SOIL SURVEY OF MANISTEE COUNTY, MICHIGAN

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DESCRIPTION OF THE AREA

Manistee County is situated in the northwestern part of the Lower Peninsula of Michigan. It is bounded on the west by Lake Michigan, on the north by Benzie County, on the east by Wexford County, and on the south by Lake and Mason Counties. It is approximately a square, the north and south dimension being about 24 miles, and the east and west dimension varying from about 21 to 28 miles. The land area of the county is 542 square miles, or 346,880 acres.

FIG. 16.—Sketch map showing location of the Manistee County area, Michigan

The topography of Manistee County is characterized by a number of separate hilly divisions or ridges and a number of associated plains and flat valleylike areas whose boundaries are fairly well defined. The county presents no relief of considerable magnitude, as the general elevation is only about 800 to 1,000 feet above sea level and approximately 200 to 400 feet above Lake Michigan. The county, however, is more or less diversified with strongly sloping and choppy areas, gently undulating areas, low swells or ridges, level plains, small tracts of swampy land, high sand dunes along the shore of Lake Michigan, and numerous streams, lakes, and forests.

The northern part of the county, lying mainly north of the Manistee River, consists from west to east of a succession of hilly or diversified belts and comparatively level plains. The country lying directly along Lake Michigan is rolling to hilly and choppy in places and dissected by deep valleys. It lies probably 200 to 300 feet above the lake level, and the high land extends up to the lake shore without any considerable width of lowland or terrace intervening. This strip of hilly land is bordered on the east by a comparatively wide plain, which occupies most of the central part of the county, that part traversed by the Pere Marquette Railway and including the towns of Copemish and Kaleva. Eastward from the boundaries of this plain there is a considerable rise in elevation to a diversified belt of hilly country including inclosed plains and flat valleylike areas. Still further eastward there is a broad, high, dry sandy plain, which extends into Wexford County on the east and which is traversed by the Manistee River.

The southern part of the county, lying south of the Manistee River, considered as a whole, is a nearly level, dry plain, but con-

tains three or four swells of higher land of rolling or sloping topography.

The hilly parts of the county are not rugged, but for the most part are characterized by smooth, softened slopes, except in a few places in the clay land directly along Lake Michigan, where the surface is quite choppy and deeply cut by streams. The streams of the hilly areas are anomalous in direction of flow, and the features are without regularity or apparent system. The plains and flat valleys are for the most part dry, owing to the pervious nature of the underlying geologic formations, although a considerable aggregate area of swampy land is found in the Kaleva-Copemish plain, which occupies the central part of the county. The Manistee River, which traverses the plains along the eastern boundary and in the southern part of the county, has cut a deep trenchlike valley and is bordered by bluffs or steep banks, in places containing clay in their lower parts.

The broader surface features are expressions of geologic formations of Glacial age. The more hilly areas, excepting the sand dunes, for the most part are moraines; the level plains in the northern and eastern parts of the county are underlain by glacial outwash deposits; and the southern part is mainly a level plain of sandy drift, probably in part deposited under the ice sheet.[1]

The greater part of the county drains into Lake Michigan through the Manistee River or its tributaries. The north-central part, extending southward only about 3 miles, drains into the Betsey River, which empties into Lake Michigan at Frankfort, Benzie County. Around the inlets, such as Portage Lake and Bar Lake, some small streams empty directly into the lake. With the exception of the valley of Bear Creek, the county is generally well drained. A few swampy areas are unsuitable for agriculture at present.

There are several lakes in the county, scattered mainly through the hilly region. The most prominent of these are Manistee Lake, Portage Lake, Rush Lake, and Bar Lake, connecting directly with Lake Michigan, and Bear Lake, Glovers Lake, Beaver Lake, Chief Lake, and Pine Lake, which are inland lakes. Of these, Manistee, Portage, and Bear Lakes are comparatively large. Portage, Bar, and Manistee Lakes constitute important harbors for lake steamers and afford facilities for marketing by water transportation.

Manistee County was organized in 1840, but settlers did not appear in any numbers until after the Civil War. Settlements were begun for agriculture in at least three places in the county almost simultaneously about 1867, at Arcadia, Bear Lake, and Marilla. The village of Bear Lake was organized in 1865 and Arcadia and Marilla in 1870. Prior to this time the lumber industry was established in different sections, with the center of activities around Manistee Lake at the present sites of Manistee, Filer City, and Stronach. The city of Manistee was established in 1855. After the war the Government allowed soldiers to take up land for homesteads and there was a marked influx of settlers. They were from Canada, New York, Pennsylvania, and other Eastern States, and

[1] Frank Leverett, Surface Geology of Michigan. Publication 25, Michigan Geological Survey, Series 21, 1917.

were mainly of Dutch, German, Scotch, French, and English stock. These early settlers showed excellent judgment in their choice of homesteads, as most of them selected the better land, so that the oldest settlements in the county are located on the better kinds of soil. The proportion of southern European stock in the population is small. In some sections Polish and Finnish people make up the majority of the inhabitants.

The population figures compiled from the Federal census reports show a steady growth from the organization of the county until 1900, when a decrease began. In 1840 and 1850 no population was reported, as it undoubtedly consisted almost entirely of lumbermen, hunters, and trappers. In 1860 the population was 975; in 1870 6,074; in 1880, 12,532; in 1890, 24,230; in 1900, the maximum or 27,856; in 1910 a slight drop to 26,668; and at the last census a great decrease to 20,899. Statistics from the work of L. A. Chase, "Rural Michigan," show the decrease in rural districts of the county to be 21.7 per cent for the period from 1910 to 1920. For the same period the decrease in total population of the county was also 21.7 per cent. The decline in population during the last decade can be attributed to two main causes, (1) the depletion of the forests which caused the lumber industry to wane, and (2) the recent war, which drew people to the larger manufacturing centers. At the present time (1922) there seems to be a slight movement back to the agricultural districts.

Manistee, the county seat and largest city, is situated between Manistee Lake and Lake Michigan. Manistee Lake is joined to Lake Michigan by a Government-maintained channel, and lake steamers provide the city with water transportation. Its principal industries are lumber and planing mills, salt factories, a tannery, iron works, and some other more specialized factories.

The villages of Onekama, Bear Lake, Arcadia, Kaleva, Copemish, and Wellston, range in size from 50 to 300 population. Onekama is located on Portage Lake, which is an excellent port for lake steamers. A canning factory and the facilities for navigation of fruit steamers make it a good market center. Bear Lake village is located on the south side of Bear Lake and is a market for local produce only, as it is not on a railway. Arcadia, also on an inlet of Lake Michigan, was formerly important as a lumber loading town, but at present its harbor is in a state of disrepair and the only industry is a lumber mill and furniture factory. It is the terminus for the Arcadia and Betsey River Railway, which is owned by the furniture company, and connects with the Pere Marquette at Henry. Copemish is a small village in the eastern part of the county, on two railroads, and is a market for farm produce. Kaleva is a trading point near the center of the county on the main line of the Pere Marquette (Petoskey Branch). Wellston, on the same railroad somewhat farther south, in a less densely settled region, was formerly the center of supply for many lumbering enterprises. Brethren, Marilla, Harlan, Norwalk, Henry, Saile, Butwell, Malcolm, Tannerville, Pomona, Pierport, Chief, Dublin, and High Bridge are small villages with from one to five stores and with less than 50 inhabitants each.

Transportation facilities are good in most sections of the county, the northern part being accessible to the lake boats at Onekama, while the southern part can obtain similar service at Manistee. The

main line of the Pere Marquette (Petoskey Division) and one branch line from Walhalla to Manistee, the Ann Arbor Railroad, the Manistee and North Eastern Railroad, and the Arcadia and Betsey River Railway traverse the county, so that no part is more than 6 miles from a railroad stop.

