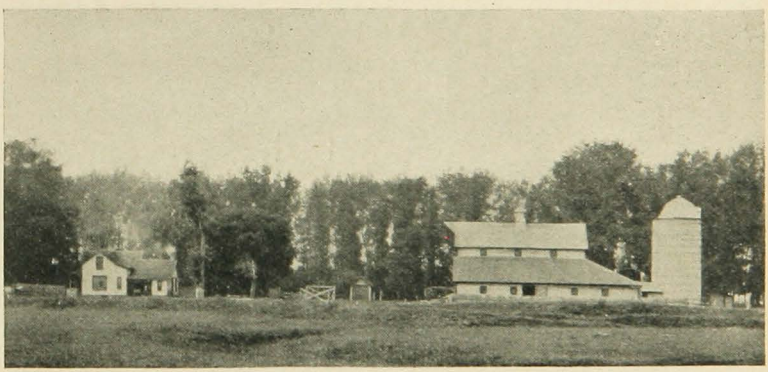
Bulletin 257 August 1929

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

TYPES OF FARMING IN MINNESOTA

L. F. GAREY
DIVISION OF FARM MANAGEMENT
AND AGRICULTURAL ECONOMICS



UNIVERSITY FARM, ST. PAUL

CONTENTS

ILLUSTRATIONS

TYPES OF FARMING IN MINNESOTA[1]

L. F. GAREY

INTRODUCTION

The factors that have a significant influence on the agricultural production of any region may be classified under three heads: (1) Physical, (2) economic, (3) biological.

Of the physical factors soil, precipitation, and temperature are most significant. Among the economic factors land values, land tenure, transportation rates and facilities, markets, and relative prices are the most influential. Of the biological factors plant diseases and insect pests are the most important.

SOIL AND SURFACE CHARACTERISTICS

The surface soil of Minnesota is nearly all of glacial origin. There is a small area in the extreme southeastern corner and in adjacent portions of Wisconsin and Iowa, the high lands of which escaped glaciation owing, it is thought, to their topography. This area has many high hills, which probably deflected the glaciers to the lower lands. The soil in the glaciated areas is derived from the natural residue caused by disintegration of rock.

Most of the glaciated land of Minnesota has been formed from what is known as glacial till and is uniform over large areas. The texture of this soil varies from clay to bowlders and has been darkened through oxidation and by decaying vegetable matter.

The soil known as Young Gray Drift is the most extensive surface formation in Minnesota. It extends over most of the southwestern and central parts of the state and well up into the north central part. It is mostly bluish gray except where oxidation has occurred—there it is reddish brown. The soil is of a clay nature and contains sufficient limestone for the production of leguminous crops. Small grains do well on this soil, as does corn where the growing season is long enough. Owing to a wide range of crop adaptation several systems of farming are followed.

The lake-bed formations in the northern and northwestern parts of the state are second in importance in agricultural production. Soil deposits of the glacial Lake Agassiz are found in seventeen of the northern and northwestern counties. Three distinct types of soil are found in these deposits: (1) Lake-bed clay, which consists of the

[1] The statistical data, charts, and maps presented are limited to Minnesota, altho many of the principles involved in the analysis of the agricultural production are applicable to other areas.

finest sediment and was deposited in the deepest water. It is found along the Red River and extends eastward, varying in width from 5 to 20 miles. It is rich in humus and very fertile. In some places it reaches a depth of 60 feet. (2) Lake-bed sand, the deposit made in the shallower parts of the lake. This deposit lies just east of the lake-bed clay deposits and varies in texture from light sand to gravel, the finer texture being deposited in the deeper water. (3) Swamp, including peat and muck. These soils are extremely rich in organic matter. Cultivation is possible only where drainage has been developed. Considerable small timber is found on these swamps.

The soil next in importance for agricultural production is that known as Red Drift, being mainly a reddish dark sandy loam. It is found along the north shore of Lake Superior and in the east central part of the state, and extends into Wisconsin. The topography is rolling and there are many small lakes. This soil is productive, being especially well adapted to the growing of red clover. It has been heavily timbered and agricultural development has been slow because of the expense of clearing the land. When once under the plow, the land is well suited to farming, especially to potatoes and root crops.

The soils in southeastern Minnesota differ in origin. In parts of Houston and Winona counties, in the extreme southeastern corner of the state, there is a small stretch of land over which the glaciers never extended. It is known as the driftless area. The bed rock is limestone and has a covering of residual clay. This underlying formation may have been a factor in determining the types of crops produced. The residual material is so near the surface that tillage implements often come in contact with it.

Directly to the west of this driftless area is a glaciated district over which has been deposited a thick layer of wind-blown soil. This glacial deposit varies in depth from 20 to 40 feet on the western side of the district to a mere scattering of pebbles on the eastern side. The covering of loess, or wind-blown soil, varies in depth from 15 to 20 feet. The soil is well drained and responds readily to good farming practices.

In the extreme southwestern part of Minnesota is a small area that was not covered by the Young Gray Drift. The early glacial deposits on this area have been covered with loess to a depth of several feet, hence they have little effect upon the agriculture. Because of limited rainfall the soil has been little affected by leaching. The soil is very fertile. Some of the highest priced land in the state is in this area.

In the east central part of the state a soil deposit lying in northern Goodhue, eastern Dakota, and Washington Counties, is known as Old

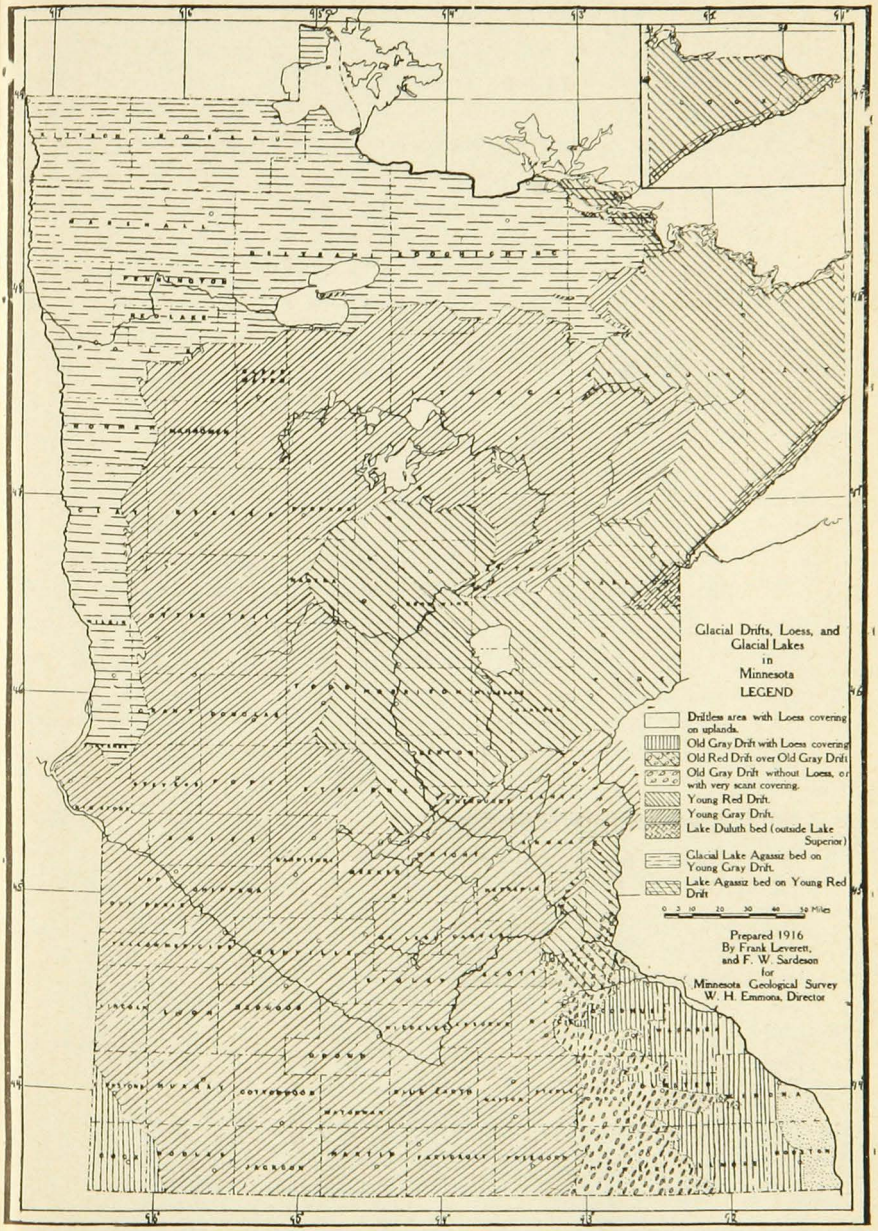


Fig. 1. Glacial Drifts, Loess, and Glacial Lake Deposits
(Courtesy of Department of Geology)

Red Drift. Both the soil and the subsoil are distinctly red, particularly in the clayey portions. There is some stone. Where tillable, the soil is productive, being well suited to the growing of red clover.

In northern Dakota, eastern Ramsey, and part of Washington Counties is a deposit known as Young Red Drift. Part of this area is covered with a grayish deposit that is less stony than the rest. In some places the soil is sandy. Because of the wide range in type of soil, a wide diversity of crops can be grown.

A large part of the three northeastern counties of Minnesota is not adapted to agricultural production. The surface soil is thin and in many places the bare rock is exposed. There are many extensive rock outcrops from which practically all the soil was removed by glaciers moving southward. This land will probably not be valuable for agricultural purposes for some time. Undoubtedly the wisest policy at present is to use it for forest crops.

The highest point in Minnesota is in western Cook County, where the altitude is 2,230 feet. The lowest point is at Lake Superior, with an altitude of 602 feet. The altitude of the largest part of Minnesota is between 1,000 and 1,500 feet.

There are three areas in the state, one in the northeastern, one in the southwestern, and one in the northwestern part, in southern Ottertail County, where the altitude exceeds 1,500 feet. These areas are not extensive and the altitude has little or no effect on the type of agriculture followed.

Two areas of importance have an altitude of less than 1,000 feet. One in the east central part of the state includes the valleys of the Minnesota, the Mississippi, and the St. Croix Rivers. The other is in the northwestern part of the state along the Red River, where the fall northward is at a rate of about a foot per mile.

CLIMATE

Climate is the most important factor in determining the kind and extent of crop production. The agriculture of a region is built around the kind of crops grown.

The elements that most influence the climate of a region are precipitation and temperature, which have a considerable influence on crop yields even where soil and other physical factors are favorable for crop growth. Large bodies of water increase the precipitation, decrease the sunshine, and moderate the temperature. With the exception of a small area adjacent to Lake Superior, the climate of the state is not influenced by large bodies of water.

