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Soil Survey

Otsego County New York

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UNITED STATES DEPARTMENT OF AGRICULTURE
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In cooperation with the
Cornell University Agricultural Experiment Station

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SOIL SURVEY OF OTSEGO COUNTY, NEW YORK

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United States Department of Agriculture in cooperation with the Cornell University Agricultural Experiment Station

COUNTY SURVEYED

Otsego County is in the south-central part of New York (fig. 1). Oneonta, near the southern boundary, is 70 miles west of Albany and about 60 miles northeast of Binghamton. The outline of the county roughly resembles a broad wedge, the top to the north and the point well over to the southwest. The area is 1,009 square miles, or 645,760 acres.

The county lies within the Allegheny Plateau, and elevations range from 1,200 to 2,000 feet above sea level. The relief, which is strong and much diversified, ranges from hilly to rolling in the extreme northern part, and high divides and deep narrow valleys prevail throughout the central and southern parts. The general trend of these major elevations and depressions is from northeast to southwest.

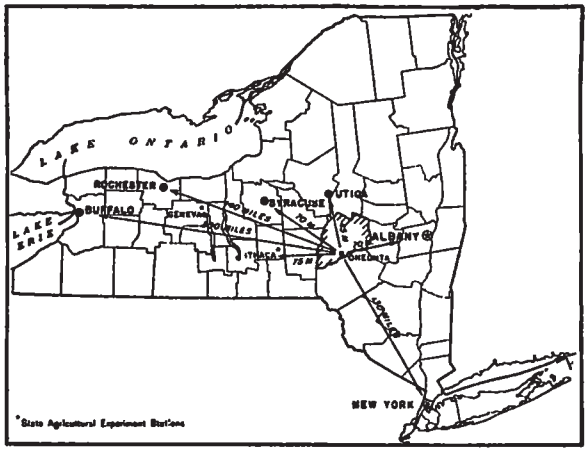

FIGURE 1.—Sketch map showing location of Otsego County, N. Y.

The relief in the northeastern part is comparatively mild. North of United States Highway No. 20, characteristic features are the oval-shaped hills whose smooth slopes decline to broad intervening depressions, but south of this highway the hills are more varied in form and height, many of them culminating in domelike crowns, most of which are wooded. Similar conspicuous elevations occur around the village of Cherry Valley. A few miles beyond the village the Helderberg escarpment cuts off several square miles of the northeastern corner of the county, and from the high limestone ledges of this escarpment the surface slopes to the Mohawk Valley. A few miles south of United States Highway No. 20, these irregular topographic forms resolve themselves into ridges and valleys, trending

[1] The Soil Survey Division was transferred to the Bureau of Plant Industry July 1, 1939.

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from northeast to southwest. The deep valley of Cherry Valley Creek is the principal one in the eastern part of the county. The valley of Susquehanna River, which includes Otsego Lake, occupies the central part, and the valley of Unadilla River extends along the entire western side. Near the southern boundary, the Susquehanna Valley turns westward, broadening and deepening until, at the southwestern corner, it is about a mile wide and lies 600 feet below the crest of the uplands. The southern wall of this great gorge, for the most part, is steep, and much of it is still wooded. Few tributary streams enter from the south, and for miles the crest of the ridge presents a comparatively even sky line. This is particularly true of the valley of Schenevus Creek. The southern wall extends for miles with only an occasional indentation by a short ravine or some outstanding point on the crest. A number of tributary streams break the continuity of the valley wall on the northern side, leaving many bold steep ascents to the ridge tops between them. The valleys with a nearly north-south trend have few branches, and the hills on each side are prevailingly steep.

The broad tops of the main divides present various forms of upland relief. Areas of undulating or gently rolling land may include as much as several hundred acres, but strongly rolling to hilly land occurs more generally, particularly along the marginal crests of the main divides and on the tops of the secondary divides.

Local inequalities of the surface are more or less rounded or smooth rather than abrupt and broken. This is the result of the smoothing effects of glaciation. The harder ledges of rock outcrop are exposed on all the steepest slopes, but their location is easily traceable along the flanks of slight swells, or ridges, where, in many places, a succession of outcrops and partial exposures form a series of steps, or benches, at various elevations on the hillsides. Much of this kind of relief occurs near Otsego Mountain and on the eastward- and northward-facing slopes in many other parts of the county.

The valley lands consist chiefly of terraces which range from low uneven second bottoms to flat-topped shelves against the sides of the slopes at elevations ranging from 50 to 60 feet. Most of the terraces which occur at the lower elevations are separated from the bottoms by short steep slopes. The terraces afford ample sites for the villages, and accommodate miles of main highways, along which hundreds of farm buildings and suburban houses have been built (pl. 1, *A*). Most of the first bottoms are narrow, especially those along the smaller streams. The flood plain of Susquehanna River in most places is less than one-fourth mile wide above Oneonta and in few places below that city exceeds one-half mile.

The valleys for the most part are open land, with only a fringe of trees along the streams, and a forest cover in the swampy places. The steepest slopes of the hills on each side generally are wooded, but the more gentle slopes are occupied by clean pastures. The intermediate slopes, those too steep for modern methods of tillage but formerly cultivated, present all stages of reversion to forest, from scattered shrubs to thick stands of young trees (pl. 1, *B*). This reversion to original conditions is in progress on much of the smoother uplands, where abandoned and unoccupied farms are numerous.

Virgin woodland commonly is limited to the steep stony land, and the younger growth is more common on the hilly land; but in all

A, Typical scene in one of the larger valleys of Otsego County, N. Y. The narrow bottom lands, the wide terraces on which the village and farms are located, and the high uplands beyond are representative of this section. *B*, One of the many unoccupied farms on Lordstown gravelly silt loam, 2 miles north of Morris The land below the buildings is a phase of the Wooster soils The middle lot is reverting to pine, haw, and wild apple trees.

parts of the county the greater part of the landscape is grassland, with farmsteads and fences in clear view.

CLIMATE

The climate is characterized by rather cool healthful summers and long winters, with considerable snow which, measured as it falls, amounts to about 70 inches per annum, of which more than 13 inches may fall in March. Fine autumnal weather usually prevails during October, but November includes cold cloudy days and occasional freezes. The proportion of cloudy and partly cloudy days in this section of the State is large. During the growing season there is one-half the number of hours of sunshine that is possible for this county to receive.[2]

The frost-free period at the Oneonta station of the United States Weather Bureau, which is in the southern part of the county, with high hills on the north and the valley of Susquehanna River to the south, is 136 days. Here the average date of the last killing frost is May 18 and of the first is October 1. At the Cooperstown station the corresponding dates are May 13 and September 30, respectively. The latest recorded date of a killing frost at Cooperstown is June 9, and the earliest, September 10; and at Oneonta the latest killing frost occurred on June 20, and the earliest on September 15. Aside from such direct influence as the lake may have, the slight difference in length of the frost-free season, in favor of the Cooperstown station, may be due to light fogs that are of frequent occurrence over the water and for some miles down the valley. Fruit growers consider the frost hazard slightly greater in the valleys than on the uplands.