There are a few stretches of macadam near the city of Manistee. Two main trunk-line highways traverse the county and are graveled the entire distance. Another improved gravel road connects Kaleva, Copemish, Brethren, and Tannerville. There are short stretches of gravel road in other parts of the county, so that the greater part of the area north of the Manistee River is passable most of the time with automobiles. South of the river, except for a main road to Wellston, the sandy nature of the roads often makes them difficult to travel in dry weather.

The marketing possibilities of the county are good. Petoskey is 115 miles; Traverse City, 38 miles; Grand Rapids, 110 miles; and Detroit, about 250 miles distant by railroad. Milwaukee is 125 miles and Chicago 185 miles by boat.

CLIMATE

The following table shows the temperature and precipitation at the Weather Bureau station at Manistee for the period from 1889 to 1922, inclusive. The records were taken somewhat irregularly, but will serve as indicators of the general weather conditions in the county.

Normal monthly, seasonal, and annual temperature and precipitation at Manistee

[Elevation, 600 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1891)	Total amount for the wettest year (1890)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	28.1	58	−4	2.17	3.44	1.02	12.8
January	23.2	59	−16	2.41	2.32	5.64	17.5
February	21.2	58	−29	2.02	2.25	2.55	16.8
Winter	24.2	59	−29	6.60	8.01	9.21	47.1
March	30.4	80	−15	1.90	2.92	2.64	7.9
April	43.1	82	9	2.26	.91	3.93	1.5
May	53.8	93	22	2.82	.12	3.17	T.
Spring	42.4	93	−15	6.98	3.95	9.74	9.4
June	62.8	94	31	3.20	2.43	3.03	.0
July	67.8	99	38	2.96	1.86	2.34	.0
August	65.8	94	36	2.42	3.16	2.69	.0
Summer	65.5	99	31	8.58	7.45	8.06	.0
September	60.8	95	32	3.03	2.40	1.12	.0
October	49.3	83	15	2.83	1.95	5.59	1.2
November	37.6	71	8	2.48	5.03	2.53	5.8
Fall	49.2	95	8	8.34	9.38	9.24	7.0
Year	45.3	99	−29	30.50	28.79	36.25	63.5

From the crop-production standpoint, it will be noted that the distribution of the seasonal rainfall is such as to promote growth during the summer months and is also favorable to fall-sown grains. The total rainfall is about equal for the summer and fall seasons under average conditions. Of the spring months the most rainy are April and May. The mean annual rainfall is 30.5 inches. The average snowfall for the last 23 years is given as 63.5 inches, the greater part of this coming during December, January, and February. In general, the precipitation is well distributed. Extended droughts seldom occur, and hail or ice storms are exceptional. Tornadoes have never visited this section of Michigan.

The prevailing winds are mainly from the southwest from May to November, inclusive, and from the west and northwest during the rest of the year, thus coming off Lake Michigan. This is quite important in the determination of the cropping possibilities of the county. The mean annual temperature is 45.3° F. This is somewhat lower than the average for counties in southern Michigan, as would be expected. The area is subject to sudden changes in temperature. During the summer months most of the nights are cool, and several days at a time may be cold and cloudy. The lowest temperature recorded occurred in February, when the thermometer registered —29° F. February is always the coldest month. The hottest day was recorded in July, the temperature reaching 99° F. The fall season is, in general, warmer than the spring.

The date of the last killing frost has ranged during the last 21 years between April 17 and June 9, the average date being May 11. The first killing frost in the fall has occurred from September 29 to November 25, the average being October 17. Thus the growing season averages 158 days. Proximity to Lake Michigan gives the county a somewhat longer period of growth than in the interior of the State at the same latitude. It should be noted, however, that even during the summer months the temperature often approaches freezing, a condition not very favorable for certain kinds of crops.

There is a marked decrease in temperature in November and most farm work ceases at this time. Not until May can work be resumed with any degree of certainty. During the winter months the temperature is considerably below freezing most of the time.

AGRICULTURE

Agriculture began in Manistee County in 1864 along the lake shore north of Arcadia. About 1870 a colony of Canadians settled north of Bear Lake and began farming. About the same time some farms were homesteaded north of the city of Manistee. It was not until 1890 that the eastern part of the county had any agricultural importance, and somewhat later, nearly 1900, before the townships of Springdale and Maple Grove were included in farms. The region south of the Manistee River is but sparsely settled. As a whole agricultural development is recent in comparison with conditions in the southern part of the State. The oldest farms have been operated for about 50 years, but some have been brought under the plow for only 1 or 2 years.

From the organization of the county in 1840 to about 1900 the lumber industry was more important than agriculture. In many

cases lumbering and farming were combined, with work in lumber camps consuming the greater part of the year. This had a tendency to bring about an exhaustive method of farming in most cases, so that some of the older farms, especially on the light-textured soils are now less productive than formerly.

From the viewpoint of agriculture the section of the county north of the Manistee River and along the shore of Lake Michigan is the best developed, and because of its location is well suited to fruit production as well as to general farming. Through this region the hilly lands are utilized mainly for grazing or fruit growing, and the more level areas are used for the production of beans, potatoes, corn, and rye. The use of legumes is not very general. A few fields of alfalfa were seen during the summer; these had been limed before seeding. Clover does well on some of the heavier soils, but the main hay crops are redtop and timothy. Some farms have been under a system of rotation of crops, others have grown beans and potatoes year after year. Wheat is not as common as rye. Corn is not very successful, except on some of the soils having a loam or sandy loam surface layer and a moderately heavy to clayey subsoil.

The eastern side of the county is not considered safe for fruit production, as the occurrence of frosts is a serious drawback. The distance from markets is also a handicap. In general farming, however, it ranks with the western side, except that it lacks the more heavy types of soil found near the lake.

South and east of the Manistee River agriculture is little developed. The land is sandy and covered with a second growth of oak and scattering pines. It appears unsuitable for fruit production, except near Lake Michigan.

The following table shows the acreage and production of the leading crops of the county as reported by the last four censuses:

Acreage and production of the leading crops in 1889, 1899, 1909, and 1919

Crop	1889		1899		1909		1919	
	Area	Production	Area	Production	Area	Production	Area	Production
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Corn	1,811	64,466	6,927	167,520	10,514	232,112	8,935	227,000
Rye	1,440	16,975	3,343	41,200	8,174	109,651	11,667	106,896
Oats	4,045	89,575	2,119	68,280	5,002	121,812	3,389	36,951
Wheat	2,629	29,806	5,548	53,220	1,994	33,445	3,557	41,790
Barley	123	2,180	68	900	23	290	236	2,225
Buckwheat	811	10,988	554	4,370	1,193	11,413	467	4,548
Beans		615	232	2,289	863	6,817	1,979	18,200
Potatoes	1,366	136,356	3,410	211,773	6,077	585,559	3,152	223,703
		Tons		*Tons*		*Tons*		*Tons*
Hay, all kinds	8,526	9,189						
Timothy					3,455	3,301	3,285	2,070
Timothy and clover					7,741	7,541	8,068	5,775
Clover			865	935	261	276	477	399
Alfalfa					9	17	402	434
Other tame hay			9,832	10,002	266	243	609	537
Wild hay			124	144	448	501	1,240	907
Grains cut green			238	291	238	221	1,964	937
Silage crops							2,086	11,304
Coarse forage			390	949	382	861	2,691	3,551
Root forage							476	1,714
		Quarts		*Quarts*		*Quarts*		*Quarts*
Strawberries			31	51,210	34	39,232	58	42,785
Raspberries			38	40,370	166	182,199	545	255,771

Acreage and production of the leading crops in 1889, 1899, 1909, and 1919—Contd.