Precipitation.—The average annual precipitation for Minnesota is 26.7 inches; only in occasional years does it average more than

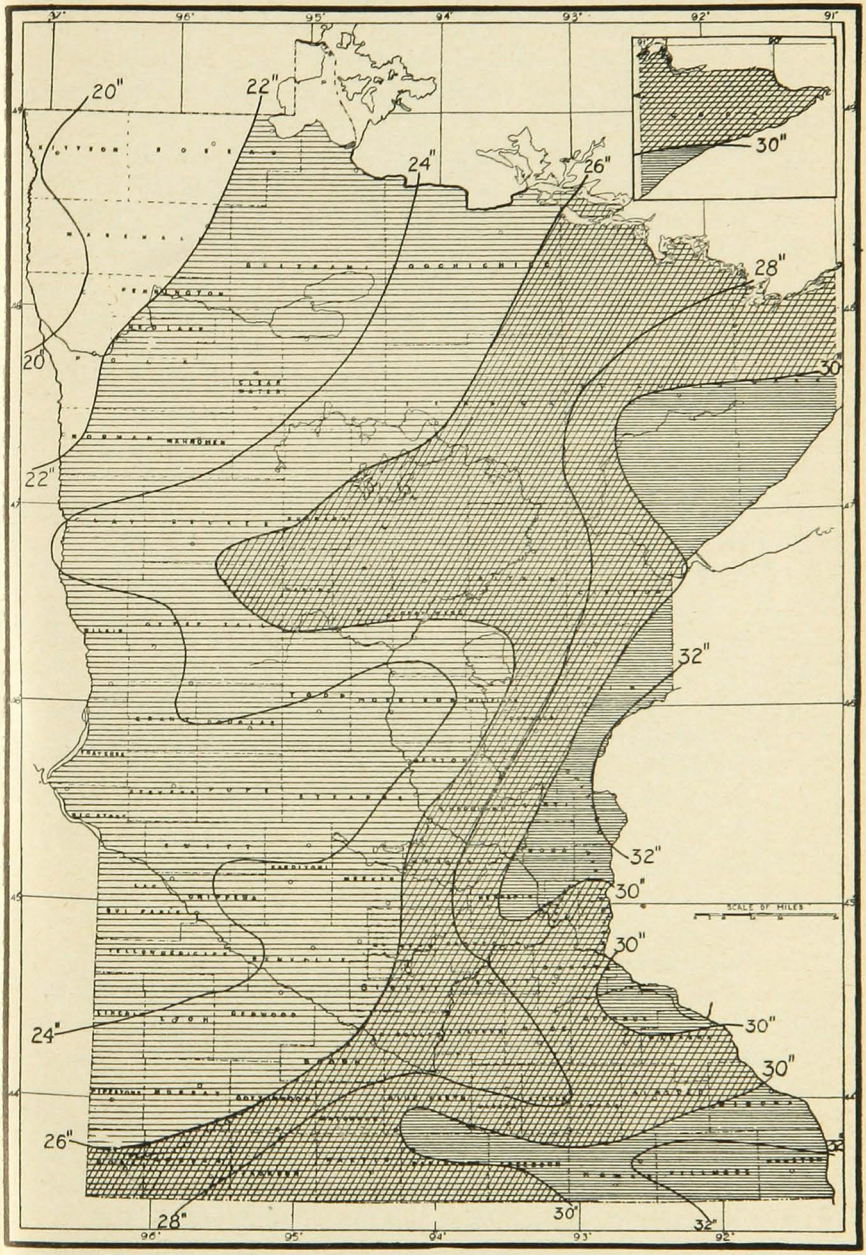


Fig. 2. Annual Precipitation for Minnesota, Inches
(Courtesy of Department of Geology)

33 inches. Seventy-six per cent of the precipitation falls between April 1 and September 30, when the amount of rainfall is equal to that in northern Illinois, Indiana, and Ohio. Evaporation, however, is much less, so the rainfall of 20 inches in Minnesota during the growing season may be worth as much as a larger amount in many states farther south.

As a rule, June is the wettest month, with an average of 4 inches of rainfall. February is the month of lowest precipitation.

The heaviest average precipitation in Minnesota, as recorded by weather stations having records for ten years or longer, is 33.7 inches, at Caledonia, Houston County. The lightest is 19 inches, at Angus, Polk County. Figure 2 shows the distribution of the precipitation in Minnesota.

Not all precipitation is in the form of rain. From 24 to 54 inches of snow falls, most of it during January, February, and March. This is equivalent to from 2.4 to 5.4 inches of water. The snowfall is lightest in the southwestern part of the state and heaviest on the Mesabi Iron Range, in the northeastern part.

Temperature.—The mean annual temperature for Minnesota ranges from 43.9 to 39.9 degrees, averaging 41.7 degrees. January is the coldest month and July the warmest. The mean summer temperature is 67.0 degrees and the mean winter temperature 12.8 degrees. Continued cold spells may last for several days or even weeks. While high temperatures are occasionally recorded, they usually last but a short time and there is little suffering from heat.

From April to September the highest average temperature is 63 degrees in the southeastern part of the state, the lowest being 55 degrees near Lake Superior and Lake of the Woods, a range of 8 degrees. This factor alone may determine whether certain crops will mature in the regions of lower temperatures. Figure 3 shows the mean annual temperature for the state.

Growing season.—The length of the growing season, which is the period between the last killing frost in the spring and the first killing frost in the fall, is important in determining the agriculture of a locality. Frosts may occur in some parts of the state every month in the year but little damage from frost may be expected between May 15 and September 15.

The average growing season in Minnesota is approximately 132 days. The longest growing season reported by weather bureaus for the state as a whole was 145 days and the shortest 118 days.

The number of days in the growing season is not the only significant factor in determining the agriculture. Total hours of sunshine during the growing season is also important. While there are fewer

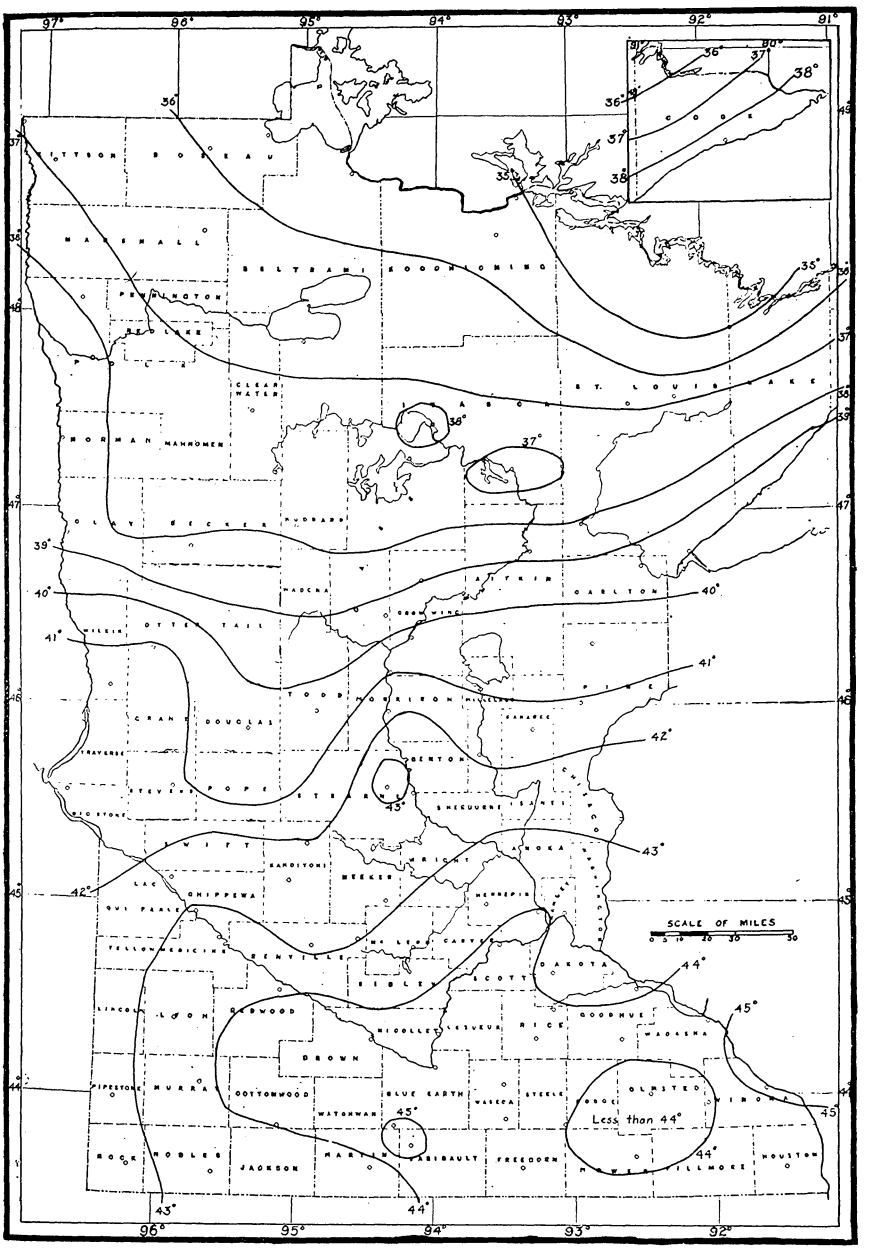


Fig. 3. Mean Temperature, Degrees Fahrenheit
(Courtesy of Department of Geology)

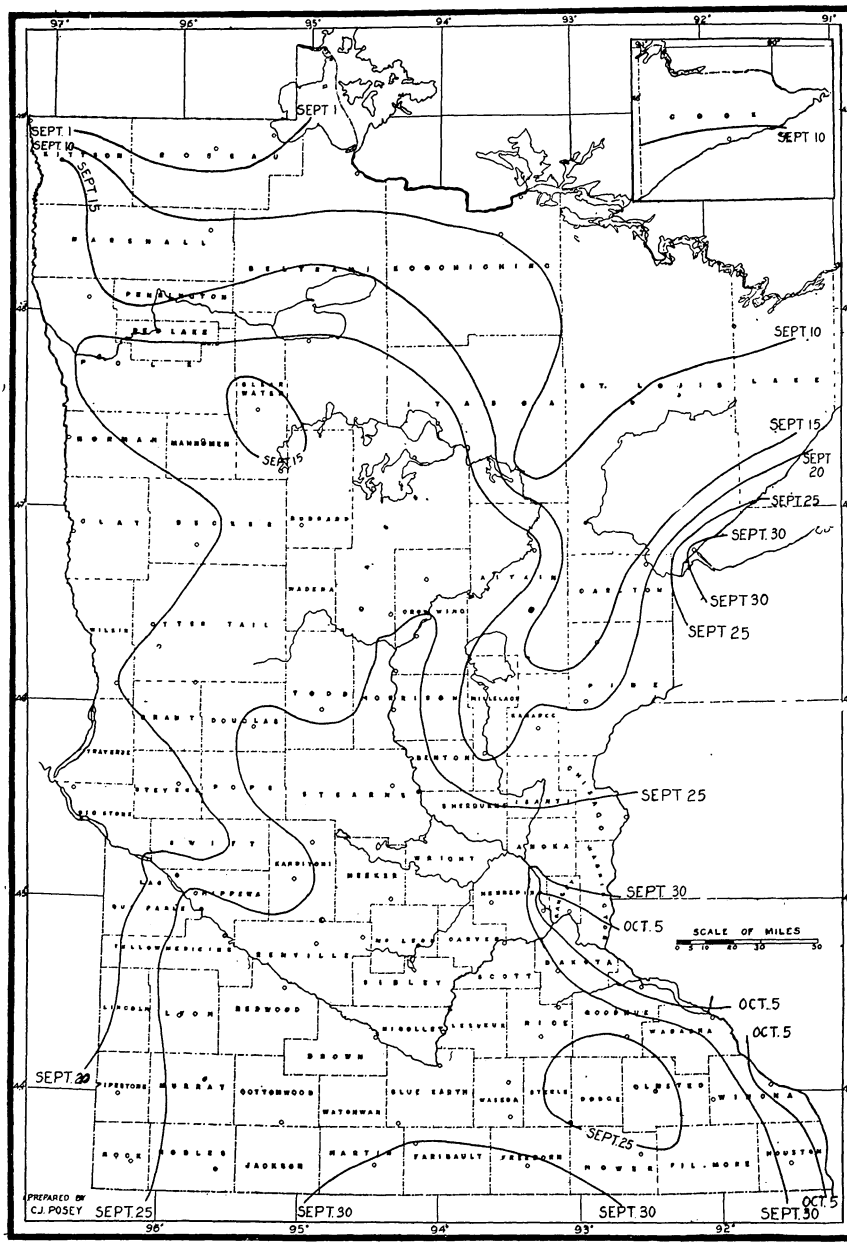


Fig. 4. Average Date of First Killing Frost in the Fall
(Courtesy of Department of Geology)