The seasonal distribution of the rainfall is highly favorable for the crops generally grown. The higher monthly averages for June, July, and August are timely, with respect to meadows and pastures on the dominant soils and are especially favorable for corn and potatoes on the Chenango and other light-textured soils. Although local deficiencies and excesses in precipitation occasion some injury to crops, no general failure from such causes has been recorded. The rainfall is well distributed and is ample for the pastures, meadows, and other field crops.

Oats are sown about May 1. Corn for grain is planted as early as practicable in May, but the planting of that for silage may safely be delayed until later in the month. Most of the great tonnage of hay is harvested in July, with scattered cuttings of clover and alfalfa made much later in the summer. Differences in time of planting and of rate of growth of corn on different soils lengthen the period for filling silos to 6 weeks, but most of this important farm operation is completed early in October. Much fall plowing is done in November.

Tables 1 and 2 give the normal monthly, seasonal, and annual temperature and precipitation, as recorded by the United States Weather Bureau stations at Cooperstown and Oneonta, respectively. Both stations are located in valleys, but they are 20 miles apart and are situated somewhat differently with respect to the surrounding country.

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[2] MORDOFF, R. A. THE CLIMATE OF NEW YORK STATE. N. Y. (Cornell) Agr. Expt. Sta. Bull. 444, 38 pp., illus. 1925.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Cooperstown, Otsego County, N. Y.*

[Elevation, 1,200 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1864)	Total amount for the wettest year (1890)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	25.0	62	−30	2.93	3.27	4.33	13.8
January	20.7	64	−33	3.08	1.68	4.39	16.0
February	20.4	62	−34	2.86	.85	2.91	18.3
Winter	22.0	64	−34	8.87	5.80	11.63	48.1
March	28.7	76	−16	3.12	2.29	4.17	13.6
April	41.5	86	5	3.25	2.19	2.86	3.3
May	54.2	87	24	3.58	3.40	8.84	.1
Spring	41.5	87	−16	9.95	7.88	15.87	17.0
June	63.4	93	29	4.58	1.00	4.89	.0
July	67.7	99	35	4.88	1.79	3.39	.0
August	65.1	94	30	4.52	5.81	6.01	.0
Summer	65.4	99	29	13.98	8.60	14.29	.0
September	58.3	89	25	3.76	2.88	7.24	.0
October	47.0	82	12	3.76	2.39	5.91	.3
November	35.5	71	−8	3.07	2.37	3.17	5.0
Fall	46.9	89	−8	10.59	7.64	16.32	5.3
Year	44.0	99	−34	43.39	29.92	58.11	70.4

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at Oneonta, Otsego County, N. Y.*

[Elevation, 1,112 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1930)	Total amount for the wettest year (1898)
	°F.	°F.	°F.	Inches	Inches	Inches
December	27.6	69	−20	2.40	1.79	1.75
January	24.3	68	−23	2.51	2.25	3.62
February	23.2	65	−27	2.54	1.68	3.66
Winter	25.0	69	−27	7.45	5.72	9.03
March	32.5	73	−9	2.95	3.45	3.01
April	44.9	84	0	2.75	2.03	3.42
May	56.6	93	21	3.03	3.33	5.00
Spring	44.7	93	−9	8.73	8.81	11.43
June	65.2	98	31	4.06	2.31	5.13
July	71.8	104	39	4.16	3.49	2.39
August	67.8	97	35	4.40	2.33	13.05
Summer	68.3	104	31	12.62	8.13	20.57
September	61.8	97	28	3.40	4.69	4.19
October	50.8	90	10	3.42	1.18	7.36
November	38.8	74	−1	2.55	1.31	5.06
Fall	50.5	97	−1	9.37	7.18	16.61
Year	47.1	104	−27	38.17	29.84	57.64

AGRICULTURAL HISTORY AND STATISTICS

After the Revolution and the cessation of difficulties with the Indians, settlement of this general region was comparatively rapid. Most of the immigrants came from the New England States and were familiar with the conditions the country then presented and were experienced in pioneer methods of land utilization. Most of the individual holdings were small, but a number of large grants and purchases of land were made during this early period. The grant acquired in 1786 by the founder of Cooperstown was the largest, originally embracing 20,000 acres. This tract was soon disposed of in small units to settlers. Some of the large holdings became well-improved estates under the management of resident owners, who maintained a style of living much superior to that of the people in general, although all the settlers formed a rural community, in which most of the farms embraced less than 200 acres each and all the villages were small. On the organization of the county in 1801, Cooperstown became the county seat. The population of the county in 1800 was 25,987, increasing to 49,000 in 1840, and for the next 20 years it remained around 50,000. According to census returns, 377,000 acres were in farms in 1850, compared with 530,270 in 1935.

The early agriculture was of a self-sufficient type, in which actual cash requirements were comparatively low. Under these conditions, many homesteads were developed on soils of inferior quality, and the population was more evenly distributed than at present. The poorer farms provided a comfortable living but afforded little opportunity for the acquisition of wealth. The census of 1850 shows a production of food crops as follows: Wheat, 76,652 bushels; rye, 86,661 bushels; corn, 290,608 bushels; buckwheat, 105,000 bushels; potatoes, 500,000 bushels; and maple sugar, 385,000 pounds. For the spinning wheels and looms, common to most households, 325,000 pounds of wool and 212,500 pounds of flax were produced. Of the 58,000 cattle reported, about 30,000 were milk cows and 28,000 were work oxen and other cattle. The total production of cheese was more than 2,000,000 pounds, and that of butter was nearly 2,500,000 pounds. The cheese was manufactured in the numerous local factories, but the butter was a farm product.

These statistical data outline the rural picture of 85 years ago, which did not change materially until the late seventies and early eighties, when a marked reduction in the acreage of wheat, rye, and barley took place, but corn, oats, and hay continued as important crops. Cattle and poultry contributed much to farm incomes, but returns from sheep and swine declined.

Much of the industrial and social life of the communities centered in the villages, where there were many small manufacturing plants, a blacksmith shop, a carpenter shop, and stores which handled much of the farm products sent to outside markets. Of the many water-powered mills for grinding wheat and corn, a few still remain and grind a small proportion of the large tonnage of mixed feeds consumed on the dairy farms.

In 1849 about 1,132,000 pounds of hops were gathered. Production of hops steadily increased until the annual yields were about 4,500,000 pounds. The rapid decline after 1900 was due primarily

to prevalence of blue wilt, an introduced disease, but a succession of low prices and increasing cost of maintaining the yards, were contributing causes.

The forests have been and still are important adjuncts to the strictly agrcultural enterprises. The early abundance of good timber rendered possible the excellent construction that distinguishes the older farmsteads and village houses. Later the direct sale of forest products contributed importantly to farm cash incomes. The exhaustion of the timber on upland farms has been a contributing cause of land abandonment.

Prior to 1900 abandonment of farms was almost unknown, and the high uplands continued to be well occupied, although the people living there were not generally so prosperous as those living in the valleys and on the limestone lands.

The change toward present conditions was greatly accelerated as the automobile came into common use. The farms on the high uplands became less attractive and a notable decline in rural population took place in those towns consisting chiefly of upland soils. This decline during the last quarter of a century is more than 30 percent in several towns, and a decrease in population has occurred in nearly all towns except Oneonta.

