little opportunity to take care of the tops under favourable weather conditions; and finally
5. beet tops have some value when plowed under for fertilizer.

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[44]Personal communication with J.W. Hall, Agricultural Superintendent, Manitoba Sugar Company, Winnipeg.

[45]Manitoba's Beet Growers Bulletin, September, 1948.

Tops from each ton of beets contain about the following amounts of fertilizing elements:

Nitrogen (N)	5.4 pounds
Phosphoric acid (P_2O_5)	1.1 pounds
Potash (K_2O)	14.0 pounds[46]

There are three principal methods commonly practiced in the utilization of the tops. They are: (1) pasturing the cattle on the harvested fields; (2) curing the tops by placing them in small piles in the field and later hauling them into the feed yards; and, (3) siloing the fresh tops. The first two methods are the most commonly practiced by Manitoba growers.

Beet pulp. The residue after the beet roots have been sliced and the sugar extracted by the diffusion process is called beet pulp. In its original state the pulp contains five to seven per cent dry matter, with the remainder being water. For longer preservation and more economical transportation of this feed, the Manitoba Sugar Company dries the pulp, thus producing a concentrate containing only eight to ten per cent water and ninety to ninety-two per cent dry matter. This allows it to be stored for a considerable length of time without danger of its deteriorating. A hundred pounds of dried pulp contains approximately the same amount of digestible nutrients as a hundred pounds of oats. In addition to its feed value, the beet pulp has a further advantage in that it is very palatable and succulent.[47] The general practice is to use the pulp as a fattening feed and is, consequently, used to finish feeder steers.

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[46] L.E. Dunn and C.O. Rost, Yield and Nutrient Content of Sugar Beet Tops, Minnesota Agricultural Station Bulletin No. 391, June, 1946, p. 31.

[47] Manitoba Beet Growers Bulletin, September, 1948.

Beet Molasses. This is also a by-product from the extraction and refining of sugar. When all the sugar that can be crystalized out of the juice obtained from the beets is removed, the remainder consists of uncrystalized sugar and minerals, and is called molasses. Sometimes molasses is fed alone, but usually it is mixed with other feed, such as hay, straw, pulp, or beet tops. The palatability of all of the coarser feeds mentioned is greatly improved by mixing them with molasses, and are fed with much less waste than fed without molasses. Beet Molasses is also used in industry for industrial alcohol purposes. The Manitoba Sugar refinery produces about 10,000 tons of beet molasses and about the same quantity of beet pulp annually. Prior to 1961 the major market for molasses was in Eastern Canada and in United States. During 1961 the Manitoba Sugar Company expected to sell all of their production of molasses in Manitoba and thereby realize a saving in freight costs.[48]

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[48]Proceedings at the 22nd Annual Meeting, Manitoba Beet Growers Association, Winnipeg, Manitoba, January 18, 1962.

Figure 34

Cattle feeding on sugar beet tops near the village of Niverville, October, 1954.

Figure 35

Remaining on the field after the beets have been topped and delivered are the tops of the beets. Grazing in the field is the simplest means of feeding the tops. They maybe easily gathered with a fork and hauled to the farmyard for curing, after which they maybe used in the feed lot as needed in the winter. Here a farmer near Niverville is gathering a truck load of beet tops, October, 1956.

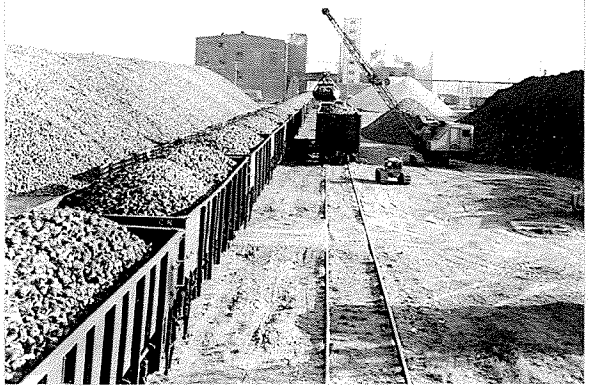


Figure 36

Sugar beets are loaded into railway cars from the huge storage piles in the yard. The beets are then dumped into the main flumes where they are washed by water into the refinery at Fort Garry. (November, 1955).

Figure 37

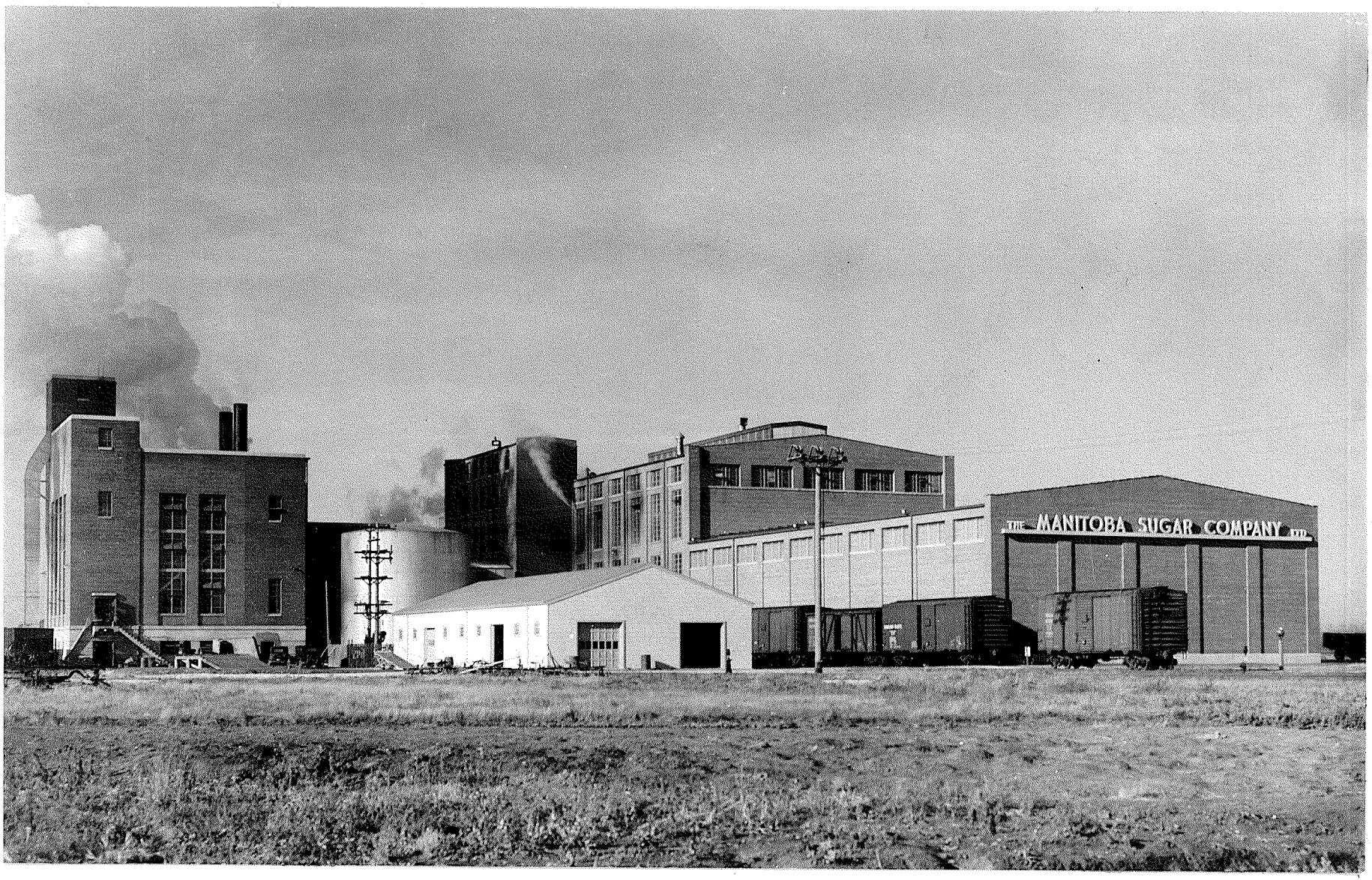
From the refinery trucks move the finished product to the wholesalers. Besides supplying great amounts of sugar to the baking and confectionary trades, the company has its packaged products sold throughout the province. (Fort Garry, November, 1955).

Figure 39

Side view of the Manitoba Sugar Beet Company factory at Fort Garry

The factory was built in 1940 with a capacity of 1,500 tons of beets per day. It has since increased to 2,400 tons per day.

(Courtesy of Manitoba Department of Industry and Commerce)


THE MANITOBA SUGAR COMPANY LTD.

