Soils of Michigan
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SOILS OF MICHIGAN

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MICHIGAN STATE COLLEGE

SECTION OF SOILS

East Lansing

FOREWORD

From time immemorial man has held a great regard, amounting almost to reverence, for the soil and a sense of dependence on it. This feeling is exemplified in the expression "Mother Earth" and in the fact that many city men own farms and look forward to the time when they can retire to a country home. In time of adversity there is a great movement of city workers back to the land.

An ample acreage of good land to supply adequate food and clothing for its people is a great stabilizing influence and source of strength in any country. When the land is so depleted that the farmer is not reasonably prosperous, business, in general, does not prosper. The United States was blessed with an abundance of good soil, but our people are notorious for their wasteful methods of handling the soil. This situation is not due entirely to carelessness or indifference on the part of the farmer, but, in part, to economic conditions which have made it necessary for him to deplete his soil in order to earn a livelihood. It is a matter of public concern that soil fertility be maintained.

Cardinal points in good soil management are: (1) Adding lime to acid soils; (2) using a cropping system by which every cultivated field grows alfalfa, clover, or a mixture of grass and alfalfa every four years, or a crop of sweet clover for plowing under; (3) the careful saving and application to the land of all animal manures; (4) the control of erosion through rearrangement of fields, cropping system and tillage practices; (5) using winter cover crops to prevent loss of plant food through leaching and erosion; and (6) the use of commercial fertilizer to supplement the plant food supply in the soil and manure.

* * *

The soils of Michigan are being classified and mapped by the Soils Department and Conservation Institute, of Michigan State College, in cooperation with the Division of Soil Survey of the Bureau of Plant Industry. Some 50 counties have now been mapped and approximately 150 separate soil types have been identified and described.

SOILS OF MICHIGAN

C. E. MILLAR

The soils of Michigan were developed from the material deposited by great ice sheets or glaciers, which covered the state thousands of years ago. There were two or more of these glacial stages, separated by long intervals of mild temperature during which time soil developed and a cover of vegetation spread over the ground. Each succeeding glacier scraped off the soil formed since the previous glaciation, mixed it with soil and rock material removed from other areas, leveled off hill tops and filled valleys, and deposited a fresh covering of glacial till or drift, composed of rock material varying in size from huge boulders to rock powder or flour. The thickness of this glacial mantle is not uniform throughout the state, but probably averages from 200 to 300 feet. The deepest covering undoubtedly is from 600 to 1,000 feet in the vicinity of Manistee and Wexford counties, but in a number of small separate areas the covering may be no more than 10 or 15 feet in thickness. In some places the old bedrock is exposed in the bluffs of river valleys and along the shores of Lakes Huron, Michigan, and Superior. The last glacier is considered by geologists to have receded from southern Michigan about 25,000 to 30,000 years ago, and from northern Michigan, about 10,000 or 12,000 years ago.

The ice masses moved down through the pre-glacial valleys now occupied by the Great Lakes because there was less obstruction in those channels, and then crowded out over the land. Thus the ice moved over the state not only from the north, but from the northeast, east, northwest, and west. At times, the ice moved forward much more rapidly than it melted, while at other times, the reverse was true and the ice front receded. At intervals the advance equaled the rate of melting, and hence the ice front remained essentially stationary. At all times great volumes of water flowed from the melting ice. These conditions resulted in deposition of the material carried by the glacier in various ways, giving rise to different topographical features such as level land, hilly land, undulating or gently rolling land, and also to different classes of soil such as sandy soil, and clay soils.

TILL PLAINS

When the ice melted more rapidly than it advanced, the load it carried was deposited as a heterogeneous mass just as the material occurred in the ice. Usually this