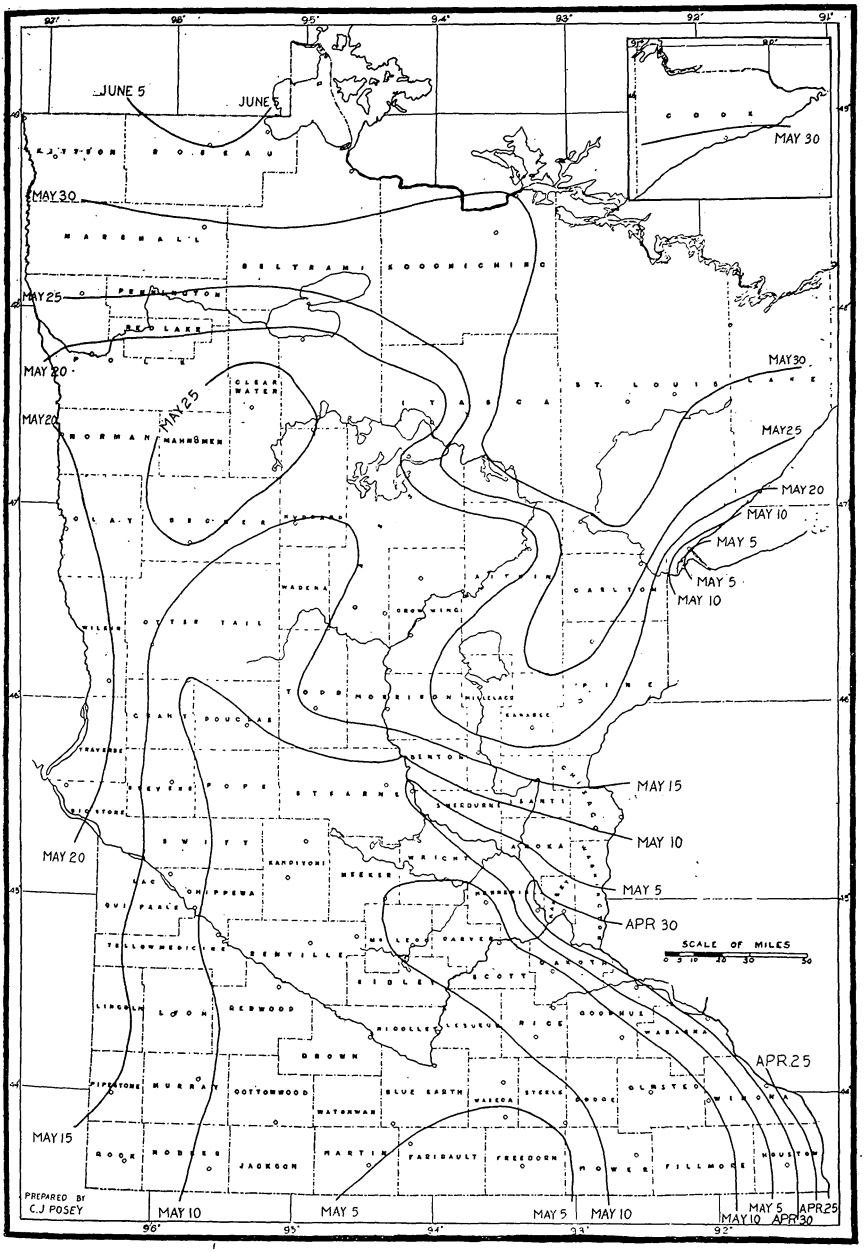


Fig. 5. Average Date of Last Killing Frost in the Spring
(Courtesy of Department of Geology)

days in the growing season in the northern part of the state than in the southern part, there are more hours of sunshine during June, July, and August. The sun is above the horizon during these three months 1,404 hours at Crookston, 1,374 hours at St. Paul, and 1,337 hours at Peoria, Illinois, which is in the corn belt. The amount of sunshine varies from 43 per cent to 53 per cent of the highest amount possible. The greatest percentage of sunshine is in the southwestern part of the state and the least in the northeastern part.

Bodies of water and altitude influence the growing season. In the region of Duluth, along Lake Superior, the average length of the growing season is 140 to 150 days, which is equal to that 200 miles farther south. It is 30 days longer at Duluth than in the highlands of Clearwater and Hubbard Counties, which are in practically the same latitude.

The section having the longest growing season is a narrow area adjacent to the Mississippi River from the Twin Cities to the southeastern part of the state; that having the shortest is in the region of the Mesabi and Vermillion iron ranges, in Lake County. Figure 6 shows the average length of the growing season in different sections of Minnesota.

TRANSPORTATION AND MARKET FACILITIES

Transportation facilities are of vital importance to the farmer; most of his products must be shipped before they reach the ultimate consumer. Nearly all the things a farmer buys reach him by means of some transportation agency.

The first method of transportation used to any extent in Minnesota so far as trade is concerned was by water. It is claimed that Minnesota was discovered through a water route. Three trade routes by water connected the Mississippi with the Red River in the early days. One was by way of the Minnesota River to Bigstone Lake, over the portage into Lake Traverse, thence to the Red River. Another was up the Mississippi, through Crow Wing and Leaf Rivers, over the portage into Ottertail Lake, thenec to the Ottertail River, which leads to the Red River. A third was by way of the Mississippi to Turtle River, over the portage at Turtle Lake into Mud Creek, from there to Red Lake, thence to the Red River by way of Red Lake River. From the Mississippi to Rainy River the route was by way of Lake Winnibigoshish over the portage to Bow String Lake, into the Big Fork River, thence to the Rainy River. From the Mississippi to Lake Superior there were two routes, one by way of Sandy Lake over the Savanah Portage to the St. Louis River; the other up the St. Croix River to Upper St. Croix Lake, over the portage to Bois Brule River, thence to

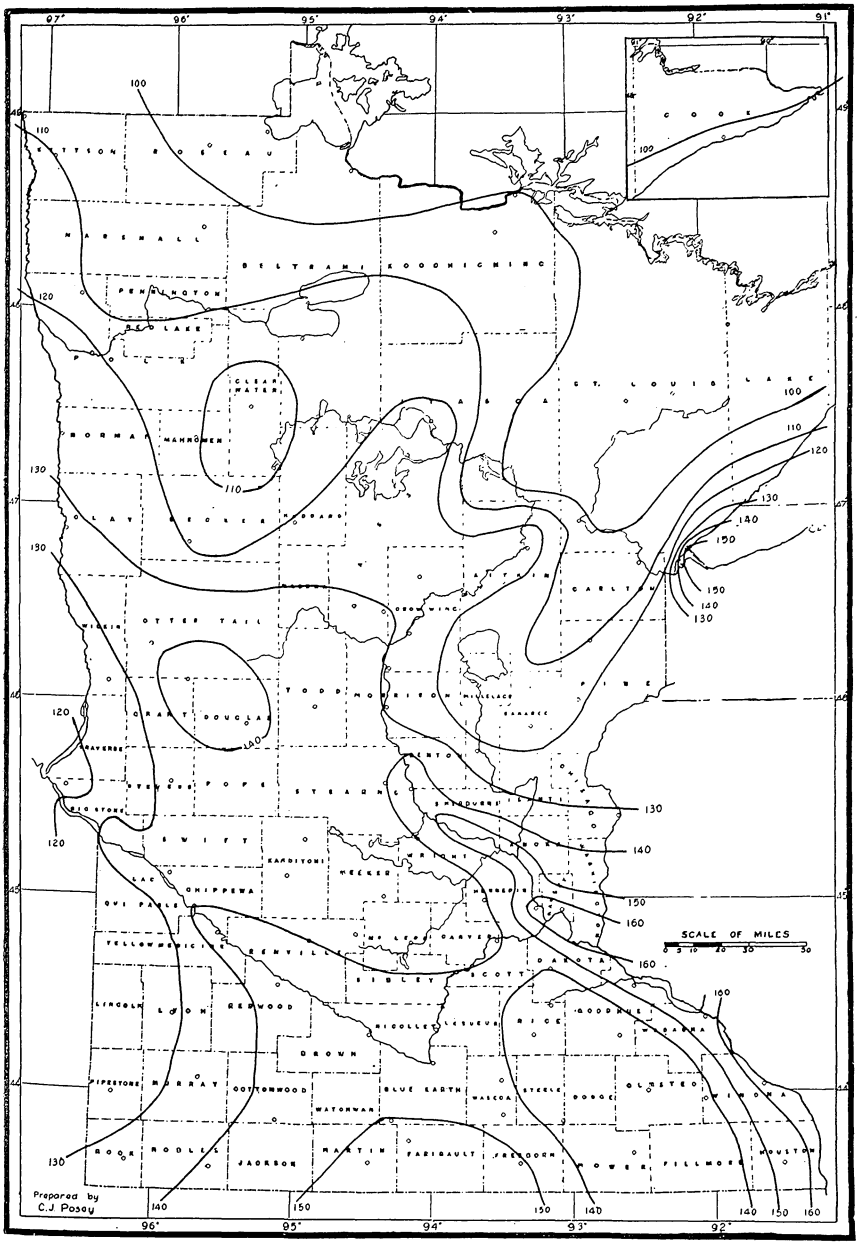


Fig. 6. Average Growing Season, Days
(Courtesy of Department of Geology)

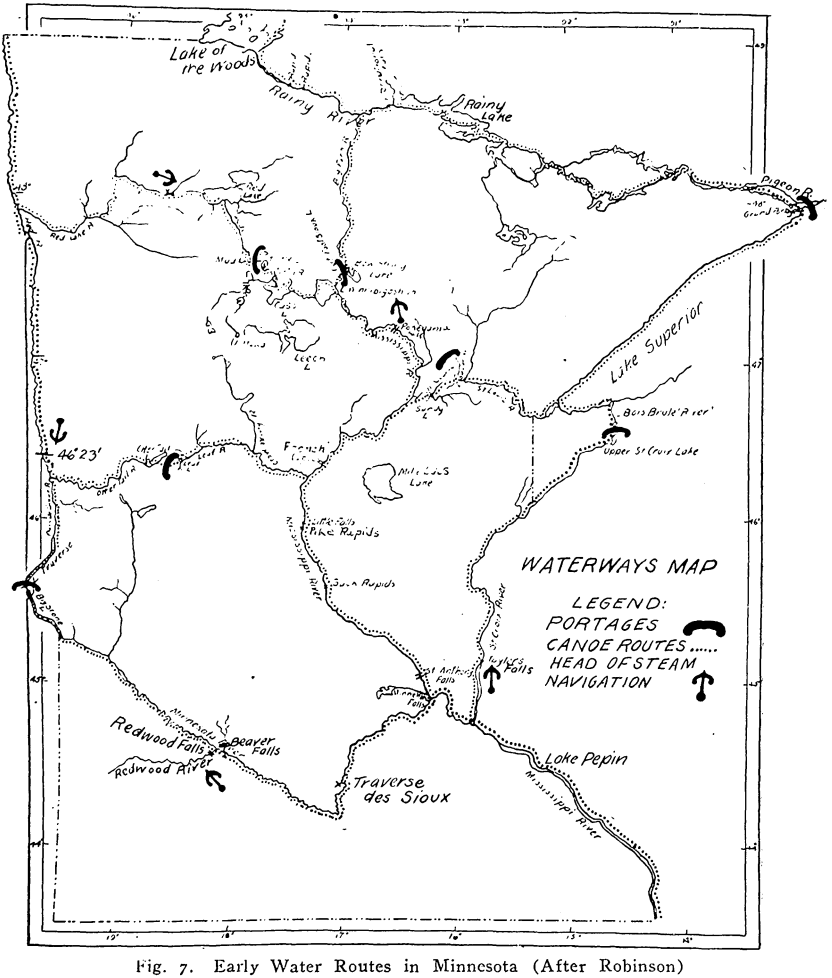


Fig. 7. Early Water Routes in Minnesota (After Robinson)

Lake Superior. Steam navigation was not possible all the way to the portages over any of these routes. Figure 7 shows the early water routes in Minnesota.