CHAPTER IX

MARKETING OF REFINED SUGAR

In the fall of 1940 Manitobans had the first opportunity to purchase and use sugar produced in their own province by Manitoba citizens. In that year 221,000 cwt. of sugar were produced.[1] The annual output of the refinery during the last five years varied from 400,000 to 690,000 cwt. of sugar.[2] The annual consumption of sugar in Manitoba is approximately 750,000 cwt.[3] Granulated sugar constitutes the largest part of the production of refined sugar in Manitoba. The plant produces pulverized sugar, icing (with starch added) and loaf sugar. Brown sugar, which constitutes from ten to twelve per cent of the total sugar consumption in Canada, is produced only from cane sugar.[4]

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[1] The Story of Manitoba's Agriculture, Manitoba Department of Agriculture, (Winnipeg: Queen's Printer, 1952), p. 20.

[2] Report on Crops, Livestock, etc. 1960, Department of Agriculture and Conservation, Winnipeg, (Winnipeg: Queen's Printer, 1961), p. 37.

[3] Restrictive Trade Practices Commission Report concerning the Sugar Industry in Western Canada, Department of Justice, Ottawa, (Ottawa: Queen's Printer, 1957), p. 66.

[4] The Sugar Refining Industry, 1959, Dominion Bureau of Statistics, (Ottawa: Queen's Printer, 1960), Pp. 1-4.

MARKET AREA

The beet sugar industry in the Prairie Provinces is hemmed in by freight rates, and has a limited though fairly certain market. In Manitoba the primary freight advantage is that represented by the freight charges from Montreal to Winnipeg. Because of the lower cost of transportation by boat during the navigation season on the Great Lakes, actual freight charges are higher in winter than in summer. The market area of the sugar produced in Manitoba includes part of northwestern Ontario, all of Manitoba, and part of eastern Saskatchewan.[5] The size of the market area fluctuates from year to year; it is dependent on the amount of sugar produced in Manitoba, cost of raw cane sugar, and the cost of transportation. The Manitoba Sugar Company has sold sugar in the City of Saskatoon, however, this is the western extremity of its market region.[6] The fluctuation of the eastern market area is dependent on the cost of transportation from the eastern refineries and storage costs at the Lakehead. During the period of navigation on the Great Lakes eastern sugar can penetrate farther into this area than during the winter months when sugar has to be shipped by rail or supplied

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[5] News item in The Winnipeg Tribune, August 27, 1949.

[6] Personal communication with Mr. J.W. Hall, Manitoba Sugar Company, Winnipeg, Manitoba.

from storage stocks at the Lakehead. Then, too, the costs of storage also becomes a factor. Since the market area for Manitoba sugar extends into Western Ontario and Eastern Saskatchewan the sugar produced in Manitoba supplies only about one-half of the needs of the Province.[7] During 1954 when the total sales of sugar were 73,886 thousand pounds the Manitoba refinery supplied fifty-four per cent, the Alberta refineries supplied twenty-one per cent, the Ontario refineries fourteen per cent, the Acadia - Atlantic refinery eight per cent; the St. Lawrence Sugar Company and the British Columbia Sugar Refinery in Vancouver each supplied two per cent.[8]

A large percentage of the refined sugar produced in Manitoba is marketed in Greater Winnipeg, where the market serves an urban population of approximately 409,000 in addition to the requirements of the biscuit and confectionery industry, the carbonated beverage industry, and the bread and other bakery products industry located there.[9] The Manitoba Sugar Company gets its sugar into the City of Winnipeg for 6¼ cents per one hundred pounds. Consequently, it gets its very highest net return from selling in Winnipeg. Substantially, over half of Manitoba's sugar consumption is right in Winnipeg.[10]

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[7] News item in The Winnipeg Free Press, July 9, 1955.

[8] 1954 was the latest year for which figures were available. See Table XX, Appendix C, p. 197 for the approximate percentage of annual sales in Manitoba by individual refineries for the years 1940 to 1954.

[9] The industries mentioned plus the fruit and vegetable preparation industry consume eighty per cent of all the sugar used in manufacturing in Canada.

[10] Restrictive Trade Practices Commission Report, op. cit. p. 169.

Since the refinery in Manitoba has been under the control of the British Columbia Sugar Refinery they (the company) have attempted to influence the sale of Manitoba sugar and sugar from the Alberta refineries in their most remunerative markets.[11] Under the railway freight rates for sugar which existed in 1956 there are considerable sections of Saskatchewan to which freight costs from Winnipeg are less than from refineries in Alberta.[12] This means that the net return to the refinery in a number of instances is greater at the plant at Winnipeg than at factories in Alberta. If there is further expansion in the production of beet sugar in Manitoba, the east Saskatchewan market might well increase in importance as a market for Manitoba sugar.

PRICING OF REFINED SUGAR

The general pattern of determining the price of refined sugar in Western Canada is one of adding the cost of transportation to any point, to the price at two refining centres, Vancouver, and Montreal. Price of sugar from west to east is determined at each point in relation to the freight cost from Vancouver until a point is reached where that price would exceed the cost of sugar shipped from Montreal. From that point and farther east prices are based on Montreal prices plus the cost of

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[11] Restrictive Trade Practices Commission Report, p. 168.

[12] See Table XXI, Appendix C, p.198 where the net returns at the refinery for shipments of sugar to various cities and towns in Saskatchewan and Manitoba are given.

transportation.[13] This is the general method of pricing. The actual structure of prices is more complex than this description would suggest.

In Saskatchewan the price of sugar determined from Vancouver meets the price made up from Montreal. Thus, the price of Manitoba sugar in Saskatchewan is determined by the base price at Winnipeg plus freight. The base price at Winnipeg is determined as outlined in the previous paragraph. Actually the prices in Manitoba distribution points are set by the cost of sugar in Montreal plus equalized freight rates which is between the cost of ship transportation and land transportation.[14] The cost of transportation involved here is the freight to the Lakehead either by water or rail, the cost of storage at the Lakehead if stocks are piled there, and the cost of rail transportation from the Lakehead to Winnipeg.[15] The price of beet sugar produced in Manitoba is determined without regard to the actual cost of production and transportation from the factory. This means that the net return to the refinery in Manitoba from the sale of its sugar varies and depends on the amount of freight charges included in the price of cane sugar.

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[13] Restrictive Trade Practices Commission Report, op. cit. p. 68.

[14] Restrictive Trade Practices Commission Report, op. cit. p. 68.

[15] Editorial in The Winnipeg Free Press, June 6, 1957

DEMAND FOR SUGAR

The per capita consumption of sugar for Canada varies slightly from year to year. During the past ten years the consumption varied from a high of 103.5 pounds per capita to a low of 92.8 pounds. The average for the ten year period was 96.8 pounds per capita per year.[16] The per capita consumption figures for various parts of Canada are affected by the location of the principal industries consuming sugar in manufacturing. The canning industry, the beverage industry, the confectionery industry, and the bakery products industry account for over eighty per cent of the sugar used in manufacturing. Approximately one-half of the sugar sold in Canada goes to the food industries. The other half is used for domestic consumption.[17]

What will be the future demand for sugar in Canada and in the Province of Manitoba? According to the Yearbook of Agriculture on Food, 1959, the average per capita consumption of sugar may remain about constant in the years ahead.[18, 19] This forecast or prediction is perhaps fairly reliable if one considers what the per capita consumption has been in the past. Therefore, any enlargement of supply will be necessitated

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[16] The Sugar Refining Industry, Dominion Bureau of Statistics, (Ottawa: Queen's Printer, 1960), p. 5.

[17] News item in the Financial Post, October 31, 1959.

[18] O.V. Wells, "The Years Ahead", Year Book of Agriculture on Food, 1959, United States Department of Agriculture, p. 706.

[19] Dr. Henry Hass, President of the Sugar Research Foundation stated that as long as sugar is used for food only, the demand can grow only with the population.

to provide for the need of an expanding population only. The future population of Canada and Manitoba as predicted by the Royal Commission on Canada's Economic Prospects is 26,800,000 and 1,240,000 respectively by 1981. The total demand for sugar in Canada by 1981, based on the two foregoing assumptions is 2,680 million pounds per year, an increase of approximately one billion pounds. The demand in Manitoba will probably increase from 75 million pounds to 120 million pounds per year by 1981. This represents an increase of 55 million pounds over the present needs.

The constant demand for sugar in Canada provides stability to the sugar market. However, while sugar from sugar beets is now being produced in Alberta, Ontario and Quebec as well as Manitoba[20] the real competition for sugar markets comes from cane sugar brought in from the West Indies and the South Sea Islands. This is imported in the raw state at low duty rate and refined at the east and west coasts of Canada and at Montreal and Toronto.

Can sugar be used for any purpose other than food? According to Dr. Henry Hass, President of the Sugar Research Foundation, sugar can be used as a raw material for the manufacture of plastics, detergents, paints, insecticides, and other products.[21] The use of sugar in the manufacture

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[20] See Table XV, Appendix C, p.192 for the relative importance of the sugar beet industry in the four provinces.

[21] Manitoba Beet Growers Bulletin, April, 1956.

of detergents could create a greater demand for sugar. Research is being done to determine how effectively and economically sugar can be used in the manufacture of detergents. However, it is premature to state that effect such research will have on the future demand for sugar.

CHAPTER X

CONCLUSION

Sugar beets have been grown on a commercial scale in the Red River Valley for over twenty years. During this period changes in areas of production, as well as in methods of production have occurred as a result of the physical and cultural factors.