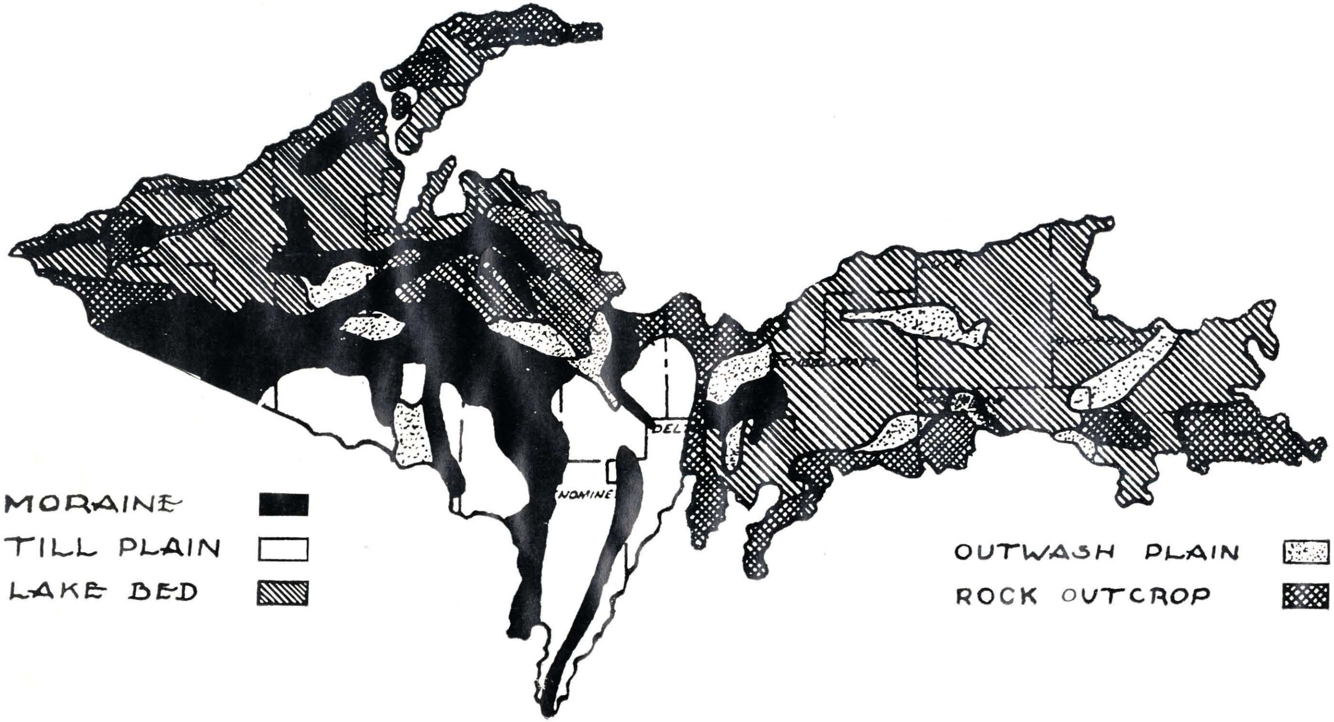
DEL
NOMINE
MORAINE
TILL PLAIN
LAKE BED
OUTWASH PLAIN
ROCK OUTCROP

Fig. 1-A.

Fig. 1-B.

Fig. 1 (A, B). A general map showing land formations produced through action of glaciers.

material consisted of rocks of various sizes together with rock powder and some sand and gravel. In some instances, there were a great many rocks, giving rise to very stony land. In other locations, the rock flour predominated, producing silt loam or clay loam land, while at times the sandy material occurred in increased proportion. Usually the soils derived from these deposits are of a loam, and silt loam texture underlaid by clay. These deposits are neither level nor are they hilly (Fig. 2). In general, they are undulating to gently rolling, and are called **till plains or ground moraines,** the former term being most commonly used. The general occurrence of these formations is shown by the white areas on the accompanying map (Fig. 1).

MORAINES

If the ice melted at approximately the same rate at which it advanced, the ice front appeared to remain stationary. As a result the load of soil material being constantly brought forward was deposited in a ridge or hill or series of hills. These are known as **moraines** and are shown in the solid black areas on the map. The moraines may be very steep hills or they may be gently rolling (Fig. 3). As a result, morainic land may be too steep for good farming, and must be used for pasture or wood lots, or it may be level enough to permit farming

Fig. 2. Till plains were deposited as the ice melted more rapidly than it advanced. As shown in the photograph, these deposits may be undulating to gently rolling. Sometimes they are much more nearly level than the photograph indicates.

Fig. 3. Moraines were produced when the ice melted at about the same rate it advanced. At times the moraines are quite hilly as shown in the photograph. In other cases the slopes are longer and much more gradual.

satisfactorily if practices are followed to prevent erosion. The moraines are composed of whatever kind of material the ice was carrying at that particular place. Sometimes this material was almost entirely sand, at other points it was largely fine, clay-like material, and again it was such a mixture as to make sandy loam, loam, or silt or clay loam. The proportion of boulders varied greatly also.

OUTWASH PLAINS

As the ice melted, great volumes of water flowed from it, carrying the ground rock of different degrees of fineness. The current in these streams was very swift, and hence the water was able to carry sand as well as silt and clay, and in some cases, gravel was carried or rolled along. As the water spread out over the land surface, the current decreased and the coarser gravel and sand were deposited. With further decrease in current, finer sand was dropped, but the silt and clay were transported into lakes or depressions where the water was comparatively quiet, or else were carried away through streams into the Great Lakes. The deposits laid down by these great volumes of glacial water are level (Fig. 4) and composed of gravel and sand; they are known as **outwash plains.** The main bodies of them are shown on the map by dotted areas.

LAKE-BED PLAINS

The retreat of the glacier left the outlets of the Great Lakes clogged with ice masses and deposits of rock material, and in some cases, as at Niagara, rock ledges formed natural dams. These situations resulted in the lakes being very much larger than at present, and, hence, over considerable areas the material brought down by the ice was covered by water for a long period. These areas are indicated by diagonal lines on the

Fig. 4. As the glacier melted, great volumes of rushing water flowed from it carrying sand, gravel, silt, and clay. Owing to the great velocity of the water the silt and clay were not deposited while the sand and gravel were laid down as broad level areas known as outwash plains. Note the moraines in the distance at the right which were formed as the ice melted, producing the water which deposited the outwash plain.

map. It will be noted that the larger part of the Upper Peninsula was under water as well as large bodies of land in the Saginaw Valley, and southeastern Michigan with smaller areas on the west shore, and at the tip of the Lower Peninsula. These lands are often referred to as the "Lake-bed Soils" of Michigan. As a whole, they are level (Fig. 5) and composed mainly of heavy soils, such as loam, silt loam, and clay loam. There are some level areas of sand, and also frequent stretches of sand ridges representing bars and beaches produced when the lake diminished in size by steps or stages as the outlets lowered owing to melting of ice barriers and the cutting of deeper channels through rock obstructions.