Previous to 1860 there was less than ten miles of railroad in Minnesota. In 1869 there were 766 miles. Figure 8 shows the railroads in operation on January 1, 1869. They were limited entirely to the southeastern part of the state and radiated from Minneapolis and St. Paul. One line was built up the Mississippi River to Sauk Rapids; another along the Minnesota River to Lake Crystal; another into the southern part of the state through Owatonna to Le Roy; and another westward to Cokato. A fifth was started northward toward Duluth, but reached only to Wyoming. All these lines later became trunk

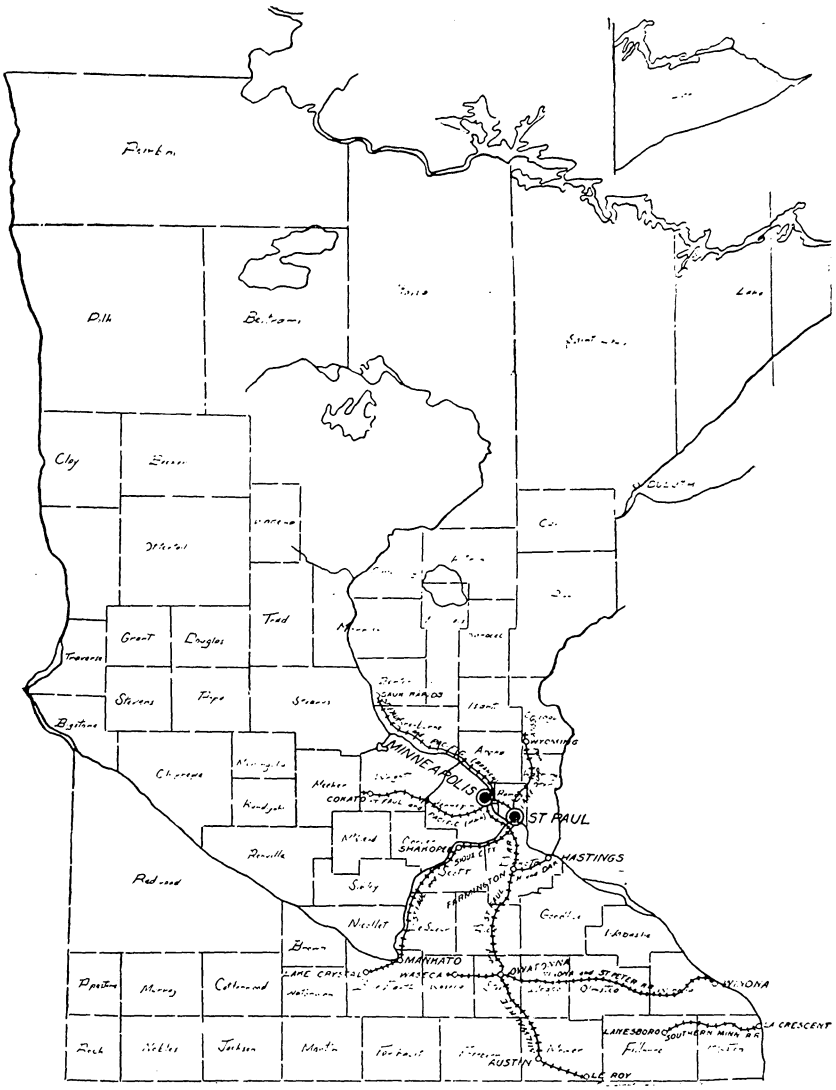


Fig. 8. Railroads Operating in Minnesota on January 1, 1869 (After Robinson)

lines. By 1879 there were 2,941 miles of railroad in the state. During this decade the Red River Valley was connected with the Twin Cities and Duluth, and the first railroad between St. Paul and Duluth was completed. Railroad construction was extended in the west central and southern parts of the state, thus opening transportation routes from that region to Minneapolis, St. Paul, and Duluth. By 1889 the miles of railroad had reached 5,303. There were approximately one and one-third millions of people in the state and more than 116 thousand

farms, 50 per cent of the farm land being used for cropping. After 1889 railroad expansion was less rapid; about 1,000 miles during the next decade, but between 1899 and 1909 it reached about 2,000 miles. In 1927 the State Railroad and Warehouse Commission reported 9,379 miles of railroads in operation in the state. Figure 9 shows the development of railroads since 1860 and its relation to land in farms, land in crops, amount of livestock, and population. Population shows a steady increase; the other factors mentioned show a closer relationship to railroad expansion. Every county is now served by one or more railroads, altho most of the railroad mileage is in the southern part of the state and in the areas of heaviest agricultural production.

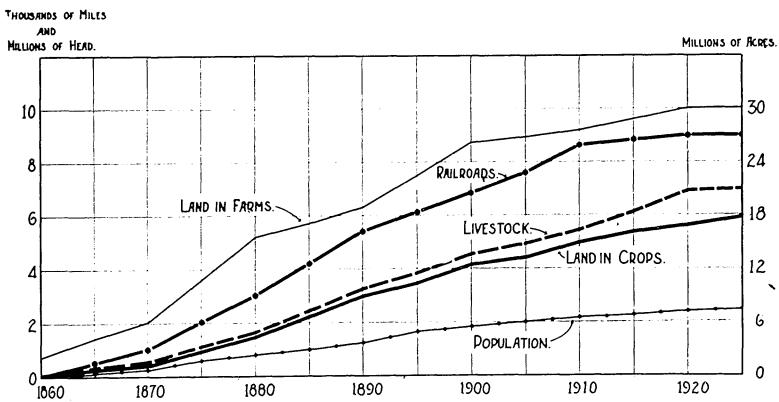


Fig. 9. Relation Between Railroads and Agricultural Development in Minnesota, 1860-1925 There has been a close relationship between the expansion of railroads and of land devoted to farming. The land in farms is more closely related to railroad expansion than land in crops or number of livestock.

Improvement in transportation facilities or a shortening of the route to the central markets, or both, may cause an expansion in the production of a certain product in an area or the introduction of a new product. Improvement in refrigeration coupled with rapid rail transportation has made it possible to ship whole milk several hundred miles to the larger consuming centers. Sweet cream is shipped from Minnesota to eastern markets. Less perishable products, as butter and cheese, can be shipped across the continent or even across the ocean.

During the last decade the development of motor transportation has had a marked effect on agricultural production most noticeable in the areas blessed with good roads. Improved roads and motor transportation have shortened the time required to market farm products and made it possible to produce them farther from market, thus increasing the area of intensive agriculture.

Method of transportation and type of road from farm to local market regulate the cost of marketing. The character of the road over which the producer goes to market, by influencing the cost, may be the deciding factor as to what he will produce on his farm.

Unless there are facilities for handling a product after it reaches the local market it is unwise to produce it, even tho it might yield well in a locality. An example is the production of sugar beets in an area where the distance to a factory makes transportation costs prohibitive. Some products must be consumed soon after they are produced. At best, they can be kept only a day or two and so must be produced near to where they are consumed.

Farms producing whole milk have an advantage when they are near shipping points. Butter, cheese, and eggs can be produced farther from the shipping station and also farther from the consuming center. As the distance from the shipping point increases, products of a non-perishable nature are produced—grain, roughage, and most kinds of livestock, which reach the market in condensed form.

As the area of the more intensive forms of agricultural production increases, the less intensive are pushed farther from the market. These, in turn, out-compete the more extensive types and thus the process continues until the most extensive forms of production are crowded out. This shifting of production is the principle of comparative advantage at work,[2] made possible through the improvement of transportation facilities.

LAND VALUE

Land used for agricultural purposes derives its value largely from its productivity. Factors that have some influence in determining the price are distance from market, desirability of location, and possible increase in value. The last factor is sometimes referred to as the speculative element in land value and is based upon anticipated increases in income.

The chief item that determines the productive value of agricultural land is its economic rent, which depends on the producing power of the land, cost of production exclusive of land, and the price of the product.

Figure 10 shows the value of land per acre in Minnesota as reported by the 1920 federal census. Land values were highest in the southwestern part of the state. A small area near the Twin Cities and one in the extreme western part of the state averaged more than

[2] The principle of comparative advantage is that an area or a region will produce commodities in which it has an advantage over other areas or regions. For an elaboration of this principle see "Production Economics," by J. D. Black, chapter 5.

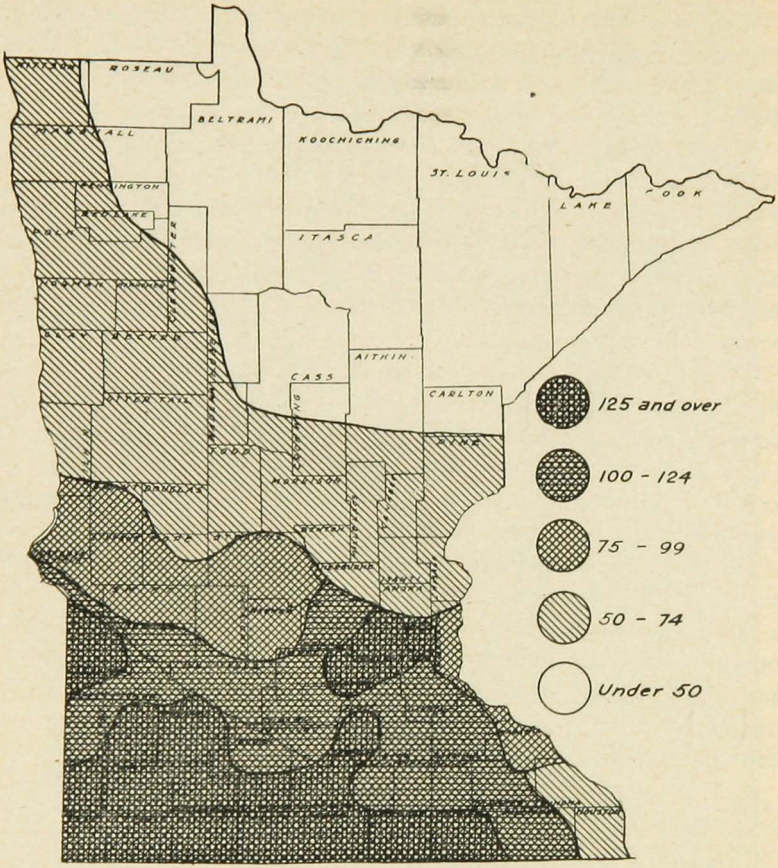


Fig. 10. Value of Land per Acre in 1920

$125 per acre. Land in Rock County, in the extreme southwestern corner, had the highest value, averaging $231 per acre.