When sugar beets were first grown on a commercial scale in the province, the acreage was more or less uniformly distributed over the Red River Valley. Since that time sugar beet production has gravitated towards particular districts. There have been several factors responsible for this shift to these districts. First and foremost is the importance of the proximity to the processing plant. Prior to the mechanization of the harvesting operations the available supply of labour had considerable influence on the location of sugar beet production. The suitability of the soil is of prime importance in this shift. There has been a marked tendency to locate sugar beets on the better-drained medium textured soils. This seems to indicate that these soils are more suitable to the commercial production of sugar beets. Accompanying this shift to more suitable soils is a trend towards higher levels of yield of sugar beets. During the second decade of production the average yield has increased to 9.67 tons per acre; the average yield during the first decade was 8.01 tons per acre. It is believed that this trend will continue.

While the sugar beet industry has responded favourably to the climatic conditions in Manitoba the climate sets rigorous controls on the quantity (in tonnage per acre) and quality of the beets produced. In the Red River Valley the growing season is about forty-five days shorter than the optimum length and the temperatures during the growing season are approximately five degrees below the optimum temperatures. These deviations from the optimum climatic conditions are reflected in a lower quantity of sugar which is produced from any one given acre of beets.[1] However, it is felt that these deviations are partially compensated for by the long hours of sunshine and the greater fluctuations between day and night-time temperatures. Normal precipitation in the areas of sugar beet production is slightly over the lower limits necessary for the successful production of sugar beets. There is a wide annual deviation from the long term average precipitation and the production of a high yielding sugar beet crop is on occasion and in certain areas impeded by excess moisture. In certain years the yields were depressed because of a lack of moisture during the growing season. Climate also controls to a large degree the length of time the refinery can operate. However, with increasing technology some of these limitations will probably diminish.

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[1] See Tables XV and XVI in Appendix C, pages 192 and 193 for a comparison of yield per acre for United States, Alberta, Manitoba, Ontario, and Quebec. The amount of sugar beets produced from a given area is also influenced by the amount of sunshine received, moisture conditions, soils, cultural or management practices as well as others.

New machines and techniques are bringing about important changes in the production of sugar beets. Since mechanical harvesting has proven to be efficient and economical, Manitoba growers have readily adopted it. In 1960 over ninety-nine per cent of the acreage was harvested by machine. The greatest opportunities for further mechanization are in the spring operations. Much effort is being made by all the segments of the industry to mechanize thinning and blocking operations. Perhaps hand labour requirements may be reduced to a single hoeing operation.

In assessing the future possibilities of the sugar beet industry in Manitoba, one question arises. Is there room for further expansion of the production of sugar beets?

While the Red River Valley has a longer growing season than many other areas in the arable portion of the province it is felt by Manitoba Agronomists that climate would not seriously restrict the expansion of sugar beet production.[2]

Soils suitable for the production of sugar beets exist in Manitoba, particularly in the Red River Valley and in the Brandon area. In the Red River Valley there are about 40,000 acres that have soils well suited to the production of sugar beets. An additional 48,000 acres have soils that are less suitable for growing sugar beets but on which they can be produced economically under normal climatic conditions and good management.[3] In the

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[2]Sugar beets have been grown at The Pas as shown by a limited number of experiments. (See page 29).

[3]Based on Soil Productivity Maps prepared by the Manitoba Department of Agriculture and the Manitoba Soil Survey. Acreages of arable land was based on the Provincial-Municipal Assessment Branch estimates. This figure takes into account the fact that only about one-sixth of the farm is usually devoted to sugar beets.

Brandon area there are approximately 40,000 acres suitable for sugar beet production.[4]

Presently the market for sugar beets is restricted to the capacity of the local plant. Acreages are subscribed by contract only and the contract demands by producers have exceeded the requirements of the processing plant. The factory has at present a capacity of 2,400 tons of beets per twenty-four hour period. It is able to process sugar beets produced on 30,000 acres. In 1960 the applications for sugar beet contracts exceeded the maximum acreage capacity of the refinery. There are several reasons why contract demands have exceeded the requirements of the local factory. First, the price paid for sugar beets is attractive in comparison with the cost of production. Second, it is a cash crop, there are no troublesome restrictions in deliveries. Third, due to increased mechanization, the labour shortage is no longer acute. Fourth, there is developing an increased interest, by sugar beet growers, in livestock feeding.[5,6]

The expansion of the industry will depend largely on whether or not the sugar can be produced at a cost lower than or comparable to the price of canesugar. According to A.M. Robertson, Vice-President of the company that controls the Manitoba Sugar Company stated that the company (Manitoba Sugar) "should slowly increase (its production) with the growth

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[4]Estimated by E.A. Poyser, Soil Specialist with the Manitoba Department of Agriculture, This figure also takes into account the fact that one sixth of the farm is normally devoted to sugar beet production.

[5]Manitoba Beet Growers Bulletin, Winnipeg, January, 1954.

[6]Proceedings of 22nd Annual Meeting, Manitoba Beet Growers Association, Winnipeg, Manitoba, January 18, 1962.

in population."[7] By 1980 Manitoba will require approximately 124 million pounds of sugar,[8] and assuming that the local source will continue to supply fifty per cent of the demand there will be room for expansion of local refining capacity to 62 million pounds of sugar in Manitoba alone. In 1955 the Manitoba Sugar Company sold 43.7 million pounds in Manitoba. As a whole the future growth of the sugar beet industry in Manitoba will depend largely upon production and marketing costs in relation to the price of imported cane sugar and upon the tariff imposed on it in our sugar production system.

The expansion of sugar production by establishing a beet sugar refinery in Saskatchewan is a possibility. In the past sugar beet production has not occurred in Saskatchewan largely be cause of lack of sufficient precipitation. However, with the completion of the South Saskatchewan River dam there is a possibility that sugar beets may be produced under irrigation. A research and demonstration irrigation farm has been established near the South Saskatchewan River project which will study the possibility of growing sugar beets under irrigation.[9] If sugar is produced in Saskatchewan this will most likely mean a loss of the western portion of the present market area.

In conclusion the writer would like to point out that nationally

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[7]Restrictive Trade Practices Commission Report Concerning the Sugar Beet Industry in Western Canada, Department of Justice, Ottawa, Canada: Queen's Printer, 1957), Pp. 163-164.

[8]See Chapter on Marketing, page 155.

[9]MacNeill, Phyllis, "They are Changing the Face of Saskatchewan," Canadian Geographical Journal, May, 1960, p. 165.

the objective in maintaining a domestic sugar industry has, it seems, been accepted. However, the question, How large a domestic sugar industry is it desirable to foster as a matter of public policy? is subject to constant debate. The answer as reflected by the policy of the federal government reflects the competition between foreign and domestic interests, between beet sugar and domestic cane sugar interests, and also between the conflicting interests of the producers and those of the consumers.

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APPENDIX A

A BRIEF HISTORY OF THE SUGAR BEET INDUSTRY

Sugar comes from many sources but the two most generally used are sugar cane and sugar beets. The extraction of sugar from beets dates back to 1747, when Andreas Marggraf, A Prussian Chemist and physicist in the Royal Academy of Science and Literature of Berling University, discovered that sugar possessing identical chemical and physical properties with that of sugar obtained from sugar cane could be extracted therefrom. This discovery attracted very little attention and was regarded for many years as being merely a laboratory determination of little practical value. In 1784 Franz Carl Achard, a student of Marggraf and later his successor, obtained financial aid from Frederick the Great, with which he resumed the laboratory researches commenced by Marggraf and undertook to improve the methods employed in sugar beet culture. With a grant of land and money from Fredrick William III, who succeeded Frederick the Great as king of Prussia, Achard erected the first real beet sugar factory in the world at Cunern, in the province of Silesia, Germany, where the extraction of sugar from the beet root, on a commercial scale, was begun in 1802.[1] The factory operated until 1807 when it was destroyed by fire, however, in the meantime the king had supplied money for the construction of other beet sugar factories in Brandenburg, Silesia and Pomerania.

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[1]George H. Coons, "Beet Sugar", The Encyclopedia Americana, Canadian edition, Vol. III, Pp.432 - 433.

The French beet sugar industry was established as a result of Napoleon's decree of March 25, 1811 which directed that 79,040 acres of land be devoted to sugar beet culture within a period of not more than two years. In addition the decree prohibited the importation of sugar from the West Indies after January 1, 1813. As a result of the decree issued by Napoleon three hundred and thirty-four beet sugar factories were erected in France during the years 1812 and 1813. With the fall of Napoleon and upon the revival of colonial trade the beet sugar industry west into a state of collapse. It was not revived until 1840 when the Imperial beet, far more rich in sucrose than the White Silesian from which it undoubtedly was derived, was introduced. By 1854 the production of beet sugar equalled the tonnage of sugar imported from foreign countries and within a comparatively short time the countries of Europe were able to export beet sugar in large quantities. In normal times the beet sugar factories in Germany, France, Austria, Hungary, Poland, Czechslovakia, Bulgaria, Rumania, Yugoslavia, Belgium, Holland, Italy, Spain, Russia, Switzerland, Denmark, Sweden and Great Britain, produce approximately 9,500,000 short tons of beet sugar annually.