SOIL FORMATION

MINERAL OR UPLAND SOILS

Through the above-mentioned processes, material was deposited which was later converted into the soils of today. The glacial deposits must not be considered as soil, but only as raw material or parent material from which soils were to be made by action of natural agencies. The most potent agencies in decomposing rocks and minerals and in building soils are water, oxygen and carbon dioxide of the air, products formed through decay of leaves, roots and stems of plants, and the work of bacteria, mold, fungi, worms, and other forms of life in the soil material. Soil formation does not consist merely of decomposition of rocks and minerals. Products of such decomposition are in part recombined to make new substances, which constitute the major part of the clay in soils. Other products of rock decay are carried away in drainage water and yet other portions are held in reserve by the clay and humus to serve as plant nutrients. Portions of the finest clay are moved downward to accumulate at a lower depth; humus develops as a product of the partial decay of vegetable material, and bacteria, and similar minute forms of life become an integral part of the soil.

Some of the soil material was derived largely from hard rocks rich in quartz, which decomposes very slowly. Such material gave rise largely to very sandy soils. Large areas of these soils are found on the outwash plains. In some instances, however, the material deposited on these plains was derived from soft rocks containing considerable lime. When this was the case, the decomposition of the material resulted in the formation of considerable clay, and hence sandy loam and loam soils were produced.

A similar condition prevailed on the moraines. In some instances very sandy soils developed because of the high quartz content of the parent material, while in other instances, loam, silt loam, and clay loam were produced because of the finer texture of the glacial deposit or a high content of soft, easily decomposed rocks and minerals.

The soils developed through rock decay on the till plains are mostly in the loam, silt loam, and clay loam classifications with lesser areas of very sandy soil. This situation may be due in part to the

Fig. 5. The "Lake-bed Soils" are level, as a whole, and are composed largely of loams, silt loams, and clay loams having a high content of organic matter. They are sometimes called "Clay Plains". When adequately drained, these soils have a high productivity rating.

chemical composition of the rock material deposited and in part to the better moisture relationships which permitted more rapid decomposition of the mineral particles.

The soils of the lake-bed areas are generally of heavy texture, as previously mentioned, with smaller accumulations of sand. The humus content of the lake-bed soils is much higher than that of soils of similar texture developed on till plains and moraines. This is due to the large accumulation of humus during the swampy stage of the existence of such soils and the slow decay of the humus because of poor drainage after the soils were definitely above lake level.

ORGANIC SOILS

Soils composed of 20 per cent or more of organic materials, largely the remains of plants, are designated as organic soils. Many such soils contain 60 per cent to 90 per cent of organic material. In instances where the plant residues are highly decomposed, so that the original plant structures are destroyed, giving the soil a finely divided "loamy" texture, the soil is called a muck. On the other hand, if the vegetable remains are still coarse and fibrous, so that they mat together, the soil is called a peat.

These organic soils are formed by the accumulation of the remains of reeds, grasses, sedges, woody plants, and sometimes mosses, in shallow lakes or swamps where the water prevents complete decay of the yearly growth. The properties of the muck or peat produced are determined largely by the kind of vegetative growth and the amount of decay which has taken place. The kind of plants contributing to the formation of the soil is determined in part by the depth of the water, the amount of lime in the water, and the temperature. As the vegetable remains fill the lake or

Fig. 6. Organic soils are composed of the remains of plants which grew in shallow lakes or swamps and have been preserved from decay by the water. In the photograph, only a small area of open water remains of the once large lake. Soon the grasses and sedges will occupy the entire area and they will probably be followed by bushes and then trees.

swamp more and more, the deep-water plants give place to reeds, sedges, and finally to grass, bushes, and trees. In acid water, mosses may develop to a considerable extent, especially in cooler locations.

QUALITY OF MICHIGAN SOIL

The quality, or productiveness, of soils is determined not only by the quantities of plant nutrients contained, but also by the physical properties which permit ample root development and the storage of abundant supplies of moisture. Other important considerations in determining soil quality are the content of humus, adequate drainage, and making certain that the location is not subject to untimely frosts. Fertility or quality is generally based on the soil's capacity to produce large yields of the most generally grown crops of a region rather than the productive capacity for a special crop. The most productive soil in a community or a county may be put in the second- or even third-class group when compared with the most productive soil in the state. On a state-wide productivity basis, Prof. J. O. Veatch, of the Soils Department, has estimated that Michigan contains from 9 to 10 million acres of first-class land, 10 to 11 million acres of second-class land, approximately 7 million acres of third-class land and 9 to 10 million acres of fourth-class land. The main areas of each class of land are shown in Fig. 7. On a nation-wide basis, the National Resources Board in its 1934 report grades the soils of Michigan as follows: First grade, 2,251,155 acres; second grade, 8,961,198 acres; third grade, 5,386,738 acres; fourth grade, 7,228,991 acres; fifth grade, 13,223,254 acres.