The marked dominance of dairying as an agricultural enterprise is a development of the last 20 years. The sales of dairy products in 1929 totaled $5,851,471. This cash income was exceptional because of the high prices prevailing at that time, but it indicates the importance that dairying has assumed in recent years. Nearly all the money came from the marketing of whole milk in cities outside the county. Big barns and silos are outstanding features of most farmsteads, and milk-receiving stations are comparable with cotton gins in the South or grain elevators in the West. Soils, climate, transportation facilities, and markets are highly favorable for this particular branch of farming. Not all the soils are high-grade grassland, but even the inferior soils are more profitably used as pastures than for other purposes. The original lay-out of most farms included some land suitable for grain and legumes, especially in the valleys where the original units in land subdivision, known as lots, are strips of about 40 acres, which usually include some bottom land with that on the adjoining hillsides. The raising of cattle and the manufacture of cheese and butter are enterprises with which the people were familiar long before the demand for whole milk had developed to its present proportions.

On most farms poultry is a source of some income, and many farms are elaborately equipped for the production of eggs, chickens, or turkeys. In 1929, the value of poultry raised and eggs produced amounted to $2,319,102.

This county is considered outside the commercial fruit belt of the State, but the soils and climate are favorable for the production of apples, also pears, cherries, and a number of ornamental shade trees and shrubs. There are a number of small commercial plantings of apple trees. Strawberries and red raspberries are the most common small fruits, and local requirements generally are in excess of the production of berries and grapes.

The census reports 4,377 farms in the county in 1935, with an average size of 121.2 acres. Most of the farms range in size between 50 and 220 acres, but small farms are numerous along the principal highways. The large estates in the vicinity of Otsego Lake are used chiefly as summer residences by the owners, but some of them are under the care of managers, and much attention is given to dairying and cattle breeding. Seven farms include 1,000 acres or more. Several of these estates embrace extensive woodlands and artificial plantings of forest trees. In 1935, 88.4 percent of the farms were operated by owners, 9.5 percent by tenants, and 2.1 percent by managers. During 1934, the prevailing monthly wage of farm hands was about $20, with meals and lodging furnished.

In 1929, the average amount spent for feed on the 3,534 farms reporting was $840.99, and the average expenditure for commercial fertilizers was $58.66 a farm on the 2,261 farms reporting.

On the larger farms, horse power is supplemented by tractors which are used chiefly in preparing land for crops. Side-delivery rakes, hay tedders, and hay loaders are in common use. Manure spreaders and binders are part of the equipment of nearly all the larger farms. On the smaller farms, especially the hilly ones, drop-bundle harvesters are in general use, and cradling grain is not quite a lost art.

Numerous lines for the transmission of electric energy render light and power available on many farms.

A few country schools are still maintained, chiefly for the primary grades, but advanced pupils attend the consolidated schools located in villages.

Table 3, compiled from the United States census reports, indicates the trend in agriculture since 1879.

TABLE 3.—*Acreage of principal crops in Otsego County, N. Y. in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	[1] 11,785	[1] 8,539	[1] 9,769	[1] 7,695	[1] 3,646	[2] 11,901	[2] 16,000
Oats	35,152	33,453	25,539	28,742	21 272	10,881	13,740
Wheat	3,974	420	320	34	1,349	166	216
Rye	1,293	638	772	130	197	112	31
Barley	1,822	2,705	851	633	933	1 098	894
Buckwheat	7,781	8,114	5,251	8,450	6,815	3,285	----------
Potatoes	7,234	7,704	6 396	7,946	5,866	3,270	4,198
Hay (all kinds)	150,483	159,055	149,789	149,534	158,233	133,309	137,290
Timothy	----------	----------	----------	15,240	11,674	----------	----------
Timothy and clover	----------	----------	----------	103,234	109,757	93,137	105,412
Clover	----------	----------	457	1,369	2,842	3 825	719
Alfalfa	----------	----------	25	175	633	1,376	3,037
Other tame grasses	----------	----------	148,029	27,548	29,809	32 105	[3] 25,449
Wild grasses	----------	----------	6	1,262	2,046	1,179	----------
Grains cut green	----------	----------	1,272	706	1,423	1,328	2,223
Legumes for hay	----------	----------	----------	----------	49	359	444
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples	----------	311,015	331,659	194,986	139,946	85,461	69,369
Pears	----------	12 303	11,110	10,358	7,692	3,155	4,602
Plums	----------	8,506	7,040	10,569	12,949	7,758	6,590
Cherries	----------	1,531	2,425	4,021	4,788	2,885	3,125

[1] For grain.
[2] For all purposes.
[3] Includes tame and wild grasses.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [3] and its content of lime and salts are determined by simple tests. Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, especial emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are: (1) series, (2) type, and (3) phase. Areas of land, such as coastal beach or bare rocky mountainsides that have no true soil, are called (4) miscellaneous land types.

The most important of these groups is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first recognized. Thus, Lordstown, Wooster, Walton, Chenango, and Tioga are names of important soil series in this county.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. The class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Unadilla silt loam and Unadilla fine sandy loam are soil types within the Unadilla series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and, because of its specific character, it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a subgroup of soils within the type, which differ from the type in some minor soil characteristic that may,

[3] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

nevertheless, have an important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion frequently are shown as phases. For example, within the normal range of relief for a soil type, there may be parts which are adapted to the use of machinery and the growth of cultivated crops and other parts that are not. Even though there may be no important differences in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance, the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each soil type, phase, and miscellaneous land type, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS[4]

For convenience in discussing the crop adaptations and agricultural uses, the soil types have been grouped with these practical considerations in mind. On this basis they form three well-defined groups—tillable land, pasture land, and nonagricultural land. Only

[4] Owing to changes in correlation of soils and to greater detail in field mapping during recent years, no attempt has been made to join the soil map of Otsego County with those of adjoining counties, except Delaware and Herkimer, which have been surveyed most recently. In joining with Herkimer County, there are many minor differences on the maps, partly because of slight differences recognized in soil texture and partly because of more detailed mapping in Otsego County. For example, small areas of Honeoye soils adjoin areas of Ontario soils north of Otsego Lake. Some Lorain silt loam in Otsego County adjoins Ontario loam in Herkimer County. Some Honeoye silt loam, steep phase, in Otsego County, adjoins Ontario loam in Herkimer County. The differences between these two soils have little agricultural significance. Two miles northeast of Plainfield Center, Otsego gravelly silt loam in Otsego County adjoins Volusia silt loam in Herkimer County. The Otsego soil is very similar to the Volusia, as mapped at that time, in profile characteristics but has less mottling than Volusia as now mapped. There are many other minor discrepancies between the soil maps of the two counties.