The early stages of the growth and development of the sugar beet industry in the United States were marked by numerous failures and set backs. The first beet sugar factory was established in 1838 at Northampton, Massachusetts, but after producing 1,300 pounds of sugar the enterprise was abandoned. Similar attempts, in the next few decades,

were made in Illinois, Michigan, Wisconsin and other states. Notable among these was the attempt made by John Taylor of the Mormon Church to establish the industry in Utah. In 1852 he ordered the heavy equipment for a complete sugar factory from France which was trekked from St. Louis across the Great Plains to Salt Lake City by ox team. All of these early attempts were unsuccessful. The real beginning of the beet sugar industry was made in 1870 in Alvarado, California when the first successful beet sugar factory was erected. Later this factory was rebuilt enlarged and finally modernized in 1936. It has run successfully ever since and can be considered the parent factory of the American industry. In the next two decades many factories were erected and by 1890 the record showed that nearly a score of factories had been built, but only the parent factory at Alvarado, one nearby at Watsonville, and one at Grand Island, Nebraska remained. In the thirty year period from 1890 to 1920, 130 sugar beet factories were built in various agricultural centres, from Michigan and Ohio westward. As of 1953 there were 85 beet sugar factories in the United States, and nearly 1,000,000 acres of land is devoted annually to the production of sugar beets, from which approximately twenty-five per cent of all the sugar consumed annually by the people of the United States is extracted.[2]

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[2]The Story of Beet Sugar From the Seed to the Sack, (Michigan: Farmers and Manufacturers Beet Sugar Association, 1953), p. 4.

The production of sugar beets in Canada started about 1890 in the province of Quebec. Two large factories were established at Farnham and Coaticook with the aid of the Dominion Government. This bold attempt had to be abandoned and at present Quebec has only one comparatively small factory which was built in 1942 and is located in the St. Hilaire area of the Eastern Townships. It has a daily slicing capacity of 1,500 tons of beets.[3] In 1958 it processed about 65,000 tons of beets produced from 6,000 acres.[4] After the year 1899, experiments conducted in Southern Ontario established the fact that the soil and climate were suitable for the growing of sugar beets. In 1902 bounties from the Provincial Government made possible the operation of four beet sugar factories: the Ontario Sugar Company of Kitchener, the Dresden Sugar Company, the Wallaceburg Sugar Company, and the Wiarton Beet Sugar Manufacturing Company.[5] The bounties expired in 1909 and the factories, with the exception of the one at Wallaceburg, were forced to close. The refinery at Wallaceburg was adapted to the production of cane sugar and this permitted a longer operating period. In 1916 the Wallaceburg Sugar Company established a sugar beet refinery at Chatham which is still existing. The Wallaceburg

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[3] Restrictive Trade Practices Commission Report, Department of Justice, Ottawa (Ottawa: Queen's Printer, 1957), p. 13.

[4] "Sugar Beets and Beetroot Sugar," The Canada Year Book, Dominion Bureau of Statistics, (Ottawa: Queen's Printer, 1960), p. 426.

[5] The Encyclopedia of Canada, Vol. 1, 1940, (University Associates of Canada, 1940), Pp. 205-206.

factory closed down in 1959 when a sugar refinery was opened in Toronto. In 1958 the province of Ontario processed about 463,000 tons of beets harvested from over 32,000 acres.[6] The Knight Sugar Company was established at Raymond, Alberta after it was discovered that the irrigated area in the Lethbridge district of Southern Alberta was suitable for the production of sugar beets. This factory was in operation during the years 1903 to 1914 when it ceased operation due to financial difficulties both in processing and producing the beets. In 1924 a new factory at Raymond was started and since then two factories have been established, one at Picture Butte, and the other at Taber. In 1958 the three Alberta factories handled 601,000 tons of beets from a harvested area of about 38,000 acres.[7]

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[6] Canada Yearbook, 1960, (Ottawa, Ontario: Queen's Printer, 1961), p. 426.

[7] Canada Yearbook, 1960, op. cit. p. 426.

SUGAR BEET PRODUCTION IN CANADA

(1960)

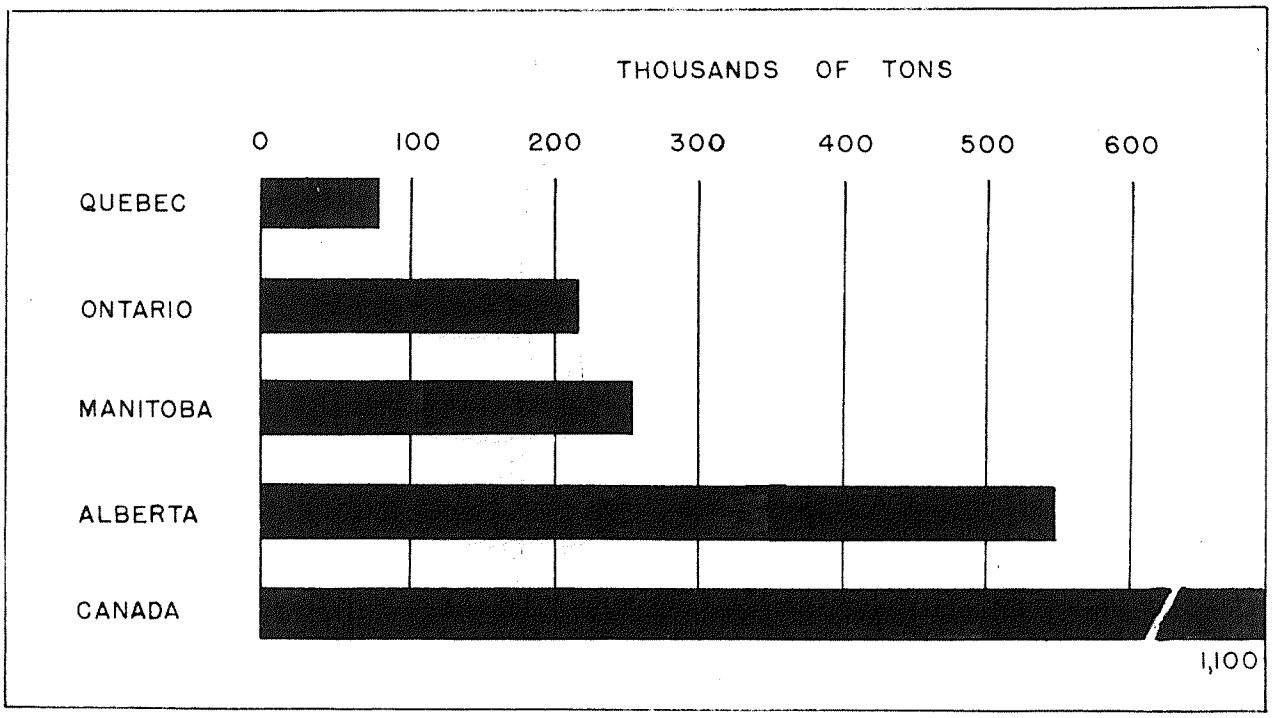


FIGURE 1

The production figures for the one year, 1960, were taken because the production in Ontario dropped from 507,000 tons in 1959 to 212,000 tons in 1960. This resulted from the closing of the beet sugar refinery at Wallaceburg by the Dominion and Canada Sugar Company. The company opened a cane sugar refinery in Toronto during 1960.

APPENDIX B

TABLE I

RESULTS OF 1903 EXPERIMENTAL PLOTS IN SOUTHERN MANITOBA

Locality	Per cent Sugar in Juice	Per cent Solids in Juice	Co-efficient of Purity
Boissevain	6.91	11.09	58.07
Silver Heights	13.88	20.73	66.95
Headingley	9.51	15.47	61.47
Louise Bridge	13.71	18.05	72.41
Pilot Mound	10.62	15.86	66.96
Morden	8.39	12.87	65.19
Brandon	17.19	21.82	78.77
Gretna	9.46	14.31	66.01
Ninga	18.71	22.73	82.31

TABLE II

ANALYTICAL RESULTS FROM 1917 EXPERIMENTS

Locality	Seeding Date	Harvesting Date	Per cent Sugar in Juice	Co-efficient of Purity
Deloraine	May 21	Oct. 17	14.7	72.4
Virden	May 28	Oct. 15	14.8	72.2
Ashern	May 3	Oct. 6	10.0	71.4
Isabella	June 1	Sept. 27	11.1	53.7
Melbourne	May 28	Oct. 8	11.9	71.7
Woodlands	May 26	Oct. 12	19.5	80.0
Oak Lake	June 4	Oct. 24	19.8	68.3
Fort Garry	May 10	Oct. 9	17.0	85.3

TABLE III

DATES OF SEEDING EXPERIMENT, 1917

(Manitoba Agricultural College)