Crop	1889		1899		1909		1919	
	Area	Production	Area	Production	Area	Production	Area	Production
	Trees	*Bushels*	*Trees*	*Bushels*	*Trees*	*Bushels*	*Trees*	*Bushels*
Apples	41,532	3,846	95,295	28,326	90,497	201,412	114,898	181,661
Peaches	1,798	308	47,275	167	35,297	30,227	39,870	3,986
Pears	1,516	315	6,099	179	4,587	3,708	6,709	5,975
Plums and prunes	5,139	1,448	19,092	1,953	6,072	4,213	6,396	2,863
Cherries	3,512	460	10,540	1,599	8,366	8,413	38,965	12,605
		Gallons		*Gallons*		*Gallons*		*Gallons*
Maple products		3,464		897	8,063	2,489	8,206	2,187
	Vines	*Pounds*	*Vines*	*Pounds*	*Vines*	*Pounds*	*Vines*	*Pounds*
Grapes			3,627	17,189	3,425	39,973	2,432	18,660

From the foregoing table the trend of agriculture in Manistee County for the last 30 years is apparent. An outstanding fact in this development is the great increase in acreage under cultivation, the area occupied by field crops in 1889 being 20,751 acres and in 1919, 54,680 acres. This increase has taken place chiefly in the corn, rye, and hay and forage-crop areas. Another fact to be noted is the marked increase in the production of orchard fruits. The development is even greater than the table would indicate, for only bearing trees are included in the figures given for 1919. In addition there are reported for that year more than 95,000 trees of nonbearing age, chiefly apples, peaches, and pears, indicating continued growth of the industry.

The value of agricultural products by classes for 1919 is given in the following table:

Value of agricultural products in 1919

Product	Value	Product	Value
Cereals	$638,186	Chickens and eggs	$161,937
Other grains and seeds	76,269	Honey and wax	3,222
Hay and forage	410,005	Wool	2,262
Vegetables	675,131	All domestic animals	874,617
Fruits	514,175		
All other crops	7,025	Total	3,689,465
Dairy products, exclusive of home use of milk and cream	326,636		

According to the census reports, the livestock on farms in Manistee County in January, 1920, included the following: 3,601 horses, 50 mules, 2,367 beef cattle, 7,387 dairy cattle, 816 sheep, 8 goats, 4,042 hogs, 53,537 poultry, and 740 hives of bees.

These census figures in connection with a field survey show that the county is mainly concerned with general farming. Dairy cattle are kept in considerable numbers to provide milk and its products for home use, the surplus being sold. Fruit growing is important in certain sections. The production of forage crops is low. Poultry and eggs are important products of most farms. Livestock production is relatively unimportant.

The proportion of purebred stock is comparatively small, so that it would be difficult to state definitely the breeds most popular among the farmers. Percherons and Clydesdales make up the majority of the horses, and the Shorthorn stock is probably dominant among the beef cattle. Grade dairy cows are most common, although a few purebred herds of Holstein and Guernsey were noted. Duroc-Jersey and Poland-China hogs are seen mostly, with a few Berkshire and Chester White. Except in rare instances, the livestock industries are incidental to general farming.

Corn, though exceeded in acreage by rye, is the most important of the cereal crops, the production in 1919 being 227,000 bushels. This represents almost all the corn crop, as there are comparatively few silos in the county. This crop is most successfully grown on land free from "hardpan" and on land that is rather new and of a sandy loam or loam texture. Cropped soils after a time fail to give good yields, as may be seen in the character of the crop shown in Plate XIII, Figure 1. The best corn is grown on the level, sandy loam areas in the eastern part of the county. Here the land is plowed in the spring, turning under as much grass growth or manure as possible. It is prepared with roller, disk, and spring-tooth harrow and planted late in May or early June with hand planters or check-row planters. Two to four cultivations are given, the crop is cut in late September, and when dry is husked by hand in the field or by means of power huskers. Commercial fertilizers are used only occasionally, although lime and acid phosphate seem to show good returns with other cereals.

Rye is a crop grown almost universally because it is able to withstand the hard winters and thrives on sandy soils. It occupies an acreage about equal to that of corn and oats combined. The annual production is around 100,000 bushels, with yields ranging from 10 to 20 bushels per acre.

Wheat is not very widely grown in Manistee County on account of the predominating sandy nature of the soils. These soils give better returns from rye, hence the greater popularity of that crop. Both wheat and rye are fall-sown crops and must withstand rather severe winters, through which rye appears to come in somewhat better condition. The comparative immunity of rye to insect pests is another point in its favor. Both crops are sown on fall-prepared seed beds and usually follow oats in rotation, but occasionally early potatoes or beans are removed in time for fall seeding.

Another important crop is oats. This crop usually follows corn, beans, or potatoes in the rotation, and is commonly raised because of its importance as a source of feed for animals and its short growing season. The corn stubble is covered by a shallow plowing or is loosened by disking or harrowing in the spring, and the seeding is done as soon as weather conditions will permit. The grain is used mainly as feed for horses and cattle. The yields of oats are not generally high.

Buckwheat is grown in some of the more hilly sections, in most cases for feed. The yields are variable.

Some of the small grain is sold as soon as harvested to elevators, some, especially of the rye, is fed to hogs to fatten them, and some is

used on the farms as feed for poultry or cattle. Very little buckwheat is marketed, except for seed.

Beans were grown more extensively a few years ago than they are now, some of the older settlers reporting a large acreage each year. The yields have been reduced, largely as a result of the continuous cropping, which increased the number of insects and diseases attacking the crop. In many cases fields have reached a condition where the crop is unprofitable. Beans are grown on newer land with good success and may probably be grown again on the older fields after they have been used a few years for other crops. Beans are planted late in May, and grow rather rapidly if moisture conditions are suitable. By the latter part of August or early in September the crop is harvested with a machine known as a bean puller. The plants are dried in piles or windrows and hauled to a covered shed or to the barn, where they are threshed and cleaned. The greater part of the crop is marketed, and in the last few years the prices have been good and the crop profitable.

Hay and forage production is low compared to the quantity of other crops grown. There are probably two main reasons for this, one being the low average production per acre of most forage crops and the other being the lack of demand or need for forage because so few animals are kept on farms. The soils of the county are in the main not very well suited to the production of timothy or clover hay because of their sandy texture. Some fields of millet appeared to be producing a fair growth. A promising forage crop for this section, judging from the fields seen, is alfalfa, which yields very well when a good stand is obtained. In 1919 clover hay produced an average of about 1,600 pounds per acre, timothy hay an average of about 1,250 pounds, and the mixed hay about 1,400 pounds per acre.

In comparison with the other hay crops, alfalfa yielded 434 tons from 402 acres, averaging about 2,160 pounds per acre. This average is much below what some fields are producing, because in the whole county there are many fields that are not good stands. In most cases the poor stands are traceable to a lack of lime in the surface soils. Sweet clover also has possibilities as a forage crop. Those farms having rather large acreages of cut-over land suitable for grazing should consider the possibilities of stock raising, the cattle to be wintered on alfalfa hay. Markets are readily available at Manistee by boat, and the original cost of the land is low. A more permanent form of agriculture would undoubtedly result if more livestock were kept on the farms of this section.

The area of sugar beets in Manistee County in 1919 was only 2 acres, and the production 17 tons. Most of the soils of Manistee County are unsuitable for sugar beet culture, being rather light and sandy. The distance to the factory is also an important factor during times of high freight rates.

Potatoes do well on nearly all soils, but give best returns on the sandy loam types that are not droughty. Some are planted as early as possible, and are dug and marketed early to receive the higher prices for new potatoes. For many years this crop has been grown on the more level plains of the northern part of the county, and it is still an important cash crop. The yields range from 75 to 150 bushels per acre.

The fruit industry of Manistee County is somewhat localized along the west side of the county and is most successfully carried on within 12 miles of the shore of Lake Michigan. Most of the common tree fruits are grown, but apples, cherries, and peaches are the most important. There are two extensive orchards within about 4 miles of the city of Manistee, in which peaches, apples, pears, and cherries are grown principally. The eastern half of the county is considered to be less valuable for fruit growing.