Land values were lowest in the northeastern part of the state, where they averaged less than $50 per acre. Koochiching County had the lowest—$19 per acre. The soil and climatic conditions have retarded the development of agriculture in that part of the state. A strip of land extending about half way down the western border of the state and through the central part varied in value from $50 to $74 per acre. A small area in the extreme southeastern part of the state had the same range. The rest of the land, which for the most part lies in the south central part of the state, varied in value from $74 to $124 per acre, depending largely on soil conditions, altho surface conditions and rainfall are important factors. The average for the state was $109 per acre.

By 1925 the state average had decreased to $80 per acre. The value of the highest priced land in the southern part of the state decreased approximately 36 per cent from 1920 to 1925; that in the west central part, 33 per cent; and that in the east central, 4 per cent. The small decrease in the east central part was due to the industrial development in the Twin Cities coupled with a rather stable type of farming, largely whole milk production. The expansion of the truck-growing area due to the growth of the cities was also a factor.

The value of land in the northeastern part of the state, which had the lowest land values in 1920, increased 6 per cent by 1925. A constant adjustment is taking place between land value and type of farming. High land values have less effect on types of farming than many of the other factors.

IMPROVED LAND

Improved land is land that is regularly tilled or mowed; land in pasture that has been cleared or tilled; land lying fallow; land in gardens, orchards, vineyards, and nurseries; and land occupied by farm buildings.[3]

Two factors determine largely the percentage of improved land in an area, returns that can be expected and surface obstructions—stones, trees, and water. Topography is also a factor. Returns are greater, as a rule, from improved than from unimproved land. Where the percentage of improved land is high the price of land is higher than where the percentage is low. The percentage is higher in southern Minnesota than in northern Minnesota, where land is cheaper.

Where surface obstructions do not interfere with farm operations, the percentage of improved land is high, altho the land may be cheaper than in other parts of the state. Along the western border of the state, even to the northern boundary line, the percentage is higher than in some areas farther south.

Figure 11 shows the percentage of farm land in Minnesota that was classed as improved land in 1920.[4] In the extreme southeastern part of the state it is low because of the topography; also, it is less along streams, particularly the Mississippi and Minnesota Rivers. To the northward surface obstructions such as stones, water, and timber reduce the percentage of improved farm land.

The percentage of improved land increased continuously from 1850 to 1920, altho the size of the farm has not always increased from one census period to the next. As the percentage increased, the value of the land and buildings increased. Table I shows the percentage of farm land improved, the average size of farm, and the value per acre of land

[3] Federal census, 1920.
[4] Federal census, 1920.

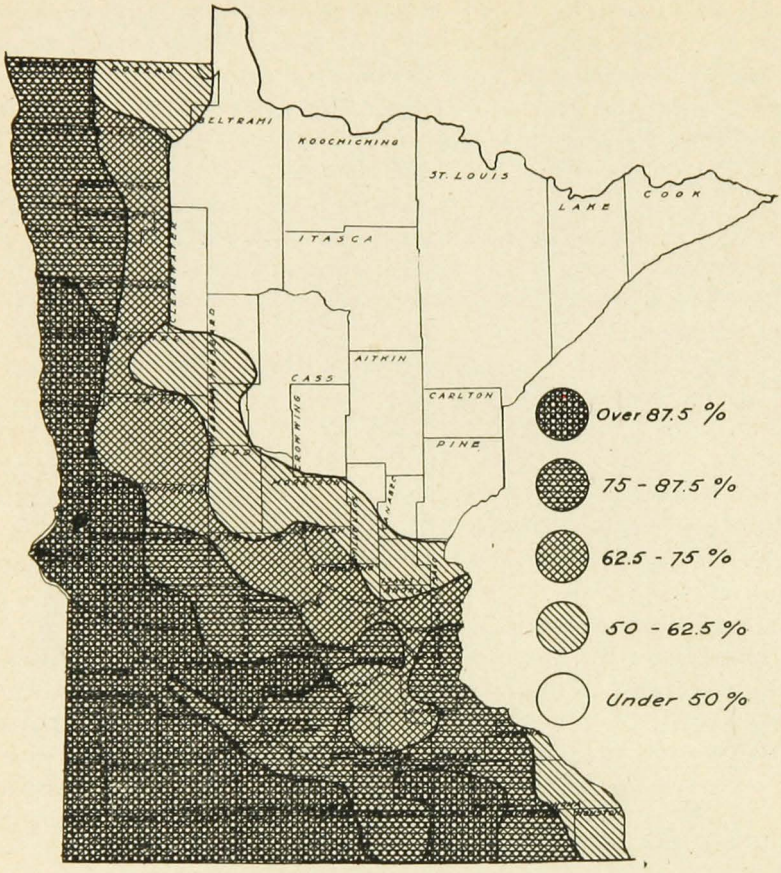


Fig. 11. Percentage of Farm Land Improved, 1920
This includes all crop land cleared or tilled, pasture, and land occupied by buildings.

and buildings from 1850 to 1925. The change in land values since 1920 is a result of the agricultural depression.

TABLE I

PERCENTAGE OF IMPROVED LAND, SIZE OF FARM, AND VALUE PER ACRE, IN MINNESOTA, FROM 1850 TO 1925

Date	Percentage of farm land improved	Size of farm, acres	Value of land and buildings per acre
1850	17.4	183.9	$ 5.61
1860	20.5	149.2	10.14
1870	35.8	139.4	12.07
1880	54.1	145.1	14.45
1890	59.6	159.7	18.22
1900	70.3	169.7	25.51
1910	71.0	177.3	45.62
1920	71.1	169.3	109.23
1925	69.6	159.7	79.63

Of the 51,749,120 acres of land in the state, only 58.1 per cent is in farms. Little more than half of the land area is devoted strictly to agricultural production. About 15 million acres are devoted to forestry. Approximately 287 thousand acres are devoted to mining or are under the control of mining companies.

LAND TENANCY

The percentage of farms operated by tenants increased from 9.1 in 1880 to 24.7 in 1920. During the next five years it increased 2.4 per cent. The percentage of both share and cash tenancy increased but cash tenancy increased more rapidly to 1920. From 1920 to 1925 the percentage of cash tenancy decreased; share tenancy continued to increase.

Tenant farming tends to flourish where cash crops are grown in abundance. The percentage of tenancy is relatively high along the western border of the state where wheat, flax, other small grains, and potatoes are sources of much of the income. On the other hand, returns from dairying depend more on the man than on the land and are not easily standardized. Dairy farms have a smaller percentage of tenancy than crop farms.

Figure 12 shows the percentage of tenancy in the state as reported by the 1920 census. It was highest in the southwestern and west central parts of the state, where land values are highest and where the largest percentage of farm land is improved. Rock County, which had the highest land value in 1920, also had the highest percentage of tenancy. The lowest percentage was in the northeastern part of the state, where the percentage of improved land per farm was less and the incomes from farms were smaller. In the south central part of the state dairy farming is well established and there was less tenancy than to either the east or the west of it. In the central part of the state dairy farming is well established and tenancy varied from 10 to 19 per cent.

SHIFTS IN PRODUCTION OF AGRICULTURAL COMMODITIES

Crop Acreages

There has been a marked shift since 1879 in the proportion of crop land devoted to the eight principal crops. In 1879 approximately 70 per cent of the crop land was devoted to the production of small grains. Wheat was the most important crop, being grown on 56.6 per cent of the entire crop land. Oats occupied 11.6 per cent, corn 8.3, barley 2.2, rye 0.3, flax 0.2, potatoes 1.0, and hay 19.8. Figure 13 shows the shifts in crop acreages from 1889 to 1924.

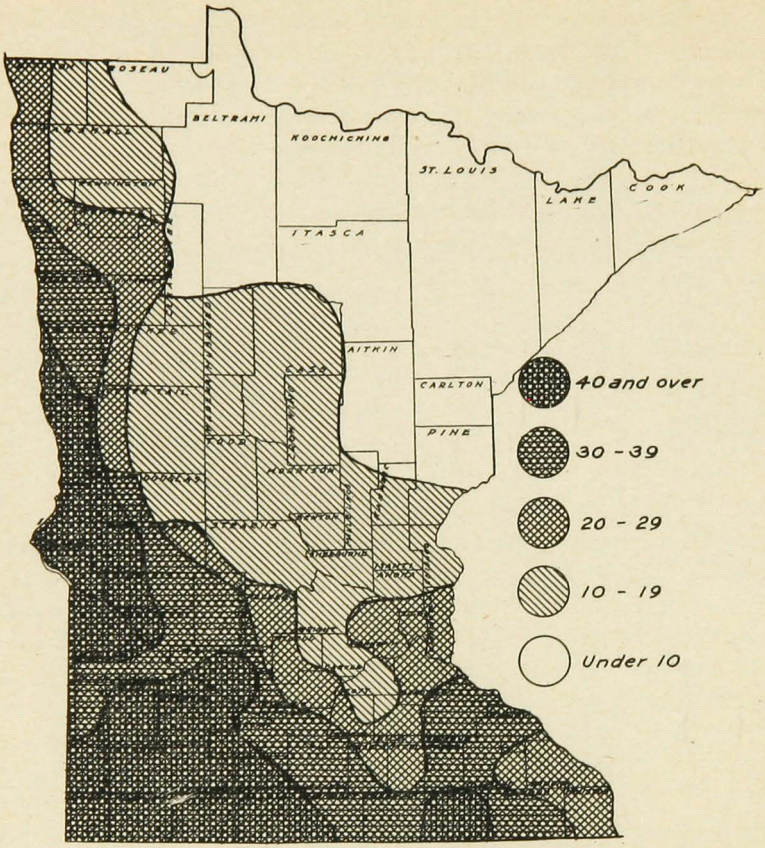


Fig. 12. Percentage of Tenancy in 1920
Note the relationship between percentage of tenancy and percentage of farm land improved (Fig. 11) and value of land (Fig. 10).

Wheat decreased in relative importance each decade since 1879 except in 1899, when it occupied 43.4 per cent of the crop land. Only 9.2 per cent of the crop land was devoted to wheat production in 1924.

The percentage of crop land occupied by oats increased from 1879 to 1889. By 1899 it had decreased 2.2 per cent. The increase was continuous from 1899 to 1924, when oats occupied 25.7 per cent of the crop land.

Barley occupied 2.2 per cent of the crop land in 1879 and the percentage increased to 10.7 by 1909. There was a decrease in 1919 to 4.8 per cent but an increase again in 1924 to 5.1 per cent.

The percentage of crop land occupied by rye has continuously increased since 1879 except for the period 1919-24, when there was practically no change. In 1879 it occupied 0.3 per cent of the crop land and in 1924 only 3.4 per cent.

The percentage of crop land occupied by flax increased from 0.2 in 1879 to 3.7 in 1899. There was a decrease to 1.7 per cent in 1919 but an increase to 3.8 in 1924.