Date Sown	Date Harvested	Per cent Sugar in Juice	Co-efficient of Purity	Yield Per Acre Tons	Pounds
May 19	Oct. 10	17.0	85.8	8	1820
May 30	Oct. 10	14.3	70.4	9	1668
June 15	Oct. 10	15.4	74.5	13	532
July 7	Oct. 10	14.5	69.4	3	996

TABLE IV

RESULTS OF SUGAR BEET EXPERIMENTS, 1920

(Manitoba Agricultural College)

No. of Plots	Per cent Sugar in Juice	Per cent Co-efficient of Purity
1	19.4	81.0
2	19.4	74.1
3	15.4	72.8
4	20.1	74.3
5	21.4	74.1
6	17.4	77.9
7	19.8	85.4

TABLE V

THE EFFECT OF MATURITY ON THE PURITY OF BEET JUICE

Seeding date	Harvesting date	Per cent Sugar in Juice	Co-efficient of purity
May 31	Sept. 13	11.6	68.5
May 31	Sept. 21	12.0	74.4
May 31	Sept. 27	13.2	68.1
May 31	Oct. 4	11.7	70.0
May 31	Oct. 11	14.0	77.3
May 31	Oct. 12	14.0	80.5

TABLE VI

RESULTS OF SUGAR BEET EXPERIMENTS, 1922

Locality	Per cent Sugar in Juice	Per cent Co-efficient of Purity
Stony Mountain	16.3	76.2
Marquette	14.9	72.7
Fort Garry	14.5	74.7
Argyle	17.7	80.4
Lockport	17.0	73.9
East Selkirk	16.4	81.2

TABLE VII

RESULTS OF SUGAR BEET EXPERIMENTS, 1923

Location	Per cent Sugar in Juice	Per cent Co-efficient of Purity
Winnipeg	18.2	89.7
Elma	23.0	90.8
Portage	19.2	82.9
Oak Bluff	15.6	80.6
Rosenfeld	19.0	81.1
Chortitz	16.6	78.9
La Broquarie	15.6	84.0
Lebau	22.6	85.3
Lakeland	18.4	87.1
Edwin	22.7	90.2
Badger	14.6	67.4
Gimli	20.0	89.3
Portage	19.4	74.5
Beausejour	19.2	84.0
Lorette	18.6	81.6
Winnipeg	19.8	82.9
Winnipeg	26.4	93.2
St. Norbert	16.8	83.3
La Rochelle	19.0	78.1
La Rochelle	21.1	81.7
La Rochelle	20.2	79.8

TABLE VIII

RESULTS OF EXPERIMENTS IN YIELDS

(Manitoba Agricultural College)

Year	Seeding date	Yield Tons per Acre
1915	May 10	11
1916	May 13	5
1917	May 17	16
1919	May 21	13
1920	May 31	15
1923	June 2	14
	Average	12

TABLE IX

RESULTS OF CO-OPERATIVE SUGAR BEET EXPERIMENTS

1924

ZONE	STATION	DOMINANT SOIL TYPE	NO. OF SAMPLES	PER CENT SUGAR CONTENT	CO-EFFICIENT OF PURITY	AVERAGE YIELD Tons	AVERAGE YIELD Pounds	HIGHEST REPORTED YIELD Tons	HIGHEST REPORTED YIELD Pounds
Red River Valley	Emerson		1						
	Morden Exp. Farm	Red River Clay	1						
	Headingley		1	16.97	85.37	11	660	13	664
	Portage		1						
	Fort Garry		3						
Assiniboine Delta	Carberry	Sandy Loam	4	14.45	84.62	7	1517	10	1080
Eastern Manitoba	Beausejour	Lacustrine	6	15.5	81.54	No	Report	No	Report
	St. Owens		1						
Northern Drift	Birtle	Glacial Loam	4	15.25	81.85	7	207	10	10
Border: Northern & Southern Zone	Brandon Exp. Farm	Alluvial Loam	7	14.50	79.34	10	1485	14	400
Southern Drift	Killarney	Glacial Gravelly Loam	1	15.00	79.50			12	200
Mean of all zones			30	15.27	82.03	9	467		

TABLE X

GENERAL SUMMARY OF EXPERIMENTAL DATA

(1917-1931)

(Manitoba Agricultural College)

Year	No. of Samples	Percent Sucrose in beets	Percent Purity of Juice
1917	17	13.4	75.2
1920	7	17.9	77.1
1921	1	14.9	77.2
1922	6	15.3	76.5
1923	23	18.3	82.6
1924	30	14.5	82.3
1925	135	15.4	84.2
1926	60	13.6	78.5
1927	31	15.2	81.9
1928	17	14.2	76.5
1931	53	20.2	89.1
Mean		16.1	79.9

TABLE XI

MANITOBA SUGAR BEET STATISTICS

(1930-1933)

Year	Acres planted	Yield tons per acre	Total (tons)	Percent sugar content	Per cent purity
1930	150	9.86	516	17.01	83.0
1931	425	6.00	2540	18.9	83.1
1932	303	8.19	2490	-	-
1933	-	-	3500	-	-

TABLE XII

RELATION OF YIELD TO SOIL TYPE[2]

	1955		1956		1957		1960		Four Year Record	
	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres
Medium Textured Soils										
Horndean Complex	9.3	2095	10.3	2165	9.9	2143	10.2	2428	9.9	8831
Altona Association (heavy phase)	11.7	3124	11.0	3410	10.2	3493	11.5	4015	11.1	14042
Emerson Association	9.6	4251	9.7	4262	9.2	3986	8.7	5133	9.3	17632
Oakville Association	12.0	963	11.6	1190	12.7	1051	10.6	1527	11.6	4731
Sperling Association	12.0	421	12.2	550	13.4	559	12.8	703	12.7	2233
Portage Association	11.8	197	11.1	328	11.4	291	11.0	615	11.2	1431
Morden Association	10.8	325	9.0	225	11.3	516	13.1	527	11.5	1593
Coarse Textured Soils										
Altona Association (light phase)	8.9	2662	9.8	3040	9.6	2080	10.7	2572	9.8	10354
Steinbach Association	9.0	244	10.5	287	8.7	202	9.8	303	9.6	1036
Fine Textured Soils										
Red River Clay	9.8	4134	10.0	3883	9.8	3052	10.5	3228	10.0	14297
Osborne Clay	7.2	1007	9.7	953	9.6	672	8.6	849	8.7	3481
Fort Garry Association	8.6	346	11.4	384	10.8	425	10.6	507	10.4	1662

[2]For sources of information and methods used see pages 189 and 190.

TABLE XIII

RELATION OF YIELD TO SOIL TYPE BY DISTRICTS[1]

(Yield In Tons Per Acre)

Soil Type	1955		1956		1957		1960		Four Year Record	
	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres
Winnipeg-Morris District										
Red River Clay	8.9	943	9.5	863	9.9	445	9.4	591	9.3	2842
Osborne Clay	6.3	212	6.4	178	9.4	97	9.1	102	7.3	589
Fort Garry Association	8.6	346	11.4	384	10.8	425	10.6	507	10.4	1662
Niverville-Steinbach District										
Red River Clay	7.6	287	10.7	310	8.0	223	10.1	202	9.1	1022
Osborne Clay	7.5	795	9.0	775	9.7	575	8.5	747	8.9	2892
Steinbach Association	9.0	244	10.5	287	8.7	202	9.8	303	9.6	1036
Emerson Association (light phase)	8.1	1401	9.5	1120	9.1	1213	8.8	1288	8.8	5022
Emerson-Letellier District										
Emerson Association (light phase)	11.0	1210	10.4	1325	10.7	1012	8.5	1777	10.0	5324
(heavy phase)	9.9	1640	9.4	1817	8.4	1761	8.8	2068	9.1	7286
Altona Association (heavy phase)	11.1	212	9.9	246	11.9	258	8.5	222	10.4	938
Horndean Complex	9.0	461	8.9	405	7.9	375	8.0	497	8.5	1738
Red River Clay	10.6	229	8.6	132	8.2	156	7.9	329	8.8	846
Altona-Gretna District										
Altona Association (light phase)	9.6	879	9.8	917	9.1	878	10.7	900	9.8	3574
(heavy phase)	11.9	2561	11.2	2863	10.0	2710	11.4	3181	11.1	11315
Horndean Complex	9.4	1417	10.8	1567	10.5	1482	9.7	1559	10.1	6025
Red River Clay	10.5	1993	10.2	1917	9.7	1612	11.4	1790	10.5	7312

[1]For sources of information and methods used see pages 189 and 190.

TABLE XII I - CON'T.