The grape industry is but little developed. Among the small fruits, strawberries and raspberries are of first importance, having a combined area of 603 acres in 1919. These are marketed along the Lake Michigan shore, at Manistee, Onekama, or Arcadia, where fruit boats from Chicago and Milwaukee make regular stops. The greater proportion of the other fruits are marketed in the same way. A canning factory at Onekama also consumes much fruit of various sorts.

The development of the fruit industry is of great importance to a large part of the population and it is probable that the acreage devoted to fruits, especially the tree fruits, will continue to expand.

Commercial fertilizers are not extensively used in fruit growing. The case of cherries is the exception, many farmers applying sulfate of ammonia at the rate of 3 or 4 pounds per tree. This is usually applied in the spring. The orchards in most cases receive cultivation during the summer, and in some cover crops are sown. In general the management of orchards is much better than the management of the general farms. There is much undeveloped land suitable for orcharding in the vicinity of the lake.

Among the special crops of the county are gladioluses, tulips, and ginseng. These are grown by only a few people, but represent a phase of the agricultural activity of the county. Plate XIII, Figure 2, shows a field of gladioluses, the flowers of which are sold, as well as the bulbs. Ginseng is grown in special shaded areas. It also requires a long period for its growth, and the cost of production is relatively large; consequently it is a crop that calls for considerable patience and capital.

Considerable maple sirup and sugar is made, the sirup production amounting to 2,187 gallons in 1919. These products bring considerable income to the farmers fortunate enough to have maple groves on their farms.

The farm buildings vary considerably in their style and condition. In the north-central part the houses and barns are mostly small and low, and many are made of logs. Around Bear Lake, Onekama, Kaleva, Copemish, Arcadia, and Manistee the buildings are larger and usually of frame or brick construction. In most cases they are in good repair. The total value of the buildings on the 1,499 farms of the county was $2,258,335, an average value on each farm of about $1,650. There are a considerable number of vacant farm buildings which always present a poor appearance. The average assessed value of all the farm property per farm in 1920, is reported by the census as $5,355.

The average size of farms in 1920 was 98.4 acres, of which 56.9 acres were improved. Only 41 per cent of the county is included in farms. The size of the individual farms in the county ranges

from a few acres to over 1,000. The greater number contain from 40 to 320 acres.

The use of fertilizers is not extensive, as can be readily seen from the census data for 1920. Out of a total of 1,499 farms, only 57 used commercial fertilizers.

The need for more forage and feed crops in the county is emphasized by the fact that 971 farmers bought feed last year, paying $148,144 for it. Considering the small number of stock on each farm, it is especially significant that nearly two-thirds of the farmers in the county are unable to raise enough forage to keep the stock.

The conditions regarding tenantry which are so marked in some of the southern counties of Michigan, have not appeared in Manistee County. Of 1,499 farms in the county in 1920, 1,366 were operated by their owners, a fact that should tend toward better and more permanent agriculture. Only 114 farms were operated by tenants and 19 by managers.

SOILS

The most noticeable feature of the soils of Manistee County is their sandy texture. This characteristic, although rather striking and very important from the agricultural standpoint, is but one of the features considered in a classification of soils. In fact texture, which is locally variable, can not be regarded as an essential characteristic in the broader soil groupings. There are many other features, most important of which are (1) the number and arrangement of layers in the soil profile, (2) color of the various horizons, especially the surface horizon, (3) structure of each horizon, (4) thickness of the horizons, (5) composition of the horizons, and (6) character of the underlying unweathered material. These characteristics, rather than texture, define the general regional soil groups of the United States, as well as the more restricted soil groups, called series. The texture, particularly the texture of the surface soil, defines the members of the soil series, the soil types.

In considering the soils of an area, such as Manistee County, in their relations to other soils of the country, it is necessary to consider, primarily, the normally developed types, or those soils in which soil development or weathering has proceeded, unhindered by poor drainage, erosion, or other influences, to a distinct and distinctive profile. But in classifying and mapping the soils of an area it is necessary to recognize, describe, and map, along with the normally developed soils, those soils of disturbed or incomplete development, such as are found in poorly drained areas and on steep slopes.

Manistee County lies within the transitional soil belt where the brown soils, characteristic of the east-central timbered region of the United States, are giving way to the gray soils of the timbered country of northern Michigan, Wisconsin, and Minnesota, and soil types of each group are found within the county.

The soils of the brown group are brown to light brown in surface color, with a small quantity of organic matter mixed with the upper few inches and with only a thin covering of leaf mold on the surface. Beneath the surface soil at relatively shallow depths is a zone of maximum concentration of clay, below which the slightly weath-

ered to unweathered parent material is found. Most of the soils of Manistee County are derived from material so sandy that the zone of clay concentration is obscurely developed, and in places is scarcely noticeable.

The generalized profile of the well-drained soils of the gray group, in the virgin state, is: (1) A surface covering of litter and mold, including a very thin layer of humus soil; (2) a grayish, leached or *podsolized* horizon of mineral soil; (3) a brownish or yellowish horizon; (4) a horizon having a maximum content of clay and maximum intensity of color due to oxidation of iron-bearing minerals; (5) a layer of slightly weathered material; (6) the geologic substratum. There are numerous variations in the thickness of the different horizons, their intensity or degree of development, and their chemical and physical nature. On the basis of these differences the soils of this group are classified into soil series.

While there are no definite boundaries between the two soil groups, approximately the southern third of Manistee County lies within the region of brown soils, and the northern two-thirds within the region of gray soils.

The materials from which the soils of the area have been derived are dominantly sandy, and the resulting soils are sandy in texture. The materials have been accumulated by ice and water and wind as unconsolidated deposits with varying topography, ranging from level to rolling. These sandy deposits are composed of various minerals, but the chief constituent is quartz. There are a few very small areas in which heavier, reddish, calcareous clays are present near the surface. In numerous depressed and poorly drained areas throughout the county the surface materials consist of plant remains in varying stages of decomposition.

By far the greater part of the land of Manistee County consists of well-drained upland soils with normally developed profiles, although in very sandy material the profile characteristics may be but dimly visible.

To the group of brown soils belong the Plainfield and Coloma series, both represented by sandy types.

To the group of well-drained gray soils belong the Roselawn, Rubicon, Manistee, Bridgman, and Ontonagon soils.

The surface soils of the Plainfield series are light brown to brown, and the subsoils are light brown to yellow. These soils occur on terraces in the Central States, and are formed of materials from the glaciated sandstone regions. Neither soil nor subsoil is highly calcareous. The subsoil and substratum are characterized by a loose porous structure.

The Coloma series comprises types with light-brown to yellowish-brown soils and a yellow to reddish colored subsoil, underlain by a heterogeneous substratum of sandy drift. The topography is generally rolling to rough and hilly—morainic. Drainage is excessive. The soils are characteristically acid in reaction to depths of 3 or 4 feet or more.