There was a continuous increase in the percentage of crop land devoted to corn production from 1879 to 1924. In 1879 it occupied but 8.3 per cent; by 1924 it had increased to 25.8 per cent—a larger percentage than was occupied by any other crop.

Potatoes increased from 1.0 per cent of the crop land in 1879 to 2.0 per cent in 1919. They decreased to 1.8 per cent in 1924.

The percentage of crop land occupied by hay was varied throughout the period. It was largest in 1889, when it occupied 28.7 per cent, and decreased in 1899 to 20.9 per cent. That was the year when wheat showed an increase. By 1924 hay occupied 24.4 per cent. No distinction was made between the different kinds of hay.

Buckwheat, speltz, sugar beets, fruits, and vegetables occupied the rest of the crop land.

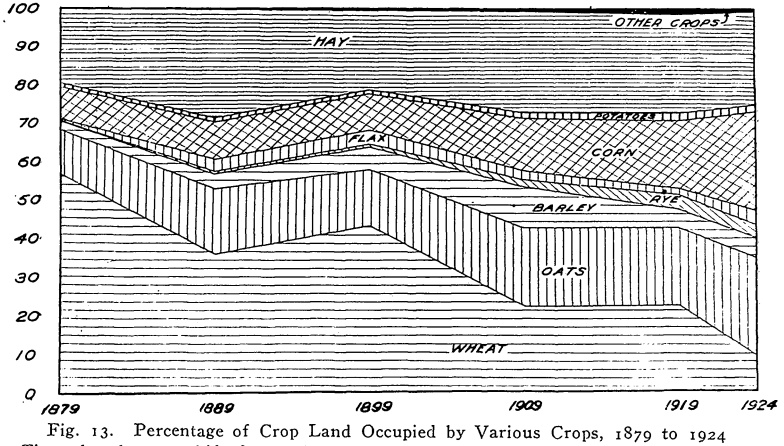


Fig. 13. Percentage of Crop Land Occupied by Various Crops, 1879 to 1924
There has been a shift from wheat to feed crops. The percentage of land devoted to feed crops, exclusive of hay, in 1924 was the same as that devoted to wheat in 1879.

Crop Yields

Table II gives the average ten-year yield for the crops indicated.

TABLE II

AVERAGE YIELD OF PRINCIPAL CROPS, BY TEN-YEAR PERIODS, 1867-1924*

	1867-69*	1870-79	1880-89	1890-99	1900-09	1910-19	1920-24
Wheat, bu.....	14.4	14.3	12.6	14.4	13.1	14.1	12.9
Corn, "	30.8	32.5	29.9	28.1	29.3	34.2	34.5
Oats, "	37.2	34.0	33.4	31.0	31.6	33.4	35.5
Barley, "	24.8	26.1	24.2	26.2	25.5	24.3	25.9
Rye, "	19.4	18.6	14.8	17.4	18.8	18.4	17.7
Potatoes "	124.3	97.7	94.3	87.2	88.4	100.5	97.8
Flax, "	....	....	....	....	....	10.5	9.1	10.3
Hay, tons	1.25	1.43	1.31	1.44	1.65	1.55	1.41

* Minnesota Crop Reports. Data previous to 1867 not available.

Hay is the only crop that had a marked upward change in yield throughout the period. The yields of rye and corn were slightly upward; of oats and barley, slightly downward. Potatoes and wheat show no change. On the whole, crop yields have been slightly upward when considered from a long-time point of view. The upward tendency is due to better seed, development of new varieties, improved cultural practices, and greater use of manures and commercial fertilizers. From 1900 to 1924 corn and oats show a marked increase in yield. Wheat, rye, and hay show decreases during this period; potatoes, barley, and flax show no change. Data on crop yields were doubtless more reliable in the later decades, which means that the changes were more significant.

Variation in Crop Yields

Altho the yields of crops have increased slightly, there may be a wide variation from year to year. Table III gives the percentage variability in yields of nine crops grown in Minnesota. Spring wheat and potatoes show the highest, each having a variability of 24 per cent. Buckwheat has a variability of 19 per cent, tame hay 17, oats, winter wheat, and corn 16 each, rye 15, barley 14, and flax 10. The less the percentage of variability the more dependable the yield. A greater variability in the yield of wheat than in that of other small grains is doubtless a significant reason why farmers are decreasing their wheat acreage. The acreage of spring wheat decreased 60 per cent from 1913 to 1927. During the same period the acreage of winter wheat increased 200 per cent. The percentage variability of yield in winter wheat was 16 and of spring wheat 24. A more dependable yield of winter wheat, as indicated by the percentage variability, undoubtedly was a factor in causing the farmers to shift from spring wheat to winter wheat production. Altho the variation in the yield of potatoes is equal to that of wheat, they are usually a more remunerative crop and farmers with small acreages are less inclined to shift from this crop on the basis of variation in yield.

TABLE III

PERCENTAGE OF VARIABILITY IN CROP YIELDS FOR MINNESOTA 1867-1927

Crop	Per cent variability	Crop	Per cent variability
Corn	16	Barley	14
Spring wheat	24	Flax	10
Winter wheat	16	Potatoes	24
Rye	15	Buckwheat	19
Oats	16	Tame hay	17

Livestock

Figure 14 shows the number of livestock units[5] on farms in Minnesota from 1880 to 1925.

Swine and poultry are the only kinds of livestock that show a continuous increase in number from 1880 to 1925, as reported by the federal census. The number of dairy cattle increased continuously until 1920; it decreased slightly from 1920 to 1925. The number of beef cattle increased from 1886 to 1910, after which it decreased continuously. The number of horses increased until 1920. There was a decrease of 10 per cent during the next five years. Sheep increased from 1880 to 1910, and decreased from 1910 to 1925.

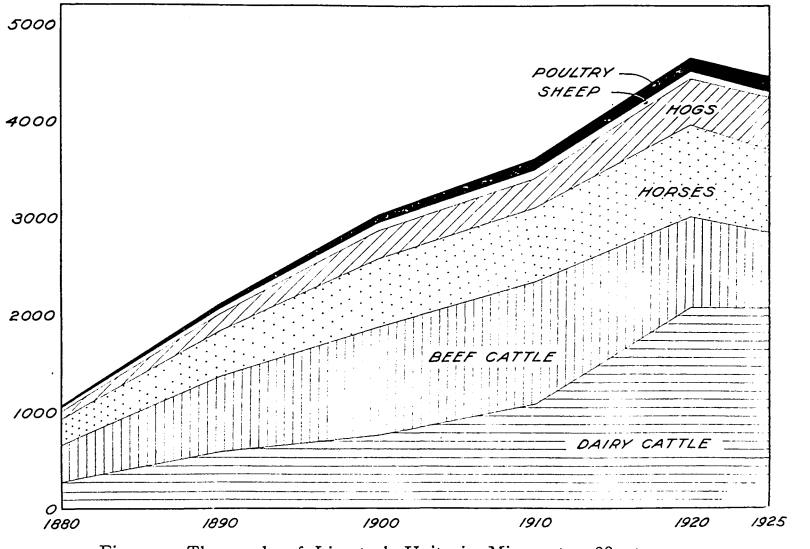


Fig. 14. Thousands of Livestock Units in Minnesota 1880 to 1925
(See footnote below for meaning of livestock unit.)

All livestock except horses and beef cattle show a continuous increase in numbers. The big increase in the number of dairy cattle offsets the decline in beef cattle. Because the census was taken in different months, the livestock figures are not strictly comparable. The error, however, is small.

The importance of a particular kind of livestock in a farm organization may be measured by comparing it with other kinds of livestock.

Table IV gives the relative importance of the different kinds of livestock on farms in Minnesota from 1880 to 1925 as reported by the federal census.

Horses decreased in relative importance from 1880 to 1925. The introduction of motor power has been an important reason for this decrease since 1900.

[5] One unit = one mature horse or cow; 5 swine; 7 sheep; 100 chickens.

TABLE IV

PERCENTAGE OF DISTRIBUTION OF TOTAL UNITS OF LIVESTOCK DESIGNATED

	1880	1890	1900	1910	1920	1925
Horses	25.1	22.2	23.2	21.0	20.3	19.0
Dairy cattle	25.9	28.3	24.9	30.1	44.7	46.5
Beef cattle	36.1	36.7	36.9	35.0	20.2	17.4
Swine	7.2	8.0	9.5	8.4	10.3	12.2
Sheep	3.6	2.7	2.8	2.5	1.6	1.3
Poultry	2.1	2.1	2.7	3.0	2.9	3.6
	100.0	100.0	100.0	100.0	100.0	100.0

The relative importance of dairy cattle increased continuously except in 1890, when there was a decrease from the previous census report.

The relative importance of beef cattle increased less than 5 per cent from 1880 to 1900 and decreased continuously thereafter. The decrease in beef cattle and increase in dairy cattle indicates that production was shifting from beef to dairy products.

Swine gained in relative importance from 1880 to 1900, decreased about one per cent by 1910, and increased after that.

Sheep were relatively more important in 1880 than at any later time. There was a continuous gain in poultry except in 1920, when there was a slight loss.

The decrease in the relative number of beef cattle was offset by an increase in dairy cattle. In the cattle enterprise as a whole there was little change throughout the entire period. The decrease in horses and sheep has been offset by an increase in swine and poultry.

PRODUCTION AREAS

As has been indicated, three sets of factors are active in determining a production area—the physical, including soil and climate; the economic; and the biological. Certain crops respond to particular soil types better than to others. Corn does better in a warm loam soil than in clay. Wheat does best in heavy soil. Certain crops can not mature in some regions because of the shortness of the growing season or because of cool nights, for example, corn does not do as well in northern latitudes as in more humid sections farther south. Neither does it do well in high altitudes because of the cool nights.

The two factors that are most influential in determining localization of production are unit value and perishability of the product. Bulky products, as hay, have low values per unit of volume. They can not stand the high transportation costs involved in shipping over long distances, so are produced comparatively close to points of consumption. Wheat and flax, with high values per unit of volume, can stand higher transportation costs, so are grown farther from points of con-

sumption than are potatoes and hay. Perishable products, including milk and most of the truck crops, must be produced comparatively close to market. Fresh vegetables may be shipped a long distance only when out of season at the consuming market, thus commanding a high price. These are the principles that cause truck farming to be the type of agricultural production adjacent to a large consumption center. A little farther out is whole milk, and beyond this the more concentrated products—butterfat, livestock, and grain.

Diseases and insects may prevent crops from developing. Rust is a menace to spring wheat. The chinch bug and hessian fly damage corn and wheat so that it is unprofitable to grow them in certain localities. Farmers are constantly required to face these conditions and they may have to make extensive changes in cropping systems.

Crops constitute the part of the business around which a system of farming is built. This basic principle is more or less followed in all localities. Where there is a wide range in the selection of crops, farmers may consider livestock as important as crops. Generally, however, livestock enterprises are built around the crops that can be grown in a locality.