Soil Type	1955		1956		1957		1960		Four Year Record	
	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres	Yield Per Acre	Total Acres
Plum Coulee-Winkler District										
Altona Association (light phase)	8.6	1783	9.8	2123	10.0	1202	10.8	1672	9.8	6780
(heavy phase)	10.3	351	10.1	301	10.5	525	13.0	612	11.3	1789
Horndean Complex	9.6	217	9.6	193	9.9	286	15.1	372	11.6	1068
Morden Association	10.8	325	9.0	225	11.3	516	13.1	527	11.5	1593
Red River Clay	9.2	293	10.3	256	11.2	272	10.8	291	10.4	1112
Portage-Sperling District										
Oakville Association	12.0	963	11.6	1190	12.7	1051	10.6	1527	11.6	4731
Portage Association	11.8	197	11.1	328	11.4	291	11.0	615	11.2	1431
Sperling Association	12.0	421	12.2	550	13.4	559	12.8	703	12.7	2233
Red River Clay	9.6	389	9.8	405	11.3	344	10.5	25	10.2	1163

Note of Explanation of how Yield Data were related to Soil Types.

The soil maps on which the analysis was based were prepared by the Manitoba Soil Survey. The yield data were obtained from the records of the Manitoba Sugar Company. The records for 1959 were omitted because only two-thirds of the crop was harvested. The balance remained unharvested because of wet harvesting conditions and early "freeze-up". Yield data for 1958 had to be omitted because of the difficulty in obtaining the required field location information. The figures showing the number of acres do not add up to the total acres harvested in any particular year. This is due to the fact that figures for soil types on which only a few acres of sugar beets were located were omitted e.g. the sugar beet acreage on the Pelan Soil Association near Steinbach. Certain yield records had to be discarded. The legal description of sugar beet fields was given by quarter section or river lot. Yield data from sugar beet fields which were located on quarter sections or river lots with more than two soil types were discarded. Where the quarter section had approximately fifty per cent of one type of soil and fifty per cent of another, the acreage of sugar beets was divided in half. To each soil type was attributed fifty per cent of the acreage and tonnage.

Certain soil types were combined after consulting the soil specialists. The soils of the Riverdale Association in the St. Eustache area were combined with the soils of the Oakville Association in this statistical analysis. In the areas surveyed into river lots it was impossible to determine the precise location of the sugar beet field in any particular river lot. And since the

river lots in the St. Eustache area consist of two main soil types, namely the Riverdale and the Oakville, the yield data from sugar beets grown on these two soils were combined. The soils of the Altona Association were divided into two main types as they appear on the Morris map sheet. However, on the South Central map sheet this association consists of three soil types: the Altona light loams, the Altona fine loams, and the Altona fine loams with a heavy sub-phase. The last two types were combined with the Altona heavy phase soils and the Altona light loams were included with the Altona light phase soils of the Morris map sheet. This combination was based on the soil productivity maps prepared by the Manitoba Soil Survey and the Manitoba Department of Agriculture.

The column showing the average yield of the four years is also, like the yearly averages a weighted figure, i.e. the average was determined by dividing the total tons produced in the four years on a particular soil type by the total acreage harvested on that soil type.

TABLE XIV

SUGAR BEET YIELDS FOR MANITOBA BY DISTRICTS

(1956-1960 with 10 year average)

District	1956	1957	1958	1959	1960	1950-60 average
Steinbach Niverville	9.59	9.40	7.80	11.25	9.20	8.86
Portage Elie	10.82	12.59	9.02	11.16	10.60	10.21
Homewood Roland	11.95	12.71	9.12	-	12.60	10.28
Winnipeg Morris	9.83	10.35	8.66	10.91	8.37	8.81
Winkler Plum Coulee	9.77	10.17	10.39	11.73	11.89	10.79[3]
Altona Horndean	10.31	10.20	8.87	10.54	10.74	10.13[3]
Emerson Letellier	9.57	9.24	8.20	10.04	8.55	9.12[3]

[3] Five year averages only.

TABLE XV

COMPARISON OF ACRES USED FOR SUGAR BEET PRODUCTION AND YIELD PER ACRE IN CANADA, QUEBEC, ONTARIO, MANITOBA, AND ALBERTA[4] (1955-1960)

	1955		1956		1957		1958		1959		1960	
	Acres	Yield per acre	Acres	Yield per acre	Acres	Yield per acre	Acres	Yield per acre	Acres	Yield per acre	Acres	Yield per acre
Canada	81,928	11.39	78,878	11.32	83,912	12.21	97,845	13.54	93,646	13.04	86,060	12.8
Quebec	5,800	11.21	5,670	9.67	5,840	11.13	5,950	10.92	4,400	13.41	5,420	15.2
Ontario	18,900	12.70	14,158	10.22	19,741	13.17	31,588	14.64	33,996	14.91	14,258	14.9
Manitoba	20,740	9.84	22,900	10.00	21,242	10.3	22,000	8.91	20,000	9.00	25,000	10.3
Alberta	36,488	11.97	36,150	12.85	37,089	12.96	38,308	15.69	35,250	13.48	41,379	13.2

[4]Quarterly Bulletin of Agriculture Statistics, Dominion Bureau of Statistics, (Ottawa, Canada: Queen's Printer), 1955, 1956, 1957, 1958, 1959, 1960.

TABLE XVI

COMPARISON OF YIELDS PER ACRE OF SUGAR BEETS HARVESTED IN THE UNITED STATES, ALBERTA, AND MANITOBA[5] (1940-1954)

Year	United States		Alberta		Manitoba	
	Tons of beets	lbs.of sugar	Tons of beets	lbs.of sugar	Tons of beets	lbs. of sugar
1940	13.4	3,885	13.5	3,926	5.7	1,403
1941	13.7	3,942	12.2	4,005	8.3	2,143
1942	12.2	3,390	11.8	3,775	8.1	1,865
1943	11.9	3,400	9.0	2,846	6.9	1,936
1944	12.1	3,528	11.3	3,520	8.6	2,333
1945	12.1	3,341	11.1	3,297	8.0	1,870
1946	13.2	3,546	12.3	3,592	8.2	2,185
1947	14.2	3,911	11.6	3,413	6.9	1,658
1948	13.6	3,689	10.3	3,132	8.0	2,140
1949	14.8	4,253	9.6	2,444	8.0	2,232
1950	14.6	4,060	11.6	3,447	6.8	1,741
1951	15.2	4,191	10.0	2,473	8.8	2,109
1952	15.3	4,231	12.3	3,877	7.6	2,169
1953	16.2	4,556	11.4	3,394	8.9	2,289
1954	16.1	4,358	11.4	3,071	9.5	2,390

[5] Restrictive Trade Practices Commission Report, (Ottawa : Queen's Printer, 1957), p. 35.

TABLE XVII

PERCENTAGE AND NUMBER OF GROWERS BY ETHNIC BACKGROUND

Year	Total	Mennonite	Anglo-Saxon	French	Undifferentiated
1940	1,100	268 24%	233 21%	291 26%	309 28%
1945	560	289 52%	83 15%	82 15%	82 14%
1950	1,007	671 67%	146 14%	81 8%	109 10%
1955	849	629 74%	71 8%	63 7%	82 10%
1960	813	600 74%	100 12%	36 4%	77 9%

TABLE XVIII

RAILROAD AND TRUCK DELIVERIES OF SUGAR BEETS AND FREIGHT COSTS
(1960)

Loading Station	C.P.R. (tons)	C.N.R. (tons)	Truck (tons)	Cost per Ton
Christie		14,259		$1.58
Curtis		9,440		$1.47
Altona	33,926			$1.58
Emerson		13,307		$1.78
Gretna	33,982			$1.58
Homewood		14,294		$1.48
Horndean	10,656			$1.58
Letellier		15,033		$1.58
Morris		2,281		$1.58
Plum Coulee	21,856			$1.58
North Elie		7,714		$1.39
Portage	11,341			$1.58
Rosenfeld	9,552			$1.58
Tuelon	1,249			$1.58
Winkler	20,229			$1.78
Steinbach-Niverville			25,334	
Fort Garry and Area			13,994	
Percentage	55.2%	28.6%	16.2%	

TABLE XIX

TOTAL PRODUCTION AND ESTIMATED TOTAL ANNUAL DOMESTIC SALES OF REFINED SUGAR BY MANITOBA SUGAR COMPANY[1,2]
(thousands of pounds)

Year	Amount sold in Manitoba	Per cent sold in Manitoba[a]	Amount sold in Sask.	Per cent sold in Sask.	Total produced
1940	7,828	11	1,035	2	22,100
1941	21,838	30	-		23,021
1942	29,836	53	-		26,360
1943	26,657	54	-		27,342
1944	23,179	43	-		21,100
1945	20,651	44	-		18,330
1946	20,758	43	-		25,431
1947	21,344	35	-		14,911
1948	18,398	24	-		20,534
1949	39,407	48	-		34,700
1950	37,579	51	30		35,175
1951	33,028	47	24		40,500
1952	37,925	53	28		35,600
1953	36,103	51	4,014	7	40,231
1954	39,721	54	3,826	6	56,433
1955	43,666		8,007	13	55,195

[1] Restrictive Trade Practices Commission Report, Department of of Justice, Ottawa, (Ottawa: Queen's Printer, 1957), Pp. 64, 66, 67.