In general, mapping of the soils in Otsego County is much more detailed than that in Delaware County, and for this reason there are many slight differences along the border and some disagreement in soil types. The Lordstown soils in Otsego County are subdivided into stony silt loam, steep phase, and gravelly silt loam. In Delaware County, all members of the series were mapped as silt loam, the stony and gravelly character being considered a fundamental part of the soil. Owing to recent changes in correlation the soil, 3 miles south of Maryland, mapped as Canfield silt loam in Delaware County, is called Mardin gravelly silt loam in Otsego County, because the original Canfield soils of New York have recently been subdivided. Some rough stony land in Otsego County adjoins the Lordstown soils in Delaware County, and several small spots of the poorly drained Chippewa soils shown along the boundary in Otsego County are not indicated in Delaware County. Rough stony land in Otsego County has been subdivided according to whether it includes Farmington, Lackawanna, or Lordstown materials. Southeast of Oneonta, there are slight texture differences, indicated on the maps, between the Chenango soils in Otsego and Delaware Counties. In the same general area Wooster gravelly silt loam in Otsego County joins Otisville gravelly loam in Delaware County. This is because the areas of Wooster soils in Delaware County were too small to be separated and were included with the similar Otisville soils. In some places along the county line, Lackawanna stony loam in Otsego County joins Walton and Lackawanna silt loams in Delaware County. Lackawanna stony loam, steep phase, in Otsego County in places adjoins rough stony land in Delaware County particularly south of Oneonta. Four miles southwest of Oneonta, Lackawanna soils in Otsego County join Culvers silt loam in Delaware County. South of Otego, Unadilla fine sandy loam joins Otisville gravelly loam mapped in Delaware County. There are a number of other minor discrepancies.

a small number of soils may be classed as nonagricultural; that is, they may be more profitably used for forestry, recreational purposes, or conservation of wildlife than for pasture or crops requiring cultural care.

To the important uses of land—cropping and grazing—may be assigned most of the soils, or the greater part of the county. Although no close distinction can be drawn between tillable soils and those suitable only for pasture, the results of agricultural practices, for the most part, are consistent in allocating the steep or the very stony land to permanent pasture. On the other hand, soils that have proved profitable under mixed cropping, with only occasional changes to grass, are considered tillable. On this basis, 77.2 percent of the county consists of cropland or potential cropland, 19.3 percent of pasture land, and the remainder, 3.5 percent, of nonagricultural land.

The 1935 Federal census reports the area of the county as 645,760 acres, of which 530,270 acres are reported as all land in farms. Of the land in farms, 184,693 acres are reported as cropland harvested in 1934; 876 acres as land on which crops were a failure; 12,527 acres as idle or fallow land; 77,614 acres as plowable pasture; 45,030 acres as woodland pasture; 121,229 acres as other pasture; 71,885 acres as woodland not pastured; and 16,416 acres as all other land in farms.

In the large soil group that embraces the tillable land, slight differences in drainage conditions are of noteworthy significance. Between the well-drained and the poorly drained soils are several types of extensive distribution, which are imperfectly drained. This condition is due chiefly to a so-called hardpan which offers considerable resistance to the free downward movement of soil water. This group includes several soils of good agricultural quality and economic importance. The group of poorly drained soils includes soils that possibly are arable but are classed with the pasture soils because of their almost universal use for grazing, as profitable reclamation is impractical under present economic conditions.

Similar differences in drainage are recognizable in the group of pasture soils, but the intermediate drainage condition is less extensively developed and of less importance with respect to the primary utilization of these soils.

In each class of soils, distinction can be drawn with respect to acidity and alkalinity. Only a few soils have an alkaline or even a neutral surface soil, but several important tillable soils meet the high lime requirements of clovers and alfalfa because of the available calcium carbonate, or lime, at a depth of less than 24 inches.

In addition to these soil distinctions, surface configuration and physiographic position are such important features with respect to land use that they are given consideration in the grouping.

In the following pages the soils are described in detail and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 4.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in Otsego County N. Y.*

Soil type	Acres	Per-cent	Soil type	Acres	Per-cent
Lordstown gravelly silt loam	115,648	17.9	Alluvial soils, undifferentiated	18,944	2.9
Lackawanna stony loam	36,672	5.7	Eel silt loam	1,280	.2
Manlius shale loam	3,456	.5	Chippewa silt loam	12,928	2.0
Wooster gravelly silt loam	42,688	6.6	Norwich silt loam	2,688	.4
Walton gravelly silt loam	7,808	1.2	Lyons silt loam	6,720	1.0
Honeoye silt loam	17,792	2.8	Lorain silty clay loam	1,024	.2
Honeoye silt loam, heavy-subsoil phase	1,344	.2	Lorain silt loam	3,264	.5
Ontario silt loam	6,080	.9	Holly silt loam, heavy phase	2,624	.4
Farmington silt loam	4,352	.7	Wayland silt loam	3,008	.5
Chenango gravelly silt loam	21,248	3.3	Lordstown stony silt loam, steep phase	77,376	12.0
Chenango sandy loam	1,536	.2	Manlius shale loam, steep phase	5,184	.8
Tunkhannock gravelly silt loam	2,176	.3	Wooster gravelly silt loam, steep phase	9,344	1.5
Otisville gravelly loam	10,624	1.7	Lackawanna stony loam, steep phase	13,568	2.1
Unadilla fine sandy loam	1,408	.2	Culvers gravelly silt loam, steep phase	6,400	1.0
Unadilla silt loam	896	.1	Langford gravelly silt loam, steep phase	1,856	.3
Palmyra sandy loam	1,152	.2	Honeoye silt loam, steep phase	4,352	.7
Palmyra gravelly loam	3,904	.6	Ontario silt loam, steep phase	2,048	.3
Groton gravelly loam	2,240	.4	Farmington stony silt loam	3,904	.6
Tioga silt loam	9,408	1.5	Rough stony land (Lordstown soil material)	18,304	2.8
Tioga silt loam, high-bottom phase	896	.1	Rough stony land (Lackawanna soil material)	3,200	.5
Tioga gravelly loam	7,872	1.2	Rough stony land (Farmington soil material)	1,344	.2
Barbour silt loam	1,472	.2	Muck	896	.1
Barbour gravelly loam	960	.1	Peat	1,664	.3
Genesee silt loam	1,728	.3			
Otsego gravelly silt loam	76,928	11.9	Total	645,760	
Mardin gravelly silt loam	4,224	.7			
Wellsboro gravelly silt loam	3,712	.6			
Culvers gravelly silt loam	9,152	1.4			
Volusia silt loam	29,824	4.6			
Langford gravelly silt loam	8,128	1.3			
Canadea silt loam	3,712	.6			
Middlebury silt loam	4,800	.7			

TILLABLE LAND

ACID SOILS OF THE WELL-DRAINED UPLANDS

The soils of this subgroup occur on the uplands and slopes of the divides. They are associated with sandstones, are predominantly acid, and under original conditions were poorly supplied with organic matter. The surface features are not quite so favorable for tillage as are those of the smoother and less stony soils associated with the limestones. Owing to their extent and wide distribution, these acid soils form a large proportion of the agricultural land. This subgroup includes Lordstown gravelly silt loam, Lackawanna stony loam, Manlius shale loam, Wooster gravelly silt loam, and Walton gravelly silt loam. The Lordstown and Manlius soils are shallow to bedrock and inclined to droughtiness.

Lordstown gravelly silt loam.—Lordstown gravelly silt loam occupies the tops of divides and the upper slopes where the degree of slope is generally less than 20 percent. Fragments of gray flaggy sandstone are on the surface and occur throughout the soil material.