Figure 15 shows the distribution of crops, by counties, in Minnesota in 1924. The length of the bar indicates their relative importance. In the extreme northwestern part of the state so little corn is grown that it does not appear on the chart. In some counties more than half the crop land is devoted to the production of cash grain crops. In the southern part, corn is very important and cash grain crops give place to feed crops. In the northeastern part of the state hay is the most important crop, there being practically no corn and little in the way of cash grain crops. However, where potatoes are grown, altho their relative importance may not be high, they contribute a large part of the income. Because of their high labor requirements they may materially affect the organization of the farm. By studying the map one is impressed with the variety of crops grown in the central and eastern parts of the state. Oats and barley are grown to some extent in every county. They are used primarily as feed crops, altho they are sold in many sections of the western and northwestern parts of the state. Hay, both native and tame, is also found in every county and is used primarily for feed. Potatoes are most important in Clay County and in the east central part of the state, largely because of the type of soil and the rainfall. Flax is grown in the northwestern counties and a small amount in the southeastern part of the state.

Figure 16 shows the distribution of livestock in Minnesota in 1924. It shows that, on the basis of livestock units, dairy cattle are more numerous than any other kind of livestock. In the northeastern counties, where hay is relatively more important than in counties farther

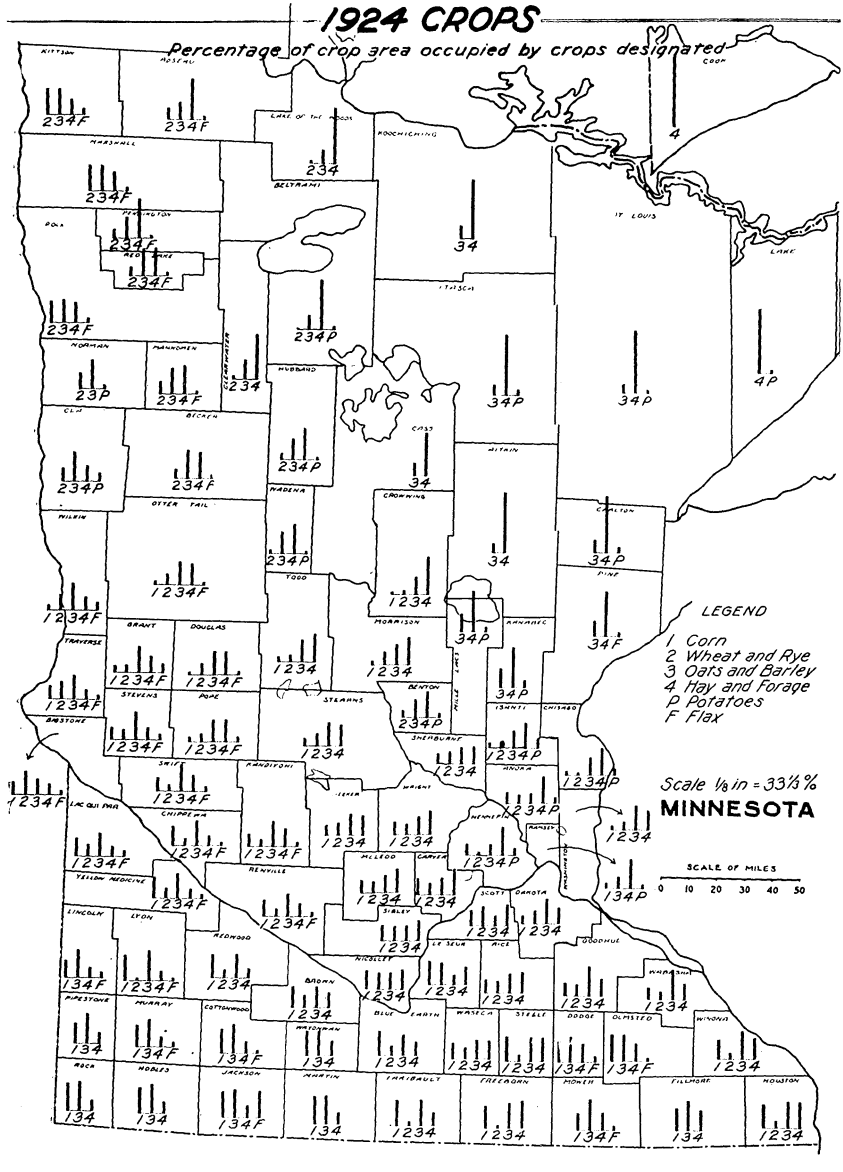


Fig. 15. Percentage of Crop Land Occupied by Crops Designated, 1924
The length of the bar indicates the importance of the crop.

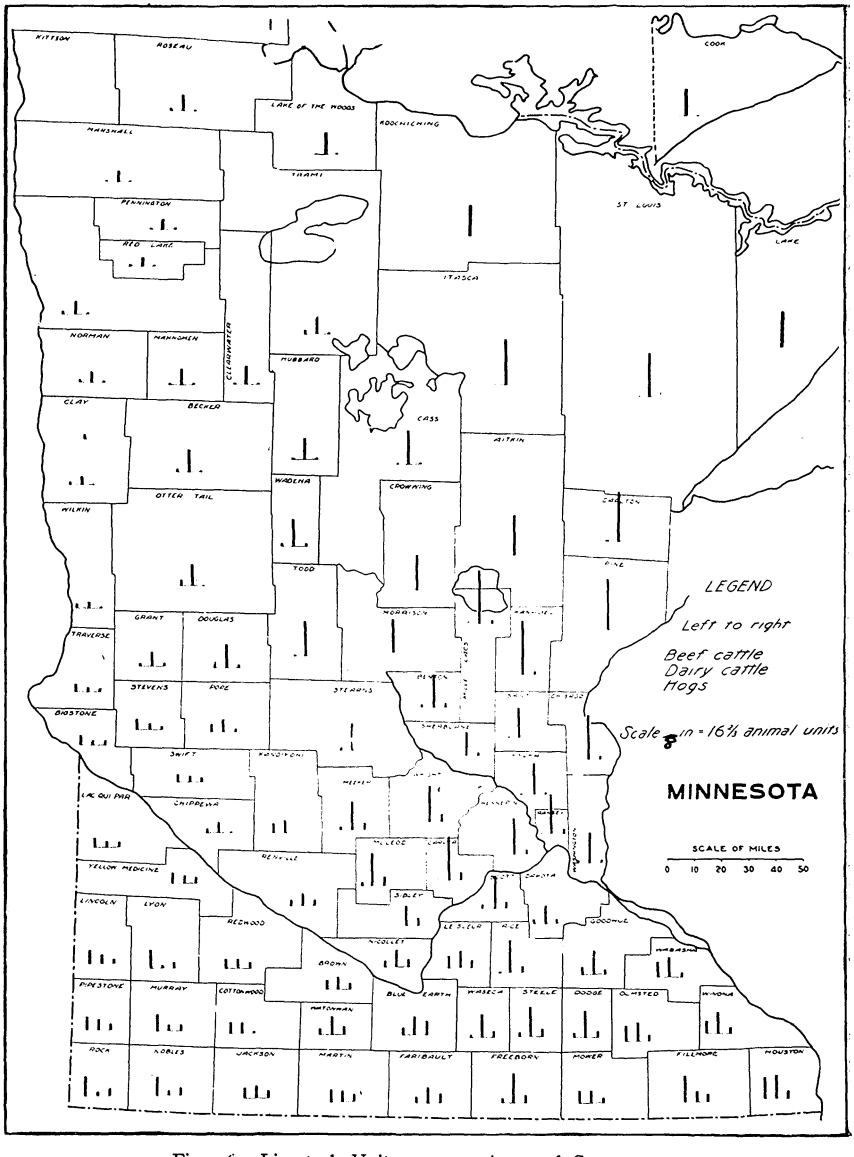


Fig. 16. Livestock Units per 100 Acres of Crops, 1924
The length of the bar indicates their importance in the farm business

south, dairy cattle are also relatively more important. In the southwestern part of the state beef cattle and swine are more important than dairy cattle. Corn is relatively more important in this area than any of the other crops. Where corn is grown in abundance, beef cattle and hogs are likely to be found in about equal proportion. In the western and northwestern parts of the state, livestock becomes of less importance as corn and hay become less important in the cropping system. In this area oats and barley are disposed of to some extent as a cash crop rather than all grown for feeding. As the growing of these crops does not affect the farm organization and their yields are dependable, they have had something to do with the reduction of the acreage of wheat. While in the northeastern counties dairy cattle are the most important kind of livestock, the total amount of livestock is so small that it has had little influence on the farm organization. The figures also indicate that in counties with a wide range in the variety of crops raised the livestock seems to be more numerous. Figure 17 demonstrates this more clearly. This may not be entirely true in the northeastern part of the state. In that region most of the livestock consists of dairy cattle, which get a large part of their feed from uncropped timber land. This accounts for the large number of livestock in proportion to crop land in this area. Farther south and west, where such pasture land is not available, the number of livestock is dependent entirely on the crop land plus what little native pasture is available and thus the livestock is more nearly adjusted to the crop land than in localities where there is an abundance of pasture.

The scarcity of livestock in the west central and northwestern areas of the state is largely due to the relatively small amount of feed crops grown. In the counties bordering the Red River little corn has been raised. While oats and barley are grown primarily as feed crops and occupy a fairly important place in the cropping system, they must be supplemented by corn before livestock becomes particularly important in the farm organization. The figure shows that there are only from three to five livestock units per 100 acres in crops in the Red River Valley small-grain area; in some of the eastern counties there are as many as sixteen units per 100 acres of crops. In other words, livestock appears to be from three to four times as important in the eastern part of the state as in the northwestern part.

DESCRIPTION OF PRODUCTION AREAS

Seven areas in Minnesota are representative of different types or systems of farming (See Fig. 18). They have been located largely on the basis of crops and livestock raised. These designated areas are not the only ones in which the particular system of farming is found;

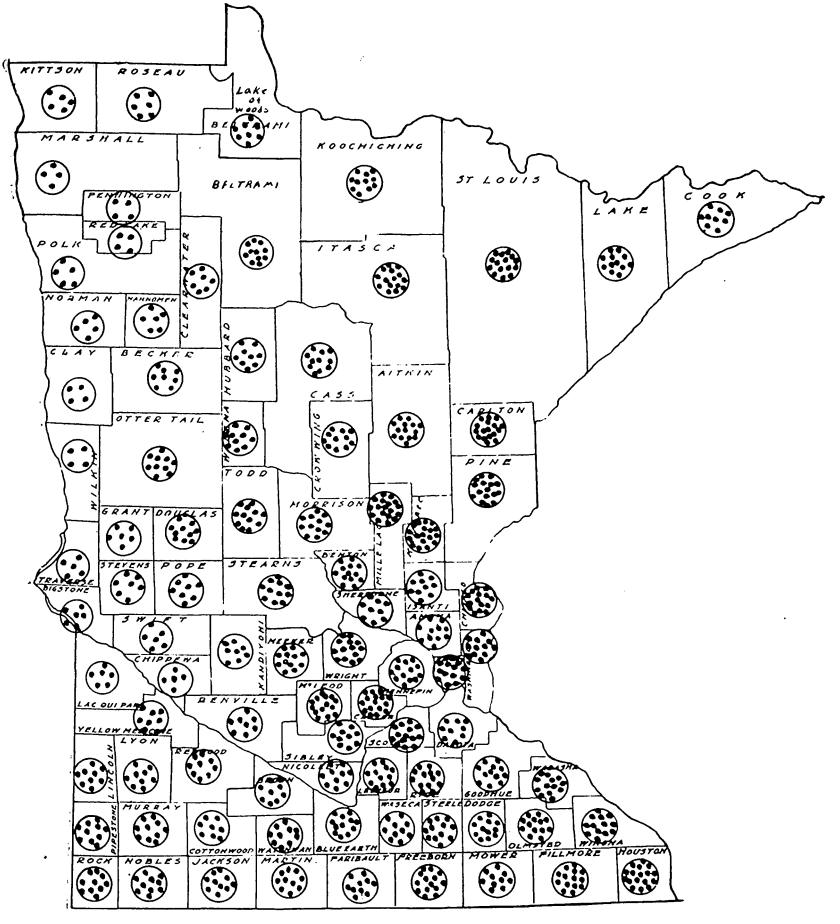


Fig. 17. Livestock Units per 100 Acres of Crops, 1924

The circle in each county represents 100 acres of crops. Each dot within a circle represents two livestock units. The number of dots in each circle represents the relative density of livestock in proportion to crop land. To illustrate, there are 8 livestock units per 100 acres of crops in Clay County and 16 in Renville County. The relative density of livestock is an indication of the importance of livestock n the farming business. In the northwestern and the middle western parts of the state some feed crops are sold. The livestock in these areas is not adjusted to the supply of feed crops as in the eastern and southern parts of the state where very little feed crops are sold.

they represent rather the areas in which it is dominant. For example, dairying is the most important part of the farm business in Area I, but there are localities in each of the other areas where dairying is just as important. Beef cattle and hog raising constitute the chief part of the farm business in Area IV, but there are localities in some other areas where they are equally important. There are similar exceptions in each of the other areas.