[2] The Story of Manitoba's Agriculture, 75 Years of Progress, (Winnipeg, Manitoba: Queen's Printer, 1956), Pp. 4, 20.

[a] This represents the per cent sold by the Manitoba Sugar Company as compared to total sales of sugar in the province.

TABLE XX

APPROXIMATE PERCENTAGE OF ANNUAL SALES IN QUANTITY OF REFINED SUGAR IN MANITOBA BY INDIVIDUAL REFINERIES[3]
(1940-1955)

Year	B.C.S.R.[a] Br. Columbia	C.S.F.[b] Alberta	Man. Sugar[c] Manitoba	St.Law.[d] Quebec	Acad.Atl.[e] New Brun.	Can. Dom.[f] Ont.&Que.
1940	-	5	11	4	42	38
1941	-	5	30	3	31	31
1942	1	26	53	3	8	9
1943	-	37	54	1	4	4
1944	-	44	43	0.3	9	4
1945	-	46	44	0.1	8	2
1946	0.1	49	43	0.4	6	2
1947	-	55	35	0.5	5	4
1948	-	19	24	8	29	20
1949	-	12	48	5	23	12
1950	-	9	51	5	22	13
1951	1	18	47	4	15	14
1952	2	15	53	3	12	15
1953	2	25	51	2	8	13
1954	2	21	54	2	8	14

[3] Restrictive Trade Practices Commission Report, Op. Cit. p.66,67.

[a] The British Columbia Sugar Refining Company, Limited, Vancouver.

[b] Canada Sugar Factories Limited, Alberta.

[c] Manitoba Sugar Company, Limited, Winnipeg.

[d] The St. Lawrence Sugar Refineries, Limited, Montreal

[e] Acadia-Atlantic Sugar Refineries, Limited.

[f] Canada and Dominion Sugar Company, Limited.

TABLE XXI

NET RETURN AT FACTORY FOR SHIPMENTS TO VARIOUS CITIES AND TOWNS IN SASKATCHEWAN AND MANITOBA, SEPTEMBER 28, 1956[4]

Towns	Net Price Beet Sugar	Net Returns Alberta Refineries	Net Returns Manitoba Refinery
Saskatchewan			
Estevan	$9.35	$8.15	$8.45
Lloydminister	9.48	8.24	7.98
Melfort	9.63	8.26	8.43
Melville	9.30	7.74	8.57
Moosejaw	9.49	8.89	8.58
N.Battleford	9.58	8.17	8.34
Prince Albert	9.71	8.30	8.54
Regina	9.51	8.81	8.65
Saskatoon	9.51	8.76	8.44
Swift Current	9.52	9.12	8.24
Tisdale	9.55	8.05	8.44
Weyburn	9.39	8.28	8.45
Yorkton	9.30	7.89	8.57
Manitoba			
Brandon	9.11	7.77	8.59
Dauphin	9.20	7.27	8.62
Flin Flon	9.61	7.43	8.43
Selkirk	8.75	7.07	8.48
Souris	9.11	7.70	8.44
Winnipeg	8.75	7.65	8.75

[4] Restrictive Trade Practices Commission Report, Op. Cit. p. 80.

APPENDIX D

BEET SUGAR FACTORY -FUNCTIONS OF BUILDINGS

Sugar Refinery:

Here all the processing is done. The raw material enters via the main flume and the finished product leaves the granulater or dryer and is stored in the warehouse after being sacked.

Sugar Warehouse:

This warehouse has space for approximately 30,000,000 pounds of sugar. Its temperature is constantly regulated to prevent any caking. In 1962 the bulk storage facilities were expanded at the refinery at an estimated cost of $600,000, giving an additional storage capacity of 3 million pounds.

Engine Room:

All power for the factory is generated by steam turbine and diesel. The steam used by the turbine is exhausted into the plant for processing.

Boiler House:

Here three high pressure boilers of latest design produce 150,000 pounds of steam per hour by burning low lignite coal.

Pulp Dryer and Pulp Warehouse:

From the pulp presses the pulpis conveyed by belt to the dryer where it is dried and moved to the pulp warehouse. At the pulp warehouse the pulp is sacked and made ready for shipment.

Lime Kiln House:

Here limerock with a certain proportion of coke is burned in the virtical kiln producing burned lime and CO_2 gas.

Pumping House:

This building contains the apparatus for pumping 180,000 gallons of water every hour from the Red River into the plant.

Molasses Tanks:

Here the beet molasses is stored before it is sold to producers of stock feed, distillers, and yeast manufacturers.

Beet Piling Yard:

Beets are piled in the yard and carried into the plant by railway cars and by the main flume.