Virgin areas of the types in the Roselawn series have the following profile: (1) A layer of litter and forest mold, 2 to 4 inches thick; (2) a layer of dark-gray humus soil, 1 to 2 inches thick; (3) a light-grayish layer, 4 to 8 inches thick; (4) a layer of brownish to dark

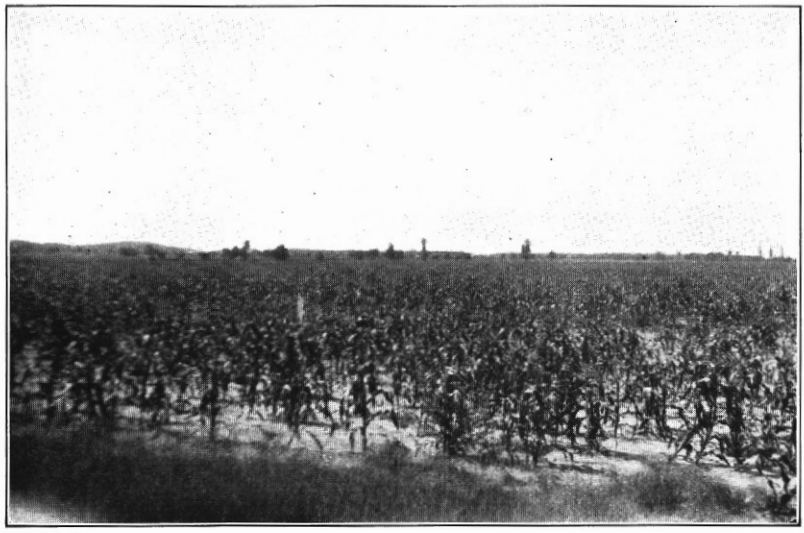

FIG. 1.—CORN IN EARLY SEPTEMBER, ON THE RUBICON LOAMY SAND WEST OF BEAR LAKE

This land is one of the oldest cultivated soils in this section, and the crop shows evidence of lack of fertility

FIG. 2.—FIELD OF GLADIOLUSES ON THE RUBICON LOAMY SAND SOUTH OF COPEMISH

This is a special crop which yields good returns

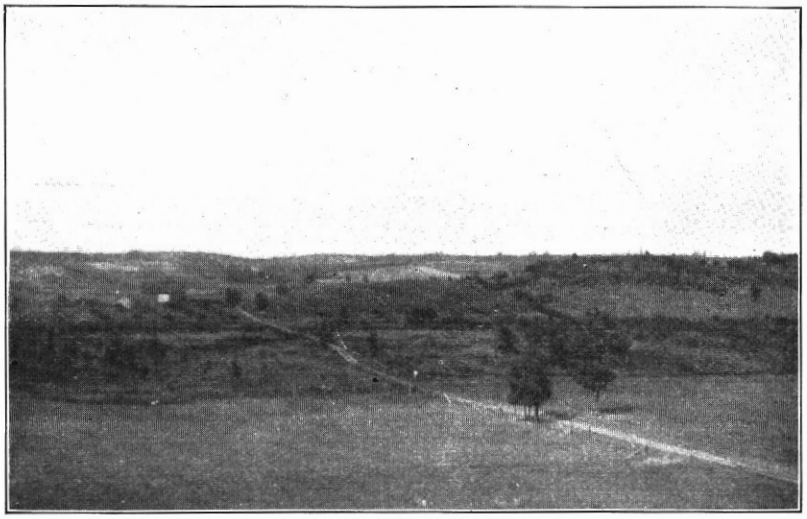

FIG. 1.—TOPOGRAPHY OF THE ROSELAWN LOAMY SAND IN THE SOUTHEASTERN PART OF THE COUNTY

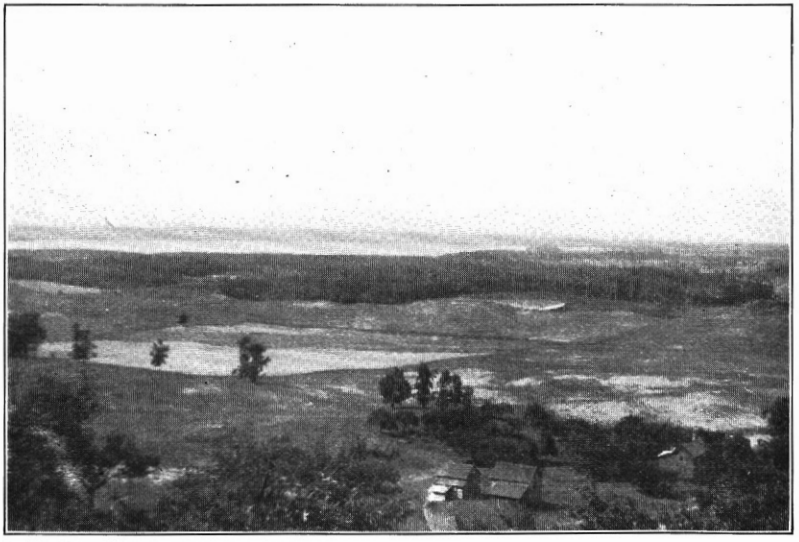

FIG. 2.—VIEW OF BEAR LAKE VALLEY, OCCUPIED MAINLY BY THE RUBICON LOAMY SAND

Buildings of an abandoned farm in the foreground

yellowish brown material having a thickness of 6 to 10 inches; (5) a layer, 2 to 8 inches thick, changing from yellowish to grayish or pinkish color; and (6) a grayish or pinkish substratum. The soils are characteristically acid in reaction to depths of 3 feet or more.

The soils of the Manistee series are identical in the upper part of the profile with the Roselawn soils, but differ in having at some level below 2 feet a reddish, moderately to highly impervious clay of alkaline reaction. The topography is smooth to rolling.

The types in the Bridgman series have (1) a grayish surface layer, (2) a yellowish layer underlain by (3) pale-yellowish to cream-colored material. The substratum is a loose incoherent sand. The soil is pervious and retains only small quantities of water, but is easily penetrated by plant roots to great depths and is not excessively droughty. The reaction is characteristically acid. The nitrogen content is low, that of calcium, phosphorus, and potash small, but not abnormally low or deficient. The series is composed of dunes, beach ridges, and deposits of wind-blown sand in the glaciated region, which have remained stable for sufficient length of time to have developed a profile.

The types of the Ontonagon series are characterized by a relatively retentive clayey subsurface layer at shallow depths. This may occur at depths of a few inches to as much as 3 to 4 feet, but in all cases it has an influence on the moisture content and in other ways directly or indirectly influences plant growth. The deeper subsurface layers and the substratum have a reddish color, Indian red or brick red when moist, and the inference is that a comparatively high percentage of ferric hydrate is present. This coloration has been inherited largely from the parent rock and is not entirely the result of weathering since glacial times. Appreciable percentages of calcium carbonate are present and an alkaline reaction is shown in the red clay at shallow depths.

The virgin soils of the types of the Roselawn series are dark gray with a high humus content in the surface 1 to 3 inches, and light gray and very low in organic matter below to a depth of 6 to 12 or 15 inches. The cultivated soils where the two layers have been mixed are gray to brownish gray. The subsoils to a depth of 18 to 24 inches are brown, ranging from a strong yellowish brown to coffee color, rather loamy, and more or less cemented in the upper part into a sort of hardpan. The lower subsoils are yellowish gray to brownish gray. The topography ranges from flat to low ridgy and undulating. The natural drainage is good. The material is waterlaid in the form of outwash plains, lake plains, and beaches.

The soils developed on permanently wet sites or under conditions of much moisture comprise both organic soils or Muck and mineral soils. The organic soils exhibit considerable difference in age, color, stage of decomposition of the organic matter, thickness, and soil reaction, but no attempt has been made to show the separate types on the soil map in this survey.

The most extensive mineral soils in the wet situations belong in the Saugatuck series. These types are characterized by dark-gray surface soils, high in organic matter, resting on a grayish or whitish thoroughly leached layer below which is a yellow to coffee-brown

sand in places firmly cemented into hardpan. The substratum is ordinarily water-logged. The soils are characteristically strongly acid.

The types in the Newton series have dark-gray soils directly underlain by water-logged material. The water table is higher than in the Saugatuck soils, and this is the chief difference between the two series.

The characteristics of the Warners series are the brown to black mucky surface soil, varying from less than an inch to several feet in depth, and the underlying subsoil material of soft white marl in places containing shells of snails and other land animals, though probably a considerable part of the marly material is due to the deposition of calcium salts by plants such as chara. The type occupies level positions where the drainage has been obstructed and where more or less organic matter has accumulated and decayed.

The acreage of the several types of soil developed in Manistee County is given in the table below, the distribution of these soils is shown on the accompanying map, and detailed descriptions of the soils appear in subsequent pages of this report.