In cultivated fields and pastures the soil to plow depth is dark grayish-brown gritty silt loam. The finer particles cohere in soft crumbs, imparting a friable consistence favorable for the maintenance of good moisture conditions. Just below plow depth, the material changes to brown or yellowish-brown silty loam which is a little less friable than the surface soil but is readily permeable to air and water. In many places the plasticity and stickiness increase at a depth of

15 or 20 inches. This condition prevails downward to bedrock which lies at a depth of less than 30 inches below the surface and in most places is a close mass of broken sandstone rather than a solid layer. The interstitial material is silty clay containing much fine grit. It is sticky when wet and tends to be feebly cemented when partly dry.

This is the dominant soil on the higher divides throughout the county, with the exception of the extreme southwestern part and a narrow belt across the northern border. It is rather easily distinguished from the Otsego and Mardin soils by its somewhat stronger relief on the ridge tops and its extension farther down the slopes. The high uplands opposite West Oneonta are typical of this soil.

As mapped, the larger areas include some steep slopes (pl. 2, *A*), but on the broad undulating tops of the main divides the Mardin and Otsego soils occupy the smoother locations. Many seepy spots, which include from a few square rods to several acres, occur on the slopes.

Nearly all of this soil was cleared at an early period and was used, for some time at least, for cultivated crops. A considerable acreage is used chiefly for such pasture and hay as it may yield, with no changes to other crops. This soil is better adapted to timothy, oats, buckwheat, and potatoes than to corn or clovers. Most of the tame grasses and vegetables require considerable fertilization for satisfactory yields, and the quality is good. This soil, which is especially desirable for potatoes, comprises much of the total acreage devoted to this crop. For best results with potatoes, sod, on which no manure has been applied the preceding year, is plowed in the fall, and a good seedbed is prepared by frequent precrop tillage. Before planting, from 200 to 300 pounds of 2-8-10[5] fertilizer are applied. Planting usually is done between May 15 and June 1. Acre yields of potatoes range from 200 to 300 bushels, and occasionally 400 bushels are obtained. The common practice is to cultivate late and "hill up" well, in order to protect the crop from possible injury by freezing weather before the potatoes are dug in the fall. Dry weather is very desirable at harvest time, as safe winter storage demands a considerable degree of dryness of the potatoes. Russet Burbank, Cobbler, and Green Mountain are favorite varieties.

Oats and buckwheat yield according to fertilization and tillage. The maximum acre yield for oats is about 50 bushels, but the average is much lower, and yields of buckwheat range from 15 to 30 bushels.

The inherently high acidity of this soil renders liming or heavy applications of manure necessary for a good crop of mixed clover and timothy. The effects of such treatment decline very noticeably after the second season. The clovers seldom survive, but timothy and possibly a little bluegrass persist in old fields for several years, but they are gradually replaced by bentgrass and poverty grass, with an increasing proportion of small weeds, among which goldenrod, yarrow, cinquefoil, and dewberries predominate. Under such conditions the acre yield of hay is commonly below 1,000 pounds, and grazing is correspondingly poor. The first trees to appear in old pastures are wild apple and haw, and in some places, pine seedlings come in abundantly.

[5] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

A, Cultivated field on steep slopes of Lordstown gravelly silt loam, about 2 miles northeast of Schenevus Much land like this has been cleared, but little of it is now in use for tilled crops Practically all is in permanent pasture or is reverting to forest *B*, Farm on west side of the Susquehanna Valley above Portlandville. The mounds and uneven slopes below the buildings are Otisville gravelly loam, the cleared land immediately above the buildings is Wooster gravelly silt loam, and the forest occupies a steep phase of Lordstown gravelly silt loam *C*, Farm about 2 miles northeast of the village of Elm Creek in Westford Town. The land in the right foreground is Otsego gravelly silt loam, and the higher ground behind the buildings is Lordstown gravelly silt loam.

This Lordstown soil is contributing to the area of farm abandonment (pl. 1, *B*) and is extensively involved in the neglected and unoccupied areas that formerly were well tilled. The soils within the reforestation areas consist in large part of members of the Lordstown series.

Lackawanna stony loam.—Lackawanna stony loam or "red land," occupies the smooth ridge tops and milder slopes of the high divides in the extreme southwestern part of the county. Most of the rock fragments on the surface and in the soil are red and brown sandstone, with some inclusion of loose gray sandstone. Outcrops on the hillsides and roadside exposures show thick ledges of the red rock.

The surface soil in old meadows is dark brownish-red soft crumbly silt loam. Between depths of 5 and 18 inches the material is a little heavier and has a somewhat coarser granular structure than the surface soil. The lower part of the subsoil is a little more compact but is not impervious to water, and, except for the presence of numerous rock fragments, it is not difficult to dig with a spade. Below a depth ranging from 30 to 40 inches the pieces of red rock form a large proportion of the mass, with red clay and very fine grit as the interstitial material.

The moisture-holding properties are good throughout the surface soil and subsoil, and tree roots penetrate to the underlying rock.

This soil presents variations in depth, stoniness, degree of slope, and occurrence of seepy spots. Many of the seepy spots are associated with actual outcrops or occurrence of ledges at less depth below the surface than is common.

The areas on the high divides above Wells Bridge and north of Unadilla are representative. Although now used chiefly as pasture, on account of their inconvenient location, all have been in cultivation.

The crop adaptations are similar to those of Lordstown gravelly silt loam, and farmers generally favor this red soil as the better of the two. It is a favorite soil for potatoes which produce satisfactory yields of good quality. In old neglected meadows, bluegrass, timothy, and white clover remain a part of the grass cover somewhat longer than they do on the Lordstown soils.

Manlius shale loam.—In cultivated fields the moist surface soil of Manlius shale loam is dark grayish-brown silt loam that assumes a much lighter color on drying, approaching an ash gray in places. To a depth of 7 or 8 inches the material is soft, crumbly, and easily tilled. The subsurface soil, to a depth ranging from 12 to 15 inches, may be slightly heavier than the surface soil, but it is not compact, as plant roots penetrate it readily and a moist sample, when crushed in the hand, breaks with slight pressure into soft friable lumps or small granules. The subsoil is compact drab-gray or dark-gray silt loam, and the resistance to a spade is increased by the numerous fragments of disintegrating shale, which increase with depth, and at a depth ranging from 25 to 30 inches, the hard dark-colored material consists chiefly of shale fragments, and a pick is required to penetrate it. At a slightly greater depth, generally about 40 inches, the thin-bedded shale is practically intact. Although the depth to underlying rock as well as the proportion of shale fragments throughout the surface soil and subsoil vary considerably, moisture relations

are good, and aeration seems to be effective down to the shale layers. In a well-cultivated field, the roots of corn were observed to be well distributed throughout the upper soil layers and some had penetrated the interstices at a depth ranging from 25 to 30 inches below the surface. In most places the surface soil is acid, especially in old neglected fields. As a rule, the degree of acidity increases with depth, and the underlying shale gives no reaction to tests for lime.