Professor Veatch has also estimated that in the state there are 9 to 10 million acres of soil which would be classified as sandy or light sandy loam. Sandy loam and loam soils comprise from 12 to 13 million acres, and heavy soils as silt loams and clay loams comprise 10 to 11 million acres. There are about 5 million acres of organic and swampy soils in Michigan.

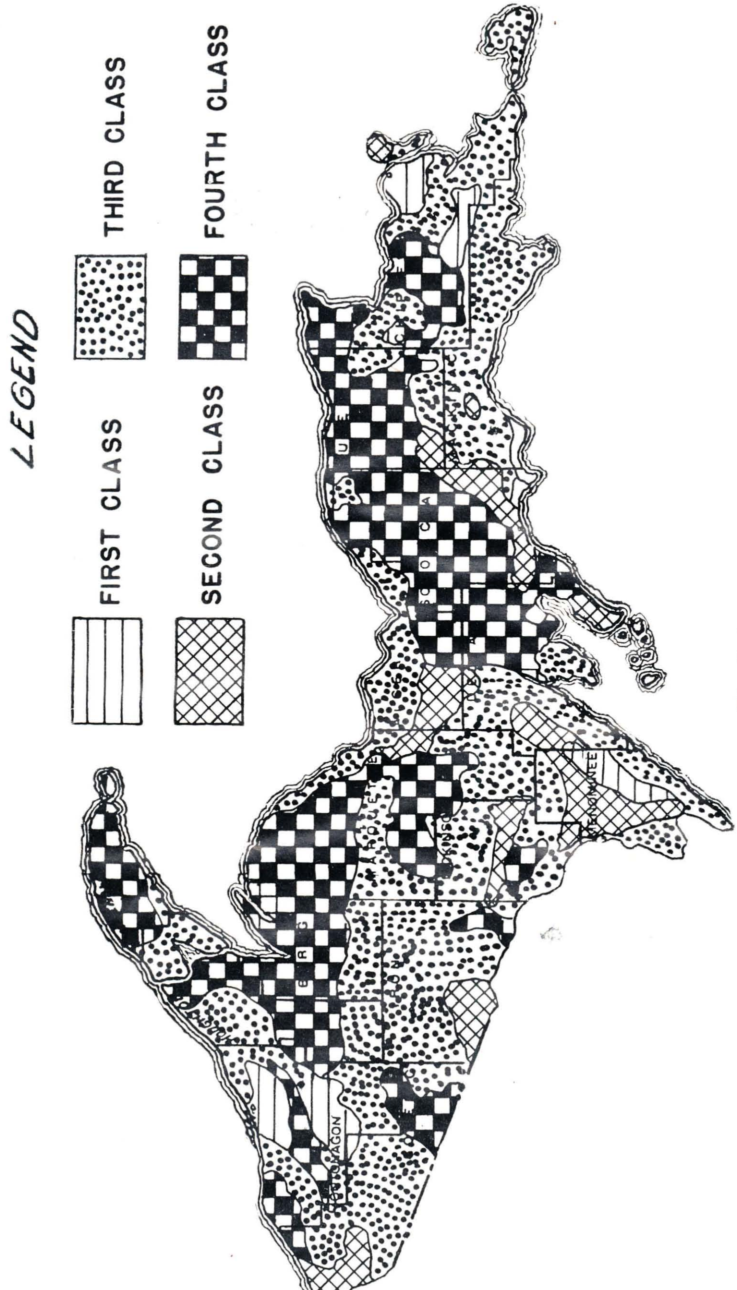

Fig. 7-A.

Fig. 7. A state-wide classification of land on the basis of productivity for the commonly grown farm crops. As only four classes of land are made, there is considerable variation in productivity within each class. Since only the best land in the state is ranked as "first-class" the best land in many communities must fall in the "second-class" group. The "first-class" land includes excellent to good soil well suited to farming. In the "second-class" land are placed the good to fair soils which are mainly suited for farming with