LAKE

MANITOBA

WEST SHOAL LAKE

EAST SHOAL LAKE

TEULON

LAKE WINNIPEG

BROKENHEAD RIVER

NETLEY LAKE

NETLEY CREEK

STONEWALL

SELKIRK

DEVIL'S CREEK

COOK'S CREEK

LONG LAKE

PORTAGE LA PRAIRIE

ST. EUSTACHE

ASSINIBOINE RIVER

WINNIPEG

ELM CREEK DRAIN

RIVIERE SALE

SEINE RIVER

MANNING CANAL

STE. ANNE

GASTER DRAIN

BOYNE DOUBLE DYKE

STE. AGATHE

ST. ADOLPHE

MORRIS RIVER

CARMAN

SPERLING

HOMEWOOD

4 N CHANNEL & DOUBLE DYKE

TOBACCO CREEK DRAIN & DOUBLE DYKE

MILAND

SHANNON DOUBLE DYKE

MORRIS

MARSH RIVER

DUFROST

ROBERT RIVER

HESPELER DOUBLE DYKE

BUFFALO LAKE DOUBLE DYKE

ROSENFELD

ALTONA

GRETNA

EMERSON

SOUTHERN MANITOBA LOWLANDS

DRAINAGE

NON-PERENNIAL STREAMS

ARTIFICIAL DRAINS

SCALE OF MILES

J. FRIESEN '56

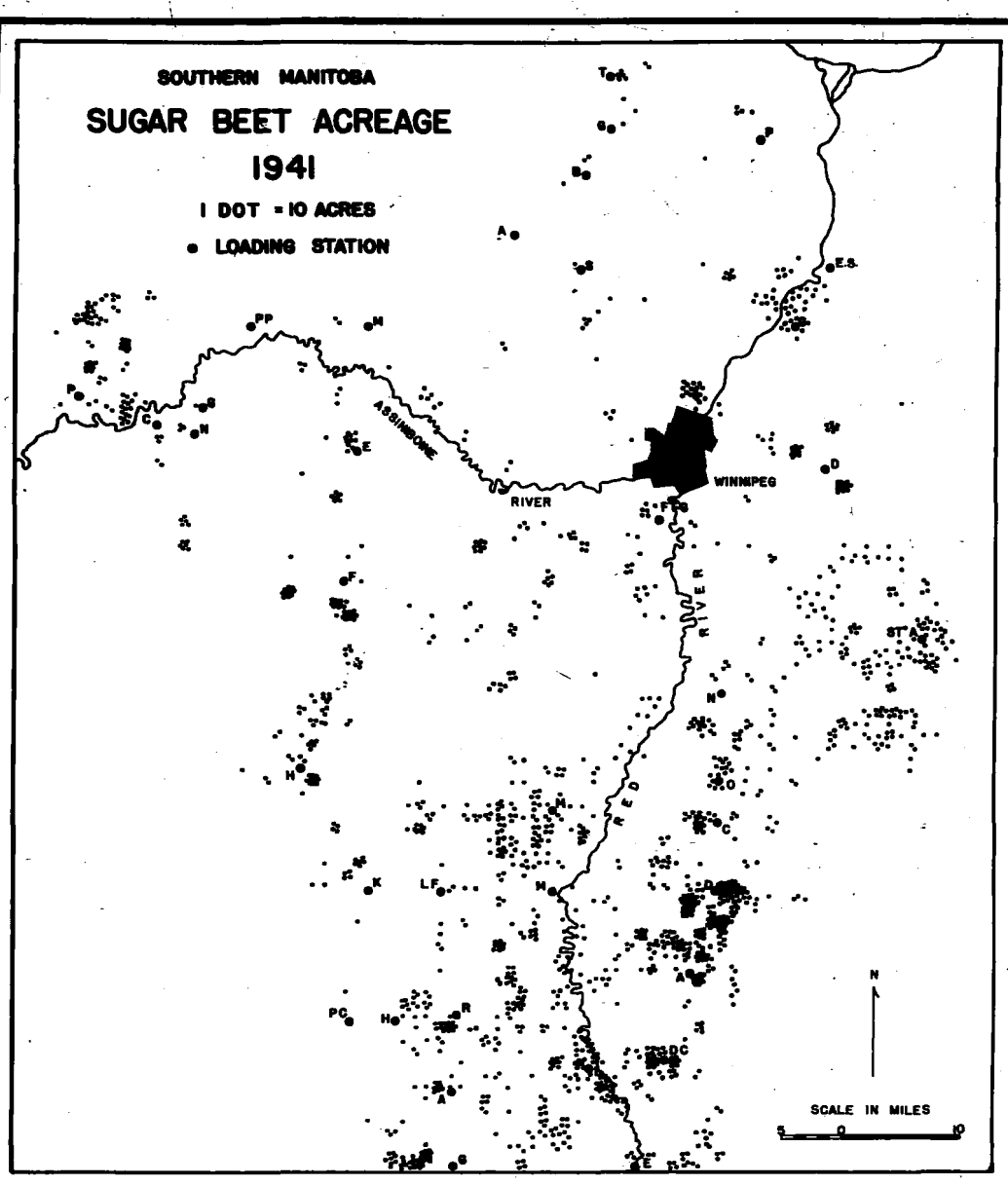
SOUTHERN MANITOBA

SUGAR BEET ACREAGE

1941

1 DOT = 10 ACRES

● LOADING STATION



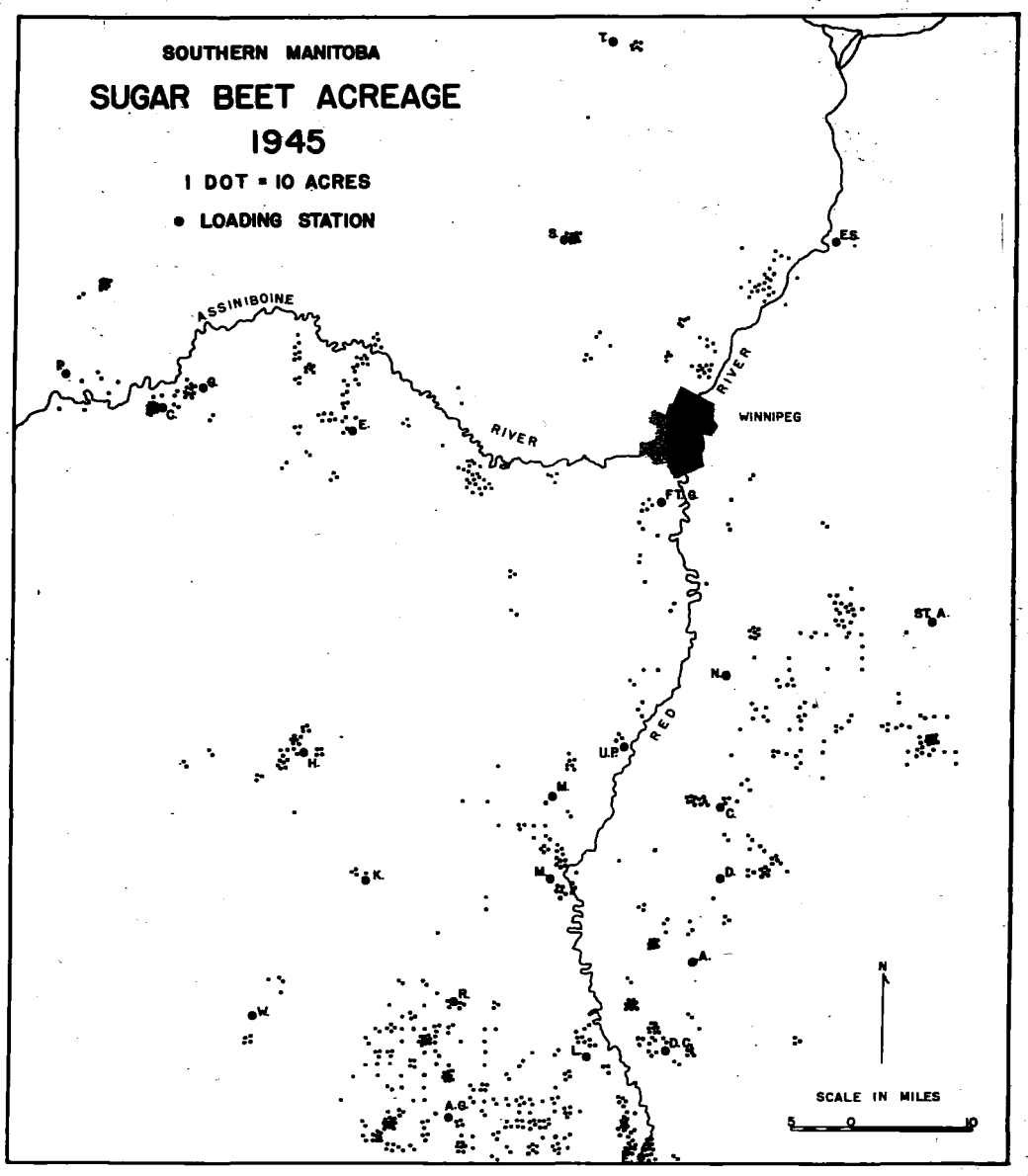
SOUTHERN MANITOBA

SUGAR BEET ACREAGE

1945

1 DOT = 10 ACRES

● LOADING STATION



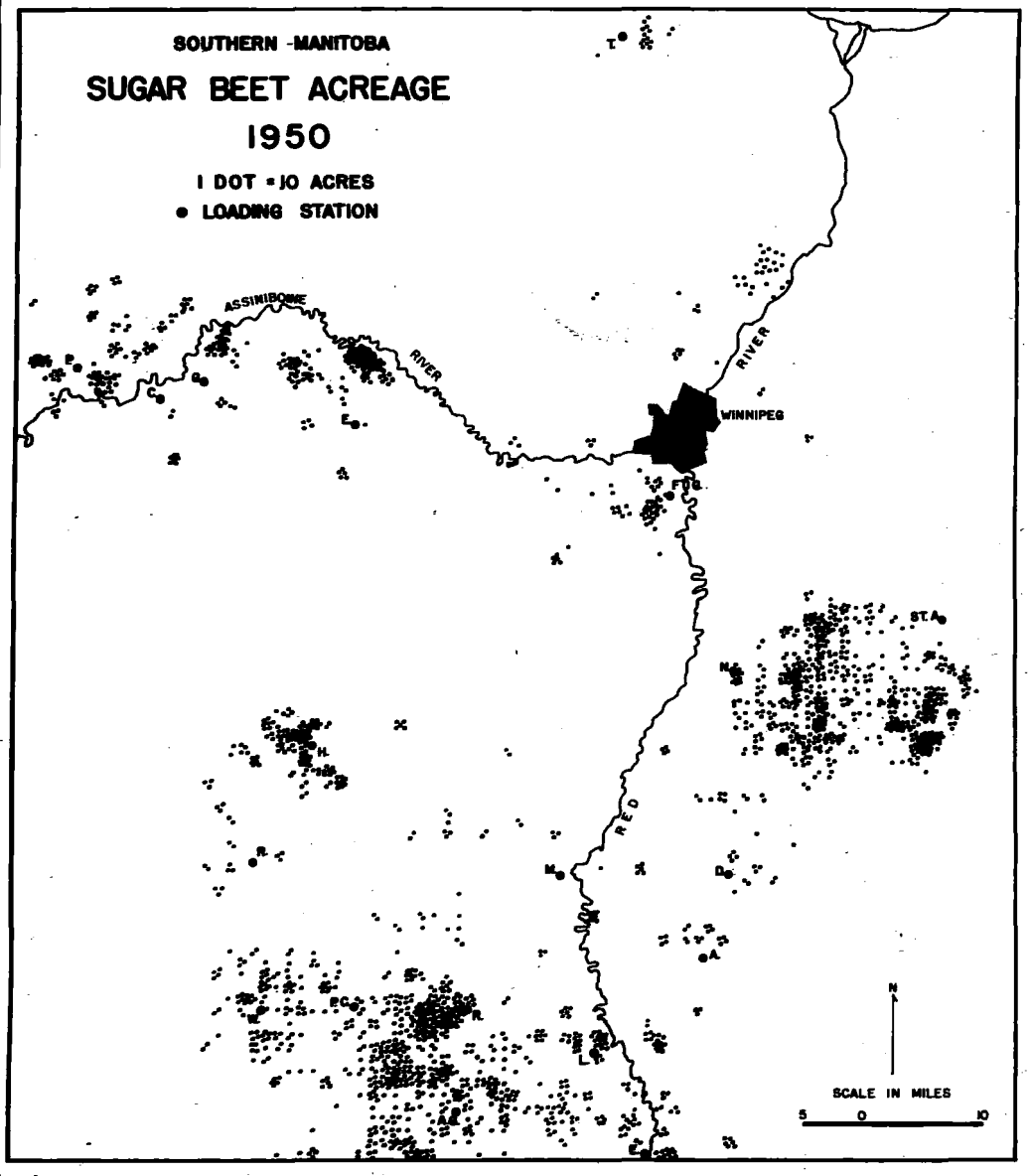
SOUTHERN MANITOBA

SUGAR BEET ACREAGE

1950

1 DOT = 10 ACRES

● LOADING STATION



SOUTHERN MANITOBA

SUGAR BEET ACREAGE

1955

1 DOT = 10 ACRES

● LOADING STATION