Areas of different soils

Soil	Acres	Per cent	Soil	Acres	Per cent
Plainfield sand	95,552	27.5	Coloma loamy sand	14,848	4.3
Roselawn loamy sand	56,512	16.3	Ontonagon loam	13,312	3.8
Rubicon loamy sand	46,528	13.4	Rubicon sandy loam	6,016	1.7
Roselawn sandy loam	37,184	10.7	Manistee sandy loam	4,288	1.2
Saugatuck loamy sand	21,888	9.1	Bridgman fine sand	1,600	.5
Better drained phase	9,600		Warners loam	128	.1
Muck	14,400	6.6			
Shallow phase	8,256		Total	346,880	
Newton sand	16,768	4.8			

ROSELAWN LOAMY SAND

There are five layers or horizons in the profile of the Roselawn loamy sand.

The surface layer in virgin areas is 1½ to 2 inches thick, dark brown to nearly black in color, and consists of moss, partly decayed leaves, and other forest litter. Toward the base of this layer some mineral soil particles are mixed in, giving the mass a speckled gray and black appearance. The material when dry is light in weight, being largely organic matter. Directly below the organic horizon or surface litter is developed a layer of bleached gray sand, from 3 to 12 inches thick. Many of the individual particles are without coloring matter and seem to be clean quartz grains. Others have a thin veneer or stain of dark organic matter, giving them a gray color.

At a depth ranging from 5 to 14 inches a dark coffee brown colored layer is encountered, which in some places is cemented into a hardpan. The density and cohesion is somewhat greater in this horizon than in the gray one above, owing to the presence of colloidal organic matter and certain iron compounds, from which the color is derived. The thickness of this layer varies from 1 to 2 inches to a foot or more. Where actually indurated the thickness is somewhat

less than where no hardness is developed. Gradually the dark-brown color fades to a straw or yellowish brown, which is the chief color in the next layer. There is no cohesion developed in this layer, and the texture remains the same as in those above. The fifth layer, beginning at depths of 2½ to 3 feet, consists of somewhat coarser, often gravelly, material which contains appreciable amounts of limestone. This material, which is only slightly weathered, has a light-gray to cream color and a porous open structure, and extends downward to considerable depths.

The cultivated surface soil is a loamy sand in texture. The color ranges from a gray to brownish gray, with occasional touches of yellow. This layer is usually about 6 inches thick, the usual depth of plowing, and really consists of a mixture of the litter and mold and the upper part of the surface mineral soil. There are a few bowlders and stones in the surface soil, but these are not abundant enough to be a serious hindrance in cultivation.

The Roselawn loamy sand is developed almost entirely in the rougher areas of the county north of the Manistee River. (Pl. XIV, fig. 1.) There is danger from washing of the hillsides in cropped areas, and crops suffer from drought at times. On account of the rough topography and the extremely light nature of the soil, much of this type is unsuitable for general farming. Fruits appear to do very well, however. The predominating native trees are beech and hard maple, with an occasional hemlock. Poplar or aspen and wild cherry are common in the growth of cut-over areas.

The table below gives the results of mechanical analyses of samples representing the various layers of the Roselawn loamy sand:

Mechanical analyses of Roselawn loamy sand

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
301710	Surface, 0 to 2 inches	2.7	15.5	21.6	42.3	2.8	8.4	6.6
301711	Subsurface, 2 to 12 inches	.8	15.4	27.3	50.7	1.4	3.4	1.0
301712	Subsoil, 12 to 20 inches	2.0	27.5	27.8	34.6	.7	3.0	4.4
301713	Subsoil, 20 to 36 inches	1.3	23.0	30.9	41.0	1.4	.9	1.5
301714	Subsoil, 36 + inches	1.4	20.8	28.4	43.6	.8	4.0	1.0

ROSELAWN SANDY LOAM

The profile of the Roselawn sandy loam is essentially the same as that described for the Roselawn loamy sand, except in texture and in the thickness of the strata. The surface layer as a rule is 2 or 3 inches thick and consists mainly of a mixture of forest litter and quartz sand. The second or gray layer is usually not over 4 inches thick. This layer has appreciably more fine material than in the loamy sand type, so that a sandy loam texture prevails. These two layers are mixed in plowing, making a dark-gray sandy loam as the surface soil of cultivated land. The third layer is brown to yellowish brown in color, somewhat more coherent in structure and 3 to 7 inches thick as a rule. The layer immediately below the brown one is yellow in color and fades toward a light-yellow or light-gray color with depth.

Usually a reddish friable sand and clay mixture is encountered at about 3 feet. The character of this unweathered material possibly points to a reason for the heavier texture of the surface soil. Throughout this layer there are lumps or isolated masses of sandy clay, pink in color, and extremely sticky. The presence of this fine-textured material must have had considerable influence on the development of the profile and undoubtedly influenced the texture. Some calcium carbonate is present at 3 or 4 feet in some places. Glacial bowlders and rocks occur in the deeper layers. There are considerably more of these stones in this type than in the loamy sand.

The Roselawn sandy loam is mapped in scattering areas north of Manistee River. One large body lies mostly in Pleasanton Township, north and northeast of Bear Lake. A large irregular area is mapped in Bear Lake and Onekama Townships. A third body, some 6 square miles in extent, lies between Portage Lake and Manistee River, and a fourth occurs in Dickson Township. There are a number of smaller areas, ranging in size from less than 1 square mile to 3 square miles.

The surface of this type is fairly even, and the land can be used for general farming in nearly all cases. This is a better soil than the loamy sand, a fact that is reflected in the appearance of the farms. Corn and potatoes are the leading cultivated crops and their yields are quite profitable. Among the small grains oats and rye also do well. There is some difficulty in obtaining stands of clover, owing to the rather acid nature of the lower layers of this soil. Liming will overcome this. There would also be a good response to the application of complete fertilizers.

COLOMA LOAMY SAND

The surface layer of leaf mold of the virgin profile of the Coloma loamy sand is usually less than 1 inch thick, is quite fibrous, and decays rather slowly. Below this shallow accumulation is a layer of brown loamy sand, generally about 8 inches thick. In a few places there is a faint suggestion of a gray layer between it and the mold. In cultivated land the surface soil consists of a mixture of the organic layer with the upper brown mineral layer of the virgin soil, and the color is a grayish brown. At a depth of about 10 inches the brown layer grades into the brownish-yellow material of the third layer which is generally about 20 to 25 inches thick. At a depth of nearly 3 feet this layer grades into the cream-colored, very slightly weathered material of the substratum. The texture varies but little to the depth of weathering; below this it is somewhat coarser owing to the presence of gravel.

The Coloma loamy sand is characteristic of a great part of the hilly region south of the Manistee River. A large area also lies north of the river east of Newland and Arendal. This soil supports a growth of scrub oak and jack pine, with scarcely any undergrowth.

The soil is deficient in organic matter, acid in reaction, droughty, and of low fertility, and therefore has little value for the production of the staple cultivated crops. Its most profitable use would probably be forestry. The present growth consists mainly of scrub oak, but the original forest consisted largely of white pine and Norway pine.

MANISTEE SANDY LOAM

The surface layer in virgin areas of Manistee sandy loam is largely forest litter, with a thickness of 1 to 2 inches, and generally of dark-brown to black color. Immediately beneath this organic matter there is a gray layer 3 to 6 inches thick, but more generally 3 inches, of sandy loam, containing a relatively large proportion of fine mineral matter, and only traces of organic substances. The cultivated soil, being a mixture of these two layers, is generally dark gray or grayish brown in color and of friable structure. Below the gray layer is a brown horizon, generally about 10 inches thick, with a range from 7 to 15 inches. This layer seems to be somewhat more consolidated than the rest, and is probably bound together by translocated organic matter and colloidal iron. Owing to the influence of the impervious clay below it, the next layer has a gray or cream color with a faint suggestion of pink. It is a little finer in texture and holds water well. The substratum is a pink or reddish clay, which is highly calcareous and almost impervious to water.