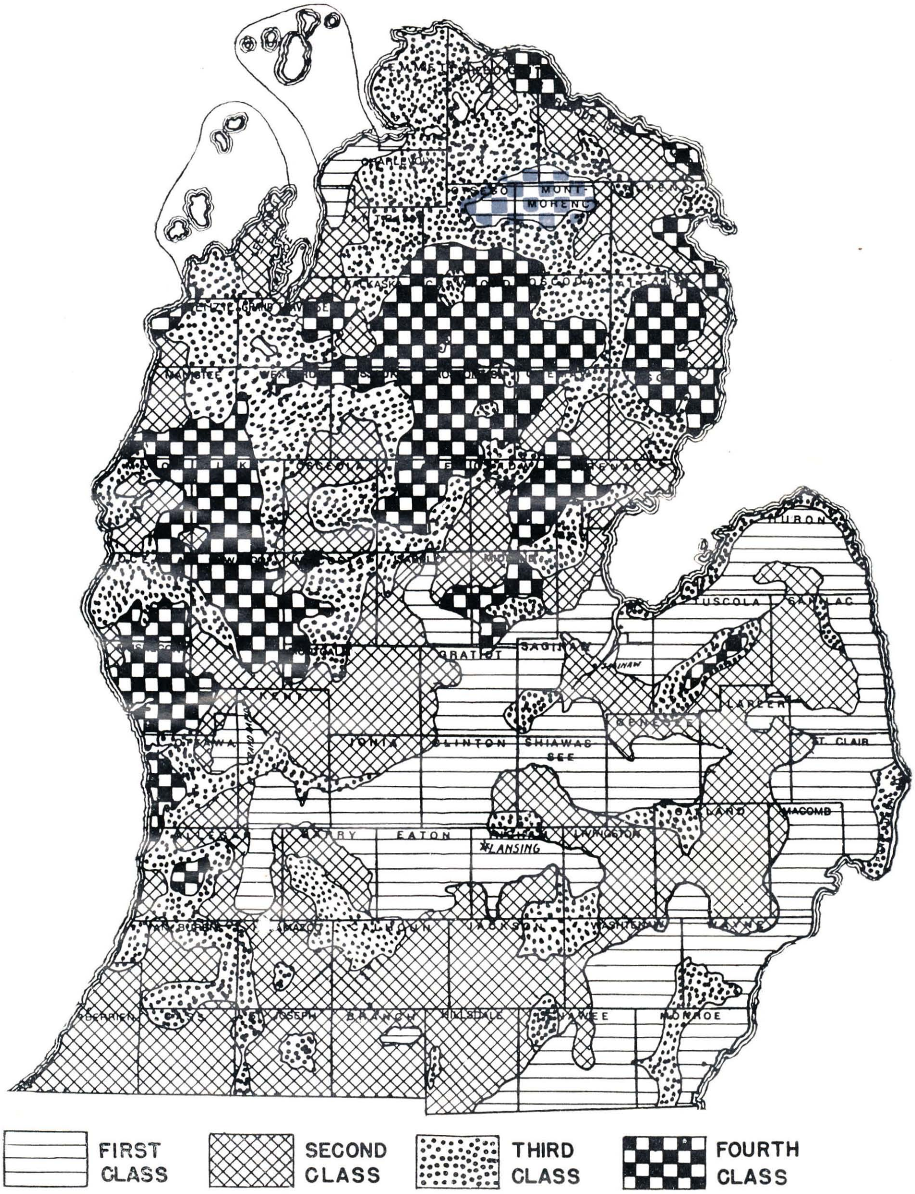

Fig. 7-B.

occasional areas which require special farming methods or should be retired from agricultural use under present conditions. The "third-grade" land includes fair to poor soil. Part should be retired from agricultural use due to stoniness, poor drainage, unfavorable topography, or drouthiness. Land of "fourth-class" is made up of soil which is submarginal for ordinary crop production. It includes some peat deposits, very sandy soil, and very stony, rocky or hilly areas.

PLANT NUTRIENT NEEDS*

HEAVY SOILS

The heavy soils as loans, silt loams, and clay loams are usually more deficient in phosphorus from the standpoint of maximum crop yields, than in other plant-food elements. As a result, phosphoric acid is the main constituent in fertilizers used on those soils and in many cases superphosphate, which is the fertilizer supplying phosphoric acid, is the only fertilizer used. The quantities of the plant-food elements, nitrogen and potassium, which are needed depend on the management the soil has received, particularly with respect to the acreage of clover and alfalfa grown, the sods and green manuring crops plowed under, and the amount of stable manure applied. The nutrient requirements of special crops grown must also be considered. Fertilizers of the following compositions are in common use on these soils: 0-20-0,** 2-16-8, 4-16-4, 2-12-6.

SANDY SOILS

The sandy loam and sandy soils are also deficient in phosphorus but usually need potassium and often nitrogen, in addition. Frequently the fertilizer should contain as much or more potash than it does phosphoric acid. The crop to be grown as well as the quantities of manure applied, and the frequency with which alfalfa and clover sods are plowed under, influence the type of fertilizer needed. Fertilizers commonly used on those soils are as follows: 4-16-8, 3-12-12, 0-8-24, 2-16-8.

ORGANIC SOILS

Potassium is the plant food element most needed by muck and peat soils. Some phosphorus is generally needed in addition to the potassium, and in some instances, a small amount ot nitrogen is also required. The degree of decomposition of the organic material making up the soil, the years under cultivation, drainage conditions, and the acidity or lime requirement of the soil are determining factors in deciding which fertilizer to use. Much attention must also be given to the special requirements of the crop grown. Fertilizers used frequently on organic soils are of the following compositions: 0-8-24, 0-10-20, 2-8-16, 3-9-18, 3-12-12.

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*Refer to Extension Bulletin 159, "Fertilizer Recommendations" for information as to what fertilizer to use for different crops on different kinds of soil.

**The composition of fertilizer is expressed in a series of numbers as here shown. The first number shows the percentage of total nitrogen, the second the percentage of available phosphoric acid, and the third number the percentage of potash soluble in water.

For information concerning the management of Michigan soils write to the Soils Department, Michigan State College, East Lansing.