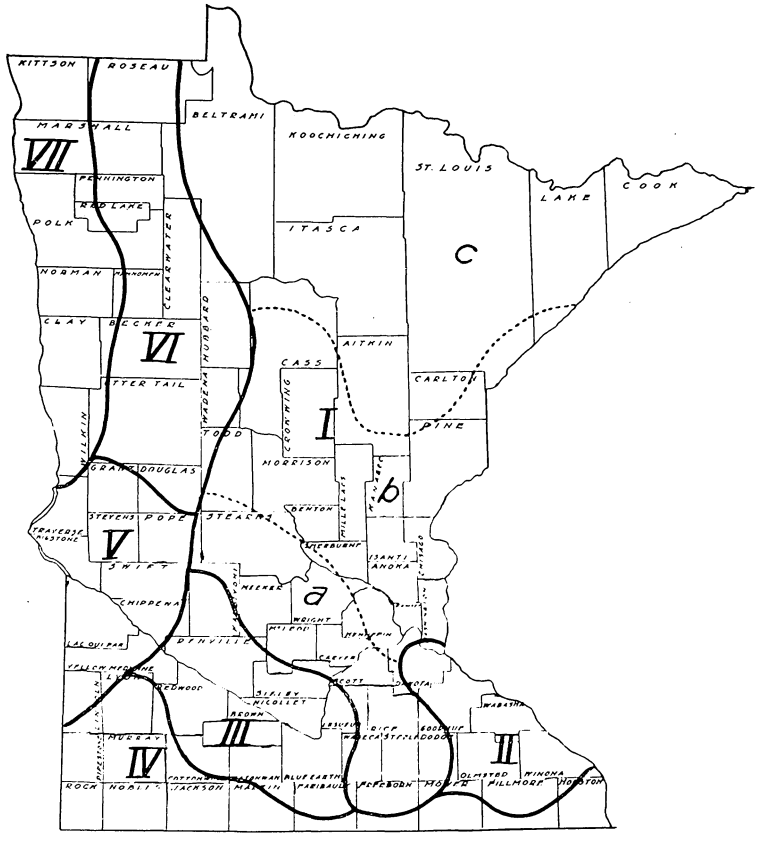


Fig. 18. Production Areas in Minnesota

Ia	Southeast Dairy	IV	Beef Cattle and Hogs
b	East Central Dairy	V	West Central Small Grain
c	Northeast Dairy	VI	Northwest Small Grain and Dairy
II	Southeast Livestock and Small Grain	VII	Red River Valley Small Grain
III	Southwest Livestock and Small Grain		

The division lines between areas do not indicate a sharp distinction between farming types—the place where one type of farming ends and another begins. They represent areas in which the systems of farming overlap or are changing. These division lines may be thought of as zones, perhaps several miles in width in some places, where the system of farming is changing. It would be impossible to make a definite division line between two areas.

There is a wide range in the kind of dairying done in Area I. While the production of dairy products is much greater per unit of land in the southern part of this area, the percentage of the farm income from dairying is greater in the northern than in the southern part. The milking of beef cattle may have much to do with determining whether

an area is used for beef or dairy production. Where farmers have cattle from which they have a choice of raising beef or dairy products there is a zone where the system of farming is more or less changing—is in a transition stage and often does not represent the practices of a well established type of farming.

Area I, Where Dairying Predominates

Southeast dairy.—Dairying in this area is conducted on an intensive scale. It constitutes the chief source of income and is supplemented by swine, poultry, and small grains, principally wheat. Some sugar beets are grown as a cash crop. Butterfat is the chief product sold. Whole milk is marketed near cities and in a few places where cheese factories are located. This is one of the old dairy sections of the state and the farming business is established on the basis of many years of experience. As dairying is largely on the butterfat basis, the enterprise is supplemented by swine. The two contribute most of the income.

East central dairy.—Dairying in this area is supplemented by hogs, poultry, potatoes, root crops, and small grains, chiefly wheat and rye. There is some income from wood. The dairy products are sold as butterfat except near the cities, where they are sold as whole milk. Much of the land in this area, especially in the northern part, is still in timber. In a few localities poultry production is expanding rapidly and is on a commercial basis.

Northeast dairy.—While dairying contributes the greater part of the farm income in this area, the total is not large. The income is supplemented by sales of poultry, sheep, potatoes, and small grains, chiefly wheat and rye. The income from small grains is relatively unimportant. As in the other dairy areas, the product sold is butterfat, except near Duluth and in some parts of the iron range, where whole milk is supplied to the local market. This area is heavily timbered. Most of the farms have only a small acreage cleared. Many of the farmers work in the woods during the winter, thus adding to their income. Agriculture is comparatively undeveloped on the iron range.

Area II, Southeast Livestock and Small Grain

The farming in Area II is of mixed type. Dairy cattle, beef cattle, hogs, sheep, and poultry contribute to the farm income. Of the small grains, wheat, flax, and barley contribute the most. The land near the Mississippi River is very rolling and supplies excellent pastures for dairy cows and beef cattle. Some of the land is timbered and furnishes fuel and some timber for buildings on the farms. Very little lumber and wood are sold.

Oats and barley occupy about 30 per cent of the crop land and corn 24 per cent. Wheat and rye occupy about 20 per cent, and hay about 18 per cent. The rest is occupied by miscellaneous crops, used largely for feed. About all the land that the topography will permit is under cultivation.

Dairy cattle rank first and beef cattle second in importance in relation to crop land. Hogs and sheep follow in the order named. Sheep are relatively unimportant in this area.

Area III, Southwest Livestock and Small Grain

Area III has a diversity of income. Beef and pork production and dairying are well established and contribute heavily to the farm income. There is a tendency toward dairy expansion in the northeastern part of the area and toward beef expansion in the southwestern part. Dairying is on a butterfat basis. Poultry and sheep add to the farm income. Wheat, rye, and flax are the cash crops. Corn is the principal crop and is practically all used for feed. Corn occupies about 30 per cent of the crop land and from this standpoint is the most important crop grown. Wheat and rye are next in importance, occupying about 27 per cent of the crop land. Hay occupies about 21 per cent. The acreage of oats and barley is about the same as that of hay.

The part of this area lying south of the Minnesota River is especially well adapted to corn production, and beef cattle and hogs will probably have an important place in the farm business for some time. North of the Minnesota River, hay is more important and probably dairying will become more important there.

Beef and dairy cattle are of about equal importance in this area. Hogs are important and supplement both the beef and the dairy enterprises. Only a few sheep are found. This region is in a transition stage.

Area IV, Beef Cattle and Hogs

The largest part of the farm income in Area IV comes from cattle and hogs. Dairying has been increasing in the southeastern part. There is some income from poultry and a small amount from sheep. Wheat contributes a small amount in the extreme southeastern part. This area produces an abundance of corn and forms a part of the national corn belt. One of the cheap-corn regions in the United States is in the southwestern part of the area, owing to the distance from market and the abundance of its production.

Oats and barley together occupy the largest percentage of crop land, approximately 38 per cent, and are practically all used for feed. Corn is next in importance, about 32 per cent. Hay occupies about 20 per cent, wheat and rye about 5 per cent, flax about one per cent, and miscellaneous crops the rest of the crop land.

Beef cattle are the most important livestock enterprise in this area. In some counties hogs are more important than dairy cattle. Only a few sheep are produced, probably because of the competition of other livestock enterprises. The farm organization in this area will doubtless continue to be built around beef cattle and hogs for some time.

Area V, West Central Small Grain

Area V depends to a great extent upon small grains for its income. Wheat and rye are important, being surpassed in acreage only by oats and barley, which are used as cash crops to some extent.

Flax is grown on a small scale and the change in acreage from year to year is slight and has little effect on the cropping system. Corn is becoming more important and may have a greater influence in determining the type of farming in the future. Corn occupies about 20 per cent of the crop land, wheat and rye 27 per cent, oats and barley 30 per cent, hay 18 per cent, flax 2 per cent, and miscellaneous crops 3 per cent. There is a tendency to increase the acreage of leguminous crops.

Beef and dairy cattle are of about equal importance. Were it not that many beef cows are milked and hence classed as dairy cattle, beef would be much more important. Hogs are increasing in importance as the corn acreage increases. Sheep are of minor importance and have little effect on the farm organization. With the increase in the acreage of corn and leguminous crops, farming in this section will likely shift from small grain to livestock, altho it will be some time before farming is established on a livestock basis.

Area VI, Northwest Small Grain and Dairy

Most of the income in Area VI is from wheat, rye, and flax, one-third of the crop land being occupied by these crops. A small acreage of potatoes and of flax is grown. Corn occupies about 6 per cent of the crop land and is used mostly for fodder. Wheat and rye occupy about 32 per cent, oats and barley 20 per cent, hay 32 per cent, potatoes 2 per cent, flax one per cent, and miscellaneous crops 7 per cent.

Dairying is the chief form of livestock production in this area. There is some beef and a small income from hogs and sheep. The southern part of the area is devoted more to dairy production than the northern. A part of this area, particularly in the southern part, will probably shift toward the dairy type of farming. An increase in leguminous crops in other parts of the area will probably stimulate livestock development.

Area VII, Red River Valley Small Grain

Area VII is the most representative small-grain type of farming in the state. About 20 per cent of the crop land in this section is devoted

to wheat. Rye, flax, potatoes, oats, and barley provide some income. Corn is of minor importance, only about 8 per cent of the crop land being devoted to it. Most of the flax grown in Minnesota and about one-twelfth of that grown in the United States is produced in this area. Wheat and rye occupy 25 per cent of the crop land, oats and barley 33 per cent, flax 6 per cent, potatoes 4 per cent, hay 20 per cent, and other crops 4 per cent. Dairying contributes most of the livestock income. In this area as in Area IV, beef cattle are milked. In recent years there has been considerable agitation for the expansion of the dairy enterprise and some good dairy farms have been established. Beef, hogs, and poultry contribute about equally to the farm income but the amount from each is small. Sheep add little to the farm income. Interest in livestock production is increasing, but this will likely be the chief small-grain producing region in Minnesota for some time.