The material from which this soil has been developed is not essentially different lithologically from that of the Roselawn sandy loam, except that the pink clay forms a continuous layer usually not over 2½ feet below the surface. The sandy covering is a separate deposit lying on top of the clay substratum, and the impervious nature of the latter has had a marked influence on the profile development. There are scarcely any stones in the clay itself, but some occur in the sandy drift above it.

The Manistee sandy loam has a small aggregate extent in the county, being mapped in only a few small bodies scattered through the western part. The topography is rather even, being only slightly rolling, and is well adapted to general farming. This type is one of the strongest and best soils in the area.

Sugar beets seen on this type during the survey had a strong, vigorous appearance. The general field crops also were making good growth, indicating a productive soil.

The yields of corn and potatoes on this soil are very satisfactory. Potatoes are remarkably free from scab. The returns from oats, barley, wheat, and rye are above the average for soils of this class. The area in clover is somewhat greater than on most of the soils of the county.

ONTONAGON LOAM

The upper layer of the Ontonagon loam, where undisturbed, consists of forest mold from 1 to 2 inches thick, black or brown in color, fibrous, and only partly decayed. The second layer is a gray loam, generally not over 1 inch thick. The gray color is not so light as in the sandy types of the area. This grades into a light brownish gray, heavier loam, which generally extends to a depth of about 1 foot and constitutes a third layer. Locally these two layers merge into each other, and in some places the surface gray layer is so thin that it is difficult to recognize a distinction between the two. There is evidence of this gray layer, however, in many places, so that it undoubtedly is an essential part of the profile. The soil has a rather granular structure, but often becomes cloddy when injudiciously handled. A fourth layer lies between those described

and the substratum. It consists of weathered, reddish-brown, mottled plastic clay or heavy clay loam, granular in structure, relatively impervious, and alkaline in reaction.

The substratum, which appears below an average depth of 18 to 20 inches, consists of unweathered, reddish clay, which is highly calcareous and almost impervious to water. This material is known to extend to great depths and is generally supposed to be a lacustrine deposit.

The Ontonagon loam is not very extensive in Manistee County. The individual areas are not large and are scattered. The largest body lies between Portage Lake and the city of Manistee. Other areas lie east and south of Arcadia. Scattered bodies of the type are mapped throughout the western three-fourths of the county.

When carefully handled, this soil is very productive. It has a characteristic rolling topography, and generally it is quite well drained. The valleys cut by surface erosion have steep sides, and sometimes the base of a hill is damp from the seepage water oozing from the heavy soil. Flowing wells and many springs occur in this type.

Alfalfa and clovers grow luxuriantly on this soil, probably because of the presence of lime in the material at relatively shallow depths. Corn is grown extensively. Potatoes are produced, but the crop is poorer in quality than on some of the lighter textured soils.

RUBICON LOAMY SAND

The profile characteristics of the Rubicon loamy sand are typical of the regional group of northern gray soils. On the surface there is a shallow layer of leaf mold not over 1½ inches thick. The soil layer beneath this organic layer is a light bleached gray in color, almost devoid of organic matter, composed mainly of medium or fine sand, and varies in thickness from 5 to 9 inches. This gives way abruptly to a brown layer, 8 to 10 inches thick, which is dark brown or coffee colored at the top, but gradually becomes lighter brown or yellowish brown. The dark-brown material is rather dense and shows some tendency to stick together and form hardpan. This appears to be due to the presence of colloidal substances around the particles, because the texture is not markedly different from the other layers. A layer of yellowish-brown material often extends from 15 inches to nearly 3 feet. The color fades gradually downward, until the signs of weathering disappear, and a cream-colored gravelly sand is reached.

The soil in cultivated fields has a gray color, except where the brown layer lies near enough to the surface to be plowed up, forming brown spots. There are many small fragments of various rocks mixed through the soil, but no glacial bowlders.

The Rubicon loamy sand is extensively developed in the country north of the Manistee River, and is mapped in a few small areas south of the city of Manistee. The topography is nearly level and drainage usually excessive. (Pl. XIV, fig. 2.) The soil is not exceptionally strong and is not very well adapted to many of the common crops.

Settlements have been made on this type to a greater extent than on the other sandy types in the county, because of the level surface

and good drainage. With proper fertilization corn and the cereals are grown successfully. There should be more legumes in the rotations, and green crops should be plowed under at short intervals. This will increase the supply of organic matter and aid the soil in holding water. Successful farming of this soil, however, requires careful management and a reasonable amount of working capital.

RUBICON SANDY LOAM

The Rubicon sandy loam consists of a surface layer of vegetable mold, in some places 2 inches thick, and quite well decomposed. Beneath this is a gray sandy loam, underlain by a brown sandy loam, which becomes lighter brown with depth. The thickness of each of these layers is 8 to 10 inches. Scattering stones and gravel are present in the lower part of these horizons. At depths of about 15 to 18 inches the nearly unweathered drift is encountered, which is a gravelly mass of light-yellow or cream-colored material, containing occasional small pockets of pink clay. The cultivated soil is a dark grayish brown in color.

The Rubicon sandy loam is confined largely to the northeastern part of the county. The topography is nearly level. The original forest growth consisted mainly of hard maple, beech, elm, and hemlock.

The soil has good moisture-holding capacity, is apparently more productive than some of the lighter soils, and is being used successfully for general farming. Excellent stands of corn and clover are obtained, and the yields of the cereal crops are above the average for the county. On account of a greater capacity for holding water, this soil is comparatively easy to farm. The use of legumes, to be plowed under, and the use of certain fertilizers, seem to be essential for the best results.

PLAINFIELD SAND

The level areas around the Manistee River have a profile strikingly different from those farther north. The first layer is shallow, not over 1 inch in thickness, consisting of forest litter, mostly of pine needles, oak leaves, and mosses. Below this mold is a layer, 8 to 10 inches thick, of yellowish-brown sand. The material becomes lighter in color with depth, being a cream color or light yellow in the fourth horizon. The latter in places is moderately gravelly. From 15 to 25 inches it is a light yellowish brown loamy sand. Below this appears a moderately gravelly or gravel-free unweathered material of cream or light-yellow color, extending to undetermined depths.

The Plainfield sand occupies most of the area of the county south of the Manistee River, and also occurs in rather large areas just north of the river. The topography is generally level.

This type of soil is so open and porous that it is unable to hold sufficient moisture for the proper growth of crops. It is also low in organic matter and plant-food elements, and in its natural state altogether of low productive power. The original forest of pines has been removed by lumbermen. The present growth consists mainly of small oaks. The pasture value of the land is low. By special treatment the soil can be made strong enough to produce crops of certain kinds.

SAUGATUCK LOAMY SAND

The Saugatuck loamy sand consists of a layer of vegetable mold, 2 to 4 inches thick, dark grayish brown to black in color. Immediately below this is a layer of gray medium sand to fine sand from 7 to 10 inches thick. Grains of quartz are easily discernible throughout this layer, and none of the individual sand particles are coated with organic matter, indicating that leaching and bleaching have been complete.

Upon passing downward there is an abrupt change of color to dark coffee brown or almost black. This layer is in many places indurated. It varies from 5 to 12 inches in thickness, and is generally thinnest where the material is hardest. Gradually the induration disappears, the color becoming a lighter brown with depth and grading into the straw color or nearly orange yellow of the layer below. This straw-colored layer, which is of slightly coarser texture than the second or gray one, extends downward 10 to 15 inches, where the water table appears. Here another abrupt change in color takes place, the material, which below the water table is but little weathered, becoming a white or cream-colored sand with scarcely any gravel.

In cultivated land the surface soil of the Saugatuck loamy sand is generally gray, with occasional spots of brown where the plow has brought up some of the hardpan layer.