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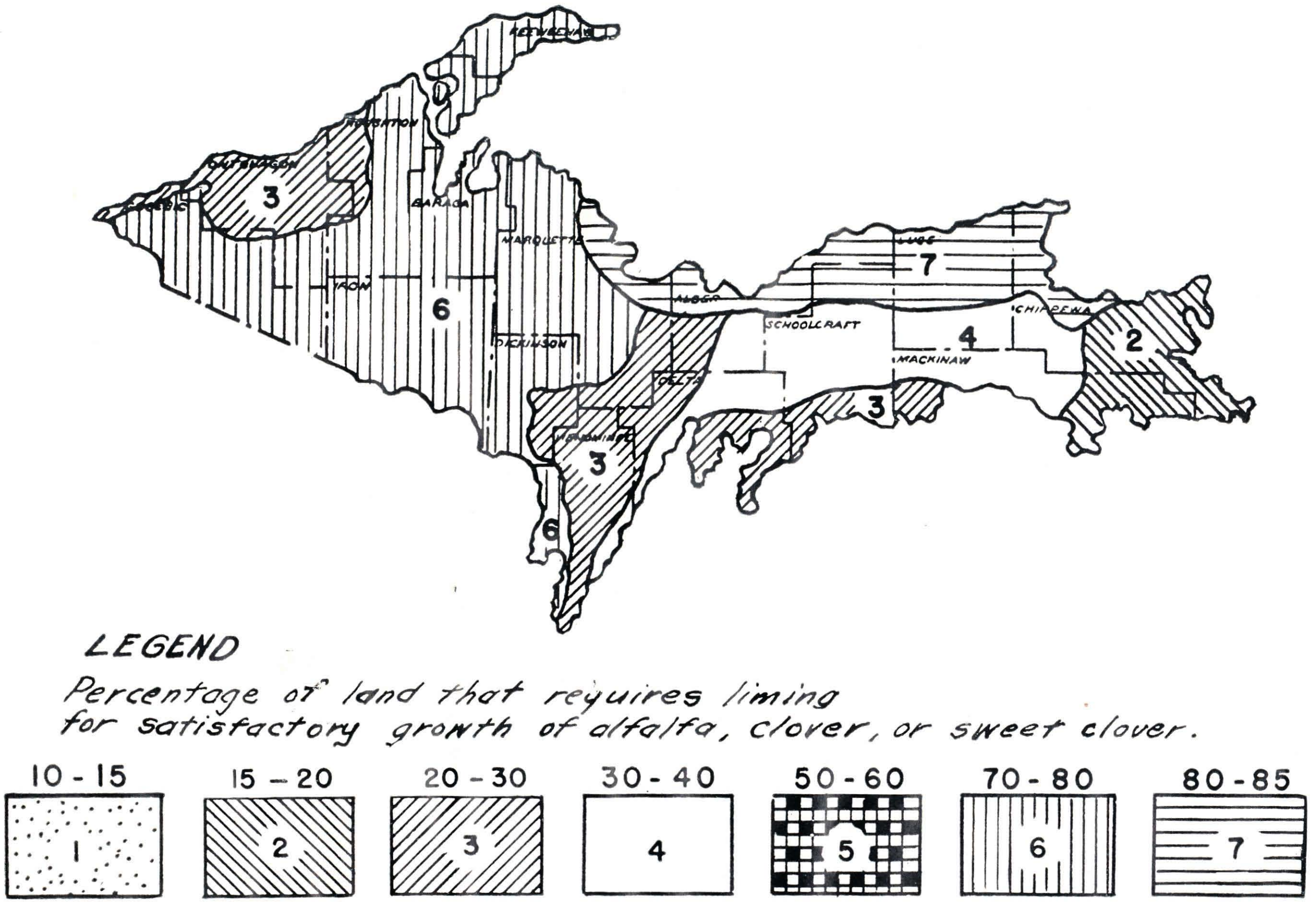

BARAGA
MARQUETTE
IRON
DICKINSON
ALGER
LUCE
SCHOOLCRAFT
CHIPPEWA
MACKINAW
DELTA
3
6
7
4
2
3
3
6
LEGEND
Percentage of land that requires liming
for satisfactory growth of alfalfa, clover, or sweet clover.
10 - 15
1
15 – 20
2
20 – 30
3
30 - 40
4
50 - 60
5
70 - 80
6
80 - 85
7

Fig. 8-A.