The surface inequalities range from moderately strong to gentle slopes. Many of the areas are more or less undulating, with low mounds, on which the soil is shallow and patches of gray shale are exposed. In the small local depressions the soil material is thicker and darker colored, with indications of obstructed underdrainage. With these exceptions, drainage generally is good.

The individual areas of this soil are small and are associated with calcareous soils. Some areas of Honeoye and Ontario soils are included. The included areas are yellowish brown, are less acid than the typical Manlius soil, and contain some limestone fragments and stony material of various kinds. Many of the steeper areas have a gray shallow surface soil containing an abundance of thin shale fragments, the result of erosion that has occurred since the land was cleared. The few remaining wood lots indicate an original cover of mixed hardwoods, with little or no pine or hemlock.

This soil responds well to good management. On a dairy farm, on which a rotation of grasses, oats, and corn is maintained, the following acre yields are reported: Silage corn, from 10 to 12 tons; oats, 50 bushels; and mixed clover and timothy hay, about 2 tons. Liberal applications of manure and about 100 pounds of a complete fertilizer were applied to the grain crop. These yields are much above the average for this soil, as much of it has been allowed to waste badly. In neglected pastures and meadows the vegetal cover consists largely of bentgrass, poverty grass, goldenrod, yarrow, common cinquefoil, and wild strawberry.

Wooster gravelly silt loam.—In cultivated fields the surface soil of Wooster gravelly silt loam is moderately dark grayish-brown silt loam. The surface is strewn with small stones and gravel of various kinds, and similar material is at all depths throughout the soil. The subsoil, below plow depth, is yellowish-brown silt loam which is a little heavier than the surface soil and more sticky under comparable degrees of moisture. The friability is due in part to included grit, gravel, and coarser materials, but the finer textured constituents tend to cause a crumbly structure that is especially noticeable where the soil material is heavier. Below a depth ranging from 30 to 40 inches, the material is somewhat lighter in color and is somewhat compact but not impervious to water. In the lighter areas the lower part of the subsoil consists of gravelly or sandy loam, in which the proportion of coarse materials increases with depth. The content of organic matter is low, and the materials are strongly acid to a depth of several feet. In the northern part of Susquehanna and Cherry Valleys calcareous material may be present under this soil at a depth ranging from 6 to 10 feet but in few places is at such a slight depth as to influence the surface soil to an appreciable degree.

Wooster gravelly silt loam occupies the lower slopes of the uneven foothills that are less steep and more rounded in form than the slopes above them (pl. 2, *B*). The areas on the west side of the Susquehanna Valley between Cooperstown and Colliersville are representative of much of this soil. The soil also occurs as uneven ridges less elevated than the crest of adjoining uplands, and as low rounded hills at the junction of small valleys with the larger ones. The areas near the village of South Valley are uneven gravelly mounds and ridges, with a heavier soil on the side slopes and intervening depressions, and the soil in a number of other places has similar relief.

Practically all of Wooster gravelly silt loam is used for cultivated crops, grasses, and legumes. For best results with clovers and alfalfa, farmers generally consider liming necessary, and a considerable proportion of the ground limestone annually used is applied to this soil. This soil receives much of the manure from dairy barns, and the heavy applications bring yields of corn to 40 or 50 bushels an acre, and from 10 to 12 tons of silage corn are common under good management. Under such treatment clover with timothy yields 2 tons or more of hay an acre. Generally, the clover does not form much of the stand the second year after seeding, but the timothy will continue to grow for several years. Bluegrass and white clover are common in yards and along roadsides. This soil is used for buckwheat and oats with satisfactory yields but is not so generally in favor for potatoes.

A large proportion of the improved roads in the valleys are through areas of this soil which is selected as sites for many farmsteads and suburban homes. The varied uses which the small acreages serve indicate the suitability of the soil to many kinds of fruit and ornamental trees, small fruits, and garden plants.

Walton gravelly silt loam.—Walton gravelly silt loam resembles Lackawanna stony loam, but it has smoother surface features, is developed on deeper and more compact till, and contains less stones. Most of the areas of the Walton soil join those of the Lackawanna. They occupy the lower slopes of hills in the red lands of the southwestern part of the county, and in some places areas of the Walton soil extend nearly to the crest of the divide.

The surface soil is dark brownish-red friable silt loam which contains some coarse grit, gravel, and small stones, but yields easily to the plow. The subsoil, to a depth of about 20 inches, is a slightly lighter shade of red, a little more compact, and has a very pronounced granular structure. The moisture relations are good. Below a depth ranging from 20 to 30 inches, the subsoil is heavy silt loam or silty clay loam, containing much gravel and many small stones. In most places this material is somewhat lighter colored than that above and so firmly cemented that, when partly dry, it is hard to penetrate with a spade. It offers considerable resistance to water, and underdrainage is more or less obstructed. Tree roots do not penetrate the more pronounced developments of this hard material. It occurs in many places to a depth of several yards, and in such places the material may have a distinctly porous, or vesicular, structure, accompanied by a varnishlike coating in the openings and on the surface of embedded stones. This characteristic of the subsoil

seldom causes trouble, except in wet seasons. Where stones and gravel are abundant and the depth to rock is only a few feet, both the surface soil and subsoil are more permeable. Many farmers consider this red soil superior to most of the lighter colored soils.

All the land is included in improved farms and is used for the field crops commonly grown. Yields are comparable to those obtained on Wooster gravelly silt loam. The Walton soil is strongly acid, and the supply of humus must be maintained by applications of manure or by plowing under cover crops. With light applications of lime, good stands of clover are obtained, but the soil is not so well adapted to alfalfa.

ALKALINE SOILS OF THE WELL-DRAINED UPLANDS

Honeoye silt loam; Honeoye silt loam, heavy-subsoil phase; Ontario silt loam; and Farmington silt loam form an important subgroup of well-drained upland soils. In places where these soils are dominant the basal formation is limestone, and every road cut reveals an abundance of limestone fragments in the underlying materials. The surface layers of these soils may be neutral, or even slightly acid, but the subsoils are alkaline. The depth at which free lime occurs in few places exceeds 30 inches. The friable consistence of the surface soils and upper subsoil layers favors good moisture conditions and easy penetration of plant roots to the lime-bearing substrata.

Honeoye silt loam.—Honeoye silt loam is an important member of this subgroup, both as regards extent and agricultural value. It is the dominant soil between the county boundary northwest of Richfield and Cherry Valley. Its most characteristic development is on the smooth evenly rounded hills north of United States Highway No. 20.

The 6- or 8-inch layer of surface soil is dark-brown or grayish-brown silt loam which has a soft granular structure, yields readily to the plow, and is easily kept in a good state of tilth. The subsoil, to a depth of about 20 inches, is dull yellowish-brown silt loam or silty clay loam, containing a little more coarse material than the surface soil. It is coarsely granular, very friable, and rather easily penetrable with any implement. The lower layer of the subsoil is lighter colored, tending, with increase of depth, to a yellowish-gray color which, at a depth ranging from 30 to 40 inches, merges with the characteristic gray or drab color of the unaltered parent material—a hard silty clay containing an abundance of fragments of limestone, chert, and other kinds of rock. Although less permeable to water than the brown material above, this stony substratum does not interfere seriously with underdrainage. In places where underdrainage is impeded, it is caused mainly by a large admixture of material from the shale formations, as is observable in the areas of Honeoye soil that adjoin Manlius shale loam or the Langford soils.