The Saugatuck loamy sand is distributed throughout the county. The topography is generally level, and the drainage naturally poor.

Very little of this type is in cultivation. The value of land of this type is very uncertain because of poor drainage, danger of frosts, presence of hardpan, low fertility, and high acidity. The cut-over land has fair value as pasture where the growth of young trees and brush is prevented.

Saugatuck loamy sand, better drained phase.—The better drained phase of the Saugatuck loamy sand lies adjacent to the typical soil, on ridges or around the edges of the lowland. The phase differs from the type mainly in having the water table at greater depth and in being better aerated. Consequently the straw-colored material which appears in the fourth layer extends to a greater depth and the whitish, unweathered substratum material is not reached within the 3-foot section. The other parts of the two profiles are essentially the same, except that as a rule the layer of organic matter on the phase is not quite as thick as on the type. The presence of hardpan is an essential of each profile.

The topography is slightly hummocky. Trees reach somewhat greater size on the better drained phase, and agriculturally the phase has greater possibilities than the typical soil. Certain special crops, such as berries, vegetables, and root crops are profitably grown on this soil. The supply of moisture is usually sufficient. The depth to the hardpan layer should be considered in selecting land of this type for cultivation and in choosing the crop to be grown.

NEWTON SAND

The surface soil of the Newton sand, ranging from 3 to 7 inches in thickness, is a very dark gray, with a "pepper and salt" appear-

ance. The texture is coarse or medium sand with scarcely any fine material. A definite humus layer is not found, the organic material being mixed through the upper layer of mineral matter. The second layer is gray or almost white in color and composed of medium to coarse sand.

The largest area of Newton sand in Manistee County is mapped along the Manistee River. Smaller areas occur along the smaller streams and in lowlands bordering lakes. Drainage is naturally poor, and the land under present conditions has little or no value for agriculture.

BRIDGMAN FINE SAND

The typical undisturbed profile of the Bridgman fine sand consists of (1) a thin layer of leaf litter and mold; (2) a leached gray layer consisting almost entirely of loose fine quartz sand, some 3 to 6 inches thick; (3) brown to yellowish-brown fine sand, which grades downward into (4) a lighter yellow, loose, fine to medium sand extending to depths of many feet. The material throughout the profile is quite uniform in texture, and the color variations form the most striking distinctions between the layers. The surface horizons are disturbed or absent where winds are at present shifting the sands, and such areas are true Dunesand.

The Bridgman fine sand is mapped in only a few small areas along the shore of Lake Michigan. These areas are mostly quiescent dunes, and have the characteristic dune topography—elongated, narrow ridges with occasional higher knolls and small depressions.

The original vegetation is notable for its diversity and luxuriance. White, Norway, and jack pines, hemlock, basswood, beech, hard maple, and white oak are among the trees found on the type.

The Bridgman fine sand has little or no importance as a farming soil.

WARNERS LOAM

There is no definite soil profile developed in the Warners loam. The surface layer consists of about 6 inches of a gray and black spotted soil, very fine in texture and having no perceptible grittiness. This gradually changes to a white chalky marl of very high purity, being nearly 95 per cent calcium carbonate, with some silica and occasional rotten tree roots as impurities. The marl is over 4 feet deep in some places, but in other places a white quartz sand is encountered at a depth of 2 feet or slightly less from the surface.

A small area of this soil is developed over a part of an extensive bed of marl which lies adjacent to the stream and inlet, east of the village of Arcadia. The soil is alkaline in reaction, and clover and alfalfa may be grown upon it. There is no tree growth on the area at present.

MUCK

Muck includes areas of organic material 3 feet or more in thickness. A profile is developed in Muck to a certain extent. The upper layer of a few inches usually is quite dark in color and often black and loamy, but with increasing depth the color changes to brown and the presence of the coarser, more fibrous and less decomposed material is easily detected. The tree growth on Muck consists mainly of white cedar, white spruce, balsam fir, and tamarack.

The Muck in this county is generally alkaline in reaction. Highly acid, raw, fibrous deposits occupied by heath vegetation, such as blueberries and cassandra, are comparatively small in extent.

There is undoubtedly a difference in mineral content of the Muck areas developed along streams and of those in depressions. This can not be determined by field examination, but it seems reasonable to suppose that during times of high water the Muck near the streams should collect more mineral particles.

Muck is mapped in relatively small areas in all parts of Manistee County. The largest body lies between Kaleva and Copemish in the northeastern part of the county. There are no large deposits upon which agricultural operations are in progress, and the future use of Muck is somewhat uncertain in the climate existing in this county.

Muck, shallow phase.—In Muck, shallow phase, the organic deposit is underlain at less than 30 inches by sand mixed with varying quantities of clay and silt. The surface horizon is in places well decomposed and presents a black appearance, with few fibers of plants visible. Certain other deposits are characterized by a higher water table, and decay has been slower, so that the material has a brown color and a coarse, fibrous structure.

The thickness of the organic layer is everywhere variable, being in places only 6 inches deep around the edge of the deposit and reaching a depth of several feet near the center of some deposits, but the average depth was used in determining whether the deposit should be mapped as typical Muck or as the shallow phase. The influence of the sandy or clay substratum is important mainly where the organic deposit is extremely shallow. Marl deposits are rare in this kind of soil. The greater part of Muck, shallow phase, has an alkaline or nearly neutral reaction.

The shallow phase deposits usually occur in small patches throughout the entire county, although there are very few of them in the region south of the Manistee River. There has been up to the present time little or no utilization of this land for agriculture.

SUMMARY

Manistee County lies in the northwest part of the Lower Peninsula of Michigan, along the shore of Lake Michigan. The land area is 542 square miles, or 346,880 acres. The county is mainly in the drainage basin of the Manistee River, although some areas near Lake Michigan drain directly into the lake. Every kind of glacial feature is developed within the area of the county, including moraines, glacial outwash plains, and old river terraces.

The first settlements and the beginning of agriculture were in 1864. The county was organized in 1840, and the city of Manistee established in 1855. The population increased until 1900, when 27,856 people resided in the county. Between this year and 1919 the population decreased to 20,899. Decline of the lumbering industry is the principal cause of this decrease. Manistee, the county seat, is the largest city, with a population of 9,694.

The climate is characterized by cold winters and moderate summers. The mean annual temperature is 45.3° F. The average an-

nual precipitation is 30.5 inches. The average annual snowfall is 63.5 inches. The growing season has an average length of 158 days.

The earliest agriculture was carried on as an adjunct to working in the lumber camps, so that the crops were usually poorly cared for, and were produced on small areas. About 1900 a more progressive agriculture began, which now includes fruit growing, cattle raising, and other agricultural lines requiring more attention. In the western part of the county, along the lake, fruit growing is the leading industry. In the eastern part general farming is more generally practiced. The use of the cut-over lands for grazing is not yet developed as it should be, and the whole livestock industry is in its infancy.

The equipment and buildings of many farms are still in the pioneer class, and up-to-date barns and other equipment are rare, except in some of the older settled sections. Horses are used for most farm work. Rotation is practiced in some cases, although continuous bean growing has been practiced to within a few years. The use of fertilizers other than manures is confined mainly to the fruit farms.

The average farm in the county contains 98.4 acres, of which 56.9 acres are improved. There were 1,499 farms in the county in 1920, only 41 per cent of the county being included in farms.

Most of the soils of the county are sandy in texture, a few areas of loam being mapped where the soil was developed from the clay deposits. There were 12 types of soil mapped in the county, also one miscellaneous material, Muck.

The soils belong to two main groups, the brown eastern soils and the gray northern soils of the United States. The Plainfield sand and the Coloma loamy sand are light-textured types belonging to the brown soil group. The Roselawn, Manistee, Rubicon, and Ontonagon series belong to the gray soil group. The more poorly drained soils include the Saugatuck loamy sand, Warners loam, Newton sand, and Muck.

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