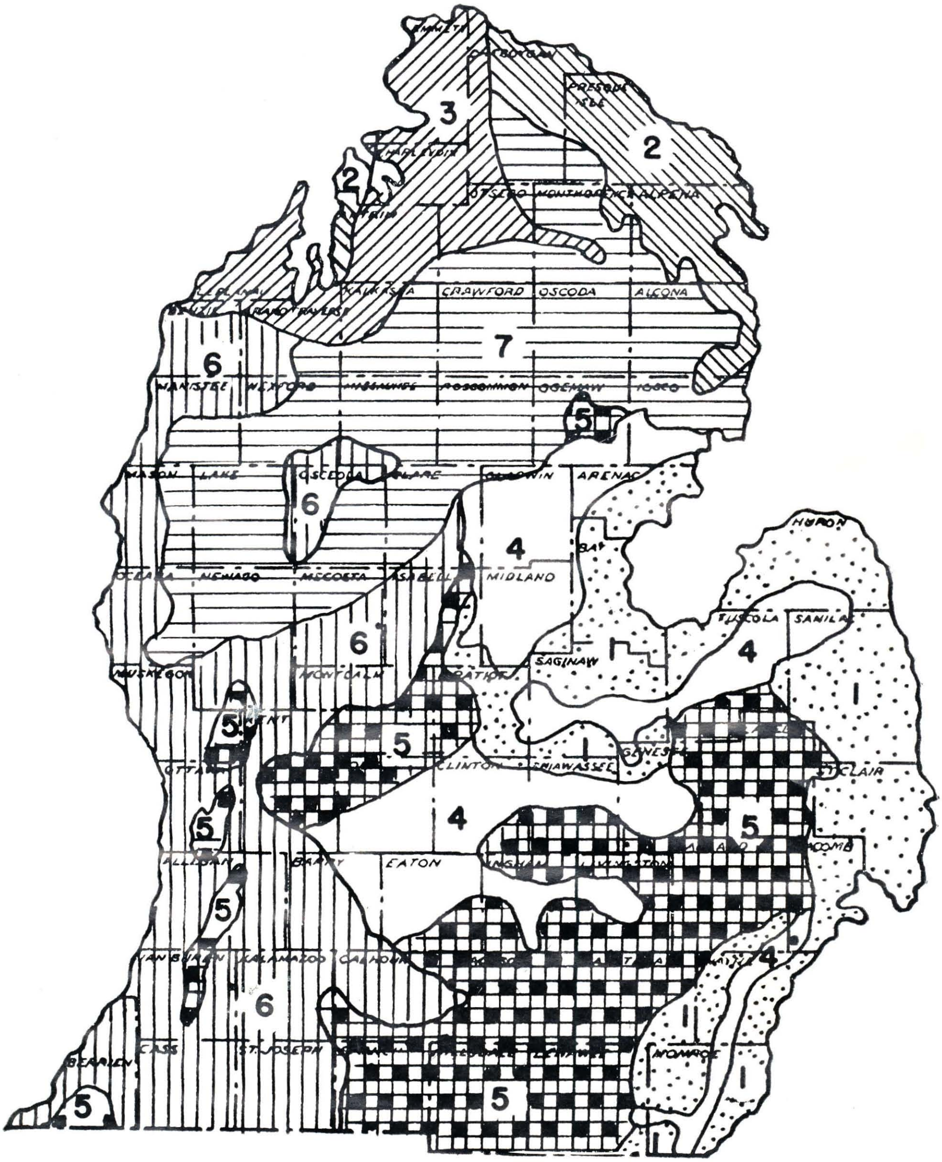

Fig. 8-B.

Fig. 8. In some sections of Michigan a very small percentage of the soils require liming to prepare them for alfalfa growing while in other sections of the state a large proportion of the soils are lime-deficient. Soils should always be tested to determine their need for lime before lime is applied. The figures in the legend give the percentage of the soils in the different areas of the state which require liming for alfalfa growing.

HUMUS

The dark color of soils is due to the presence of partially decayed organic matter derived from the roots, stems, and leaves of plants, animal manures, and the bodies of worms, fungi, bacteria, and other small forms of life. The value of humus, or organic matter which has undergone considerable decomposition, in maintaining the productivity of soils is evidenced by the fact that in judging soils farmers lay great stress on the darkness of their color. The development of an adequate supply of organic matter in soils is one of the first steps in building up infertile soils, and the maintenance of this supply is essential for the maintenance of productivity. Humus is developed in soils through addition of manure, plowing under legumes as clover, sweet clover, and alfalfa, and by keeping the land in grass or other sod-forming crops a reasonable proportion of the time. The excessive plowing and cultivating of soil results in a decreased humus content.

EROSION*

The depletion suffered by Michigan soils through erosion by both water and wind is gradually becoming appreciated. Erosion losses pass unnoticed until one becomes acquainted with the signs left by this stealthy soil robber. Accumulations of rich black soil near the foot of slopes, the appearance of ever-increasing spots of yellowish colored subsoil on the slopes, small spring gullies in fall-plowed fields, and the comparatively poor growth of crops on the steeper parts of rolling fields, all indicate the loss of fertile surface soil which is the chief source of food for plants. Clouds of dust in fall and spring from fields on which no crop is growing, as well as drifts of sand in fields of sandy soil, testify to the loss of surface soil by wind.

Erosion is a cause of soil depletion on virtually every Michigan farm. The loss on some farms is small but on others it constitutes the main factor in soil deterioration. Twenty-five per cent of Michigan land has lost 2 to 3 inches of topsoil, according to the results of a survey made by the Federal Soil Conservation Service. Figure 9 presents the results of this survey.

Erosion is being controlled by planting crops in strips across the slopes, alternating cultivated crops with small grains and hay. Planting hay and pasture on the rolling ground and putting the cultivated crops on the more level fields also helps to defeat the destructive work of wind and water. Plowing and cultivating across the slopes, planting the roughest land to forest trees, and setting fruit trees in rows around the hill in-

*See Michigan Extension Bulletin 203 "Conserving Soil by Better Land-Use Practices," for more detailed information concerning erosion.