Practically all of Honeoye silt loam was cleared many years ago, and it has contributed largely to the agriculture of the northern towns of the county. It has been profitably used for wheat, hops, and other crops that were grown formerly, but its present use is chiefly for tame grasses, clovers, alfalfa, corn, and oats. It is used also for potatoes and garden crops to a small extent. It seems well

adapted to most of the tree fruits, as well as shrubs and flowers grown on many of the well-improved homesteads on this soil.

Acre yields of corn, under the usual cultural methods, range from 12 to 15 tons of silage, or from 40 to 50 bushels of grain. Two cuttings of alfalfa generally are obtained, and the total yields in most seasons are more than 2 tons an acre. Lime is seldom used, and farmers state it is not necessary, except possibly for included areas of some other soil. Mixed timothy and clover form most of the hay crop. Hay yields are heaviest, as a rule, on recently seeded land and are noticeably influenced by seasonal rainfall, but they average more than 2 tons an acre. Oats do well on this soil, and acre yields of 50 to 60 bushels are common. Potatoes are grown on a commercial scale by a few farmers, and acre yields average less than 200 bushels. Some commercial fertilizer is used, but no manure is applied to land preceding a potato crop. Most of this soil is farmed under the usual rotation of corn and oats, followed by 2 or 3 years of grass, and the yields of the various crops reported were obtained under this system of management.

Most of the low areas of the Honeoye soils adjoining Lyons silt loam are excellent grassland, but they may not be so suitable for alfalfa on account of less effective drainage.

In some places, Honeoye silt loam contains more chert and other stony material than typical, and in such areas the soil is somewhat lighter colored and coarser textured than typical. It may be coarse-textured loam and is mapped as loam on the soil map of Herkimer County. The crop adaptations, however, are very similar to those of Honeoye silt loam.

Honeoye silt loam, heavy-subsoil phase.—In the extreme northeastern part of the county, a heavy-subsoil phase of Honeoye silt loam is associated with dark-colored shales which form the substrata and in many places are exposed in shallow washes and road cuts. Most of this soil occupies rolling or somewhat hilly areas ranging from 900 to 1,000 feet above sea level. Some loss of surface soil is evident on all slopes of more than 10 percent.

In cultivated fields, the dry surface material is brownish-gray or, where much eroded, slate-colored silt loam which becomes considerably darker when wet. The soil in all areas generally is very friable but is less granular than typical Honeoye silt loam. Below plow depth the subsoil is light grayish-yellow or pale-yellow silt loam which is friable, easily penetrated with a soil auger, and has good moisture-holding properties. Below a depth ranging from 15 to 20 inches the drab-gray silty clay loam is more compact but develops a somewhat granular structure when partly dry. This material becomes somewhat looser with depth, but hard shaly clay is reached at a depth ranging from 40 to 50 inches below the surface. This basal material contains considerable stone, as well as fragments of shale, and it is strongly alkaline. In most places, the surface soil is acid, but the subsoil, at a depth ranging from 10 to 15 inches, is neutral or slightly alkaline.

Tame grasses and clovers do well, and alfalfa may be grown successfully. The moisture-holding properties are not quite so good as are those of typical Honeoye silt loam, but injury to crops during

dry weather seldom is serious, except on stony knolls and eroded spots on the steeper slopes. This heavy-subsoil phase of Honeoye silt loam resembles Mohawk loam and Mohawk silt loam of Herkimer County, but in Otsego County the subsoil materials contain considerable limestone rock.

Ontario silt loam.—Ontario silt loam differs from the Honeoye soils in the somewhat lighter color of the surface soil and subsoil and the greater depth to free lime which occurs at a depth ranging from 30 to 40 inches below the surface and may, locally, exceed a depth of 60 inches. This irregularity is most frequent in those areas of the soil associated with Manlius shale loam or adjoining areas of Langford and Lordstown soils.

In old fields the surface soil generally is brownish-gray or light grayish-brown friable silt loam containing some coarse grit, gravel, and small stones but few, if any, pieces of limestone. The subsoil is yellowish-brown friable silt loam which is coarsely granular in structure. Roots of plants penetrate freely to a depth of 30 inches. In most places the infiltration of the dark-colored silt into old root channels and worm holes has been considerable. In most places the material in the lower part of the subsoil is similar to that in the corresponding layer of Honeoye silt loam. Any important difference generally is due to a greater admixture of materials from shale or sandstone and tends toward a lower degree of alkalinity throughout the soil mass than is typical.

The areas near the eastern boundary of the county include spots of dark-brown crumbly silt loam overlying rather heavy granular dark yellowish-brown silty clay loam which, at a depth of a few feet, is underlain by dark-gray shale. This is an alkaline soil over a calcareous subsoil, and it is somewhat superior to the typical Ontario soil with respect to richness in lime and consequent adaptation to alfalfa and clovers. The areas associated with the Langford and Otsego soils include transitional areas toward those soils, with a consequent tendency to slower drainage and less available lime than the typical Ontario soils possess.

Ontario silt loam is characteristically developed in the rolling or somewhat hilly uplands. The slopes in many places are less smooth than those of the Honeoye soils, but they are easily tillable. Large boulders are numerous on some areas near the eastern side of the county. Much of this stony material consists of chert and the harder kinds of sandstone.

All this soil is under cultivation, and the crop adaptations are similar to those of Honeoye silt loam.

Farmington silt loam.—The distinguishing characteristic of Farmington silt loam is the slight depth to limestone, which in most places is less than 30 inches. Exposures of the gray unweathered rock may be seen on many of the gentle slopes, and thick vertical outcrops form a part of the steep stony land that slopes away from the margin of a comparatively smooth tract of Farmington soil. Old pastures contain much loose rock on the surface, and some patches of smooth gray limestone are as clear of soil as a pavement. In wooded areas the rock is less in evidence, but the extremely uneven relief is caused by many small deep vertical fissures, some of which are a foot or more in width.

In the wooded areas, below the accumulation of loose litter, is very dark colored silty earth, several inches thick, over dark-brown soft crumbly silt loam which gradually changes to lighter shades of brown or yellowish-brown heavier silt loam. This material has a more or less granular structure and is easily penetrated with a spade, except for the interference of rock fragments that may be present at any depth. At the contact with the bedrock, the lower layer of material in most places is less friable, is lighter colored, and may bear evidence of frequent saturation. Otherwise, this shallow soil has excellent physical properties, and, with few exceptions, the virgin soil seems to maintain a high moisture content, which may be due, in part, to the fragmental and fissured condition of the upper layer of the limestone. In pastures and old abandoned fields the evidence of droughtiness was very apparent in the summer of 1933. Exhaustion of the humus content and erosion on slopes were the chief causes of this injury. In local depressions and over the numerous deep fissures, vegetation suffered less injury. Included spots of Honeoye and Lyons soils resist dry weather much better, and they are easily observable during the summer.