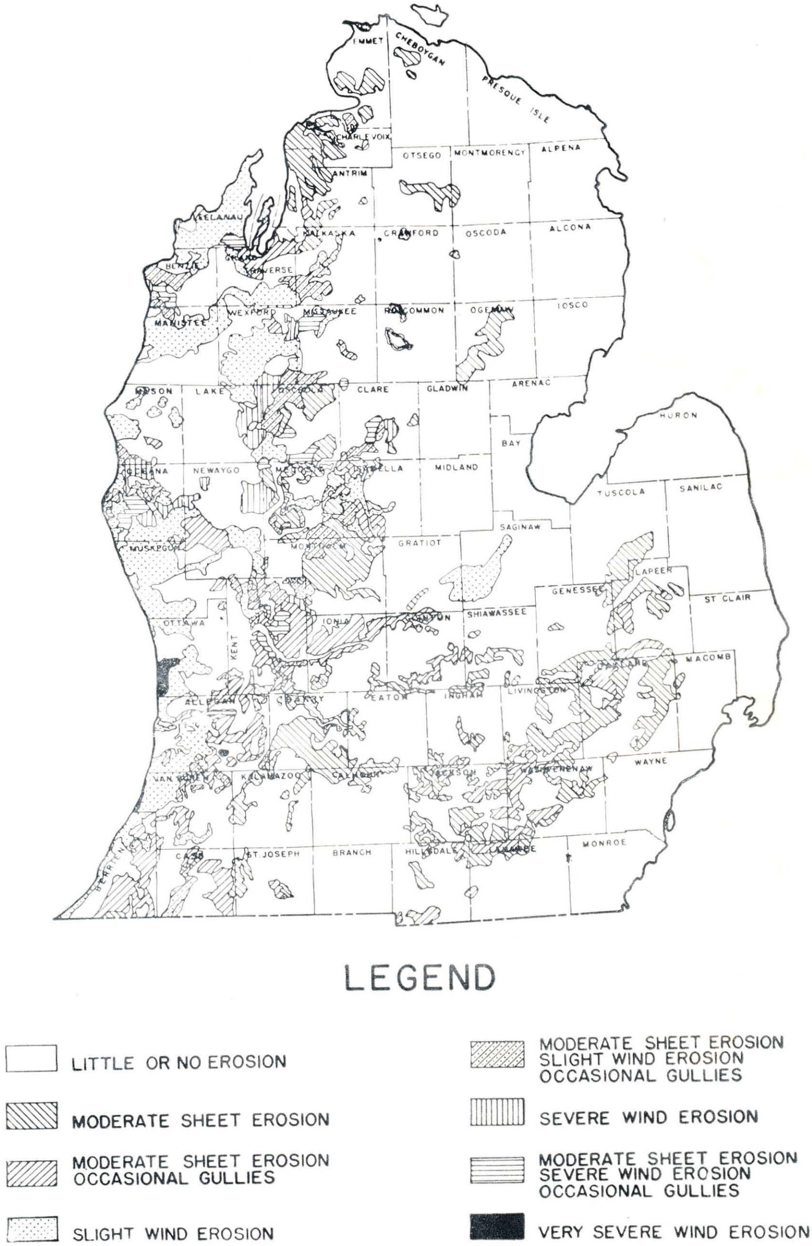

Fig. 9. Recent surveys show that about 25 per cent of Michigan land has lost 2 to 3 inches of topsoil and in some areas, the loss has been much greater. Erosion is, or is likely to be, a problem on every farm in this state because one finds fields with slopes as low as 2 per cent which have the topsoil washed away and gullies formed. Many instances of serious erosion occur in places shown as having little, or no erosion on this map.

stead of up and down the slopes are effective means of saving soil. Simple adjustments in the field arrangements and cropping plans of the farm will go far toward controlling erosion.

FAILING FERTILITY

The fertility of Michigan soils has been greatly depleted as measured by crop yields for the last 60 years. In case of a few crops as potatoes and wheat, some increase in yield is shown, but, on the whole, the average yields of the most generally grown crops are about the same as they were more than a half-century ago.

This situation is astounding when one considers all the improvements in farming which have been made and which should have resulted in increased yields of crops. For example, there are the improved varieties of many crops brought about through the work of the plant breeders. Seed from approved sources and of superior quality is largely used. Much larger quantities of lime and fertilizer are used and the drainage of vast acreages of good land has been improved. Manufacturers have improved farm implements for fitting the land and for planting and cultivating the crops. Farm periodicals and newspapers, the radio, and many trained agriculturists assist the farmer by supplying dependable information about farming derived from experiments and observation. Yet, regardless of all this progress, acreage yields have not increased. Some of these improvements alone, such as the use of superior crop varieties and of lime and fertilizer, should have greatly increased yields.

How can one account for this failure of crop yields to increase? He is forced to the conclusion that soil fertility has been decreased at a sufficiently rapid rate to offset the efforts of federal and state scientists, extension specialists, farm periodicals and newspapers, the radio and of the farmers themselves to increase farm efficiency.

Such a state of affairs is almost unbelievable and becomes the concern of every citizen. The farmer is concerned because decreased fertility means decreased income. The city dweller is concerned because decreased income to the farmer means decreased ability to buy products and professional services manufactured or offered by city men. This leads to unemployment. All Americans are concerned because an ample acreage of fertile land is a great National resource which should be conserved because it constitutes a strong stabilizing factor both economically and socially. All persons should join in the movement to provide for the proper use and maintenance of our soil.

12-40: 15M