About one-half of this soil is forested, chiefly with hard maple, but many other kinds of hardwoods thrive equally well. In pastures, bluegrass forms much of the growth, with some white clover and timothy, and goldenrod and wild carrot (Queen-Annes-lace) are characteristic weeds.

Much of this shallow soil that has been unwisely cleared and carelessly farmed is now of little value for tilled crops. These spots and rock exposures alternate with areas of deeper soil, but in such an intricate and irregular manner that the entire acreage can be used only for pasture. Protection from further injury by erosion is advisable, and seeding to sweetclover might prove advantageous in many places. All clovers thrive well on areas of deeper soil, and they grow well on areas of shallow soil during seasons of frequent rainfall.

ACID SOILS OF THE WELL-DRAINED TERRACES

The soils on the terraces are well drained because of their gravelly substrata. These agriculturally important soils occur as level areas of considerable extent and at elevations much below the neighboring uplands. An abundance of surface gravel is characteristic, but few of the stones are more than 4 inches in diameter. Except on marginal slopes and a few stony knolls, the land is favorable for the use of farm machinery. Most of the villages are located on these terraces, and they also afford convenient and healthful sites for farm buildings and suburban homes (pl. 1, *A*). The soils included in this subgroup are Chenango gravelly silt loam, Chenango sandy loam, Tunkhannock gravelly silt loam, Otisville gravelly loam, Unadilla silt loam, and Unadilla fine sandy loam.

Chenango gravelly silt loam.—Chenango gravelly silt loam is the most extensive soil on the terraces. It occurs in all the valleys in the southern two-thirds of the county and occupies terraces that range from 10 to 15 feet above the adjoining bottom lands, the line of separation in most places being a steep gravelly slope. The surface soil is characterized by an abundance of gravel and small stones, and

the substrata are the irregularly laid sands and gravels revealed in the numerous gravel pits.

The surface soil consists of grayish-brown silt loam or coarse-textured loam, containing much gravel and many small rounded stones. It is loose rather than friable to such a depth as tillage has mixed the surface materials. Beneath this and continuing to a depth of about 20 inches, is the subsoil of yellowish-brown coarse-textured loam which is firm but not compact. Although permeable to water and air, this layer is retentive of moisture, and roots of plants extend well down into it. With increase in depth, the lower part of the subsoil is coarse-textured sandy loam or loamy sand, containing so much gravel and stones that, in many places, the material cannot be penetrated with a soil auger. At a depth ranging from 5 to 6 feet is the loose unweathered sand or gravel.

The high terrace on which the county farm is situated is representative of this soil in the upper Susquehanna Valley, and the terrace on which the aviation field at Oneonta is located is more typical of the larger tracts in the lower section of the valley. The smaller areas present more variations with respect to elevation, surface features, and texture of the surface soil, and on these, the relief may be uneven, including knolls, low ridges, and cobbly side slopes extending down to the adjoining bottom lands.

In the small valleys, Chenango gravelly silt loam occurs at several elevations. The areas in the upper parts of the Unadilla, Wharton, Susquehanna, and Cherry Valleys are the weathered surface soils of gravelly deposits, that still retain traces of free lime at a depth ranging from 5 to 8 feet; but in the lower parts of these valleys this gravelly base material contains no free lime to a depth of many feet. In all places, the surface soil and yellowish-brown subsoil are distinctly acid. On the terraces, where lime occurs at a depth of less than 6 feet, it is possible that lime may be brought within reach of deep-rooted plants by the movement of capillary soil moisture. Exposures in gravel pits show deep penetration of rain water and indicate the possibility of such a movement of soil water. All this Chenango soil is a little more susceptible to dry weather than are any of the upland soils, as the moisture-holding zone is, for the most part, above a depth of 30 inches. This soil absorbs rainfall rapidly and returns it readily to growing plants. This characteristic was observed in July 1934, when the local rainfall was deficient for some weeks in the Schenevus and lower Susquehanna Valleys. During this dry period, examination of the subsoil in well-cultivated corn and potato fields generally showed the subsoil sufficiently moist to "pack" when a sample was pressed in the hands. Crops were somewhat injured, but none seriously, where the soil had been kept in good tilth.

Nearly all of this soil was brought into cultivation during the early settlement of the county. A very few small maple sugar camps remain, but there are no large wood lots. The common rotation of corn, oats, and grasses is generally practiced, with occasional changes to potatoes, clover, and truck crops, in small patches. Yields are determined more largely by precrop treatment and tillage than by seasonal deficiencies in rainfall, although the soil in general is sensitive to this factor. The following crop record from a field near

Milford is indicative of returns under good soil management: In 1931, on land to which about 12 tons of manure an acre had been applied the previous year, the yield was nearly 20 tons of silage corn. In 1932, oats yielded 40 bushels an acre. On June 17, 1933, the clover on the same field was about 20 inches high, and the estimated yield was 2 tons an acre. No commercial fertilizer or lime was used with these crops.

Similar crop yields were observed on many other farms, but on all farms the land had been well manured and the rotation included frequent changes to grass or clover. For best results with clover, liming is necessary, especially on all areas of this soil in Schenevus Valley and in the smaller valleys of the southwestern part of the county. The areas in the central and eastern parts are invariably acid to a depth ranging from 30 to 40 inches, but at a slightly greater depth they may be alkaline. The condition varies greatly within the same small field.

Chenango gravelly silt loam near West Oneonta includes some areas that are free of gravel to a depth ranging from 10 to 15 inches. Similar silty areas occur in the lower part of Butternut Valley and between Unadilla and Homesville. In some places where such soil occupies low benches adjoining the Lorain or Unadilla soils, it is less strongly acid than the more gravelly areas and seems adapted to grasses and clovers.

Chenango sandy loam.—The surface soil of Chenango sandy loam is brown or yellowish-brown sandy loam comparatively free from gravel and stones. The textural range is from light sandy loam to moderately heavy loam. These variations are observable in many places within a patch of a few acres. Below a depth ranging from 10 to 15 inches, the subsoil, in most places, is yellowish-brown coarse-textured loam, but in many places it is rather stiff silt loam without much coarse material. All these variations are permeable to water, and none is compact. At a depth of about 40 inches, the basal material may be darker colored loamy sand or sticky yellowish-brown silty sand, containing more or less gravel and small stones. In nearly all places, the character of the deeper material allows good underdrainage.

This soil occupies undulating or gently rolling areas associated with the Chenango and Wooster soils. The largest areas are near Milford, and smaller areas are at other places in the Susquehanna Valley and in Cherry Valley. The smaller areas are variable with respect to texture of the surface soil and the depth at which gravel occurs. All afford warm early locations for truck crops, and the soil generally is used for these crops. Sweet corn, potatoes, strawberries, and many kinds of vegetables are produced on the areas near Milford. Rather heavy fertilization is required for best results with such crops. Both the surface soil and subsoil are acid, and additions of lime and manure are needed for clovers and alfalfa.

Tunkhannock gravelly silt loam.—Tunkhannock gravelly silt loam is the red equivalent of Chenango gravelly silt loam. It is less extensive than the Chenango soil and occurs only in a few valleys in the southwestern part of the county. Unadilla is located on a low terrace consisting chiefly of this soil. The crop adaptations and fertilizer requirements are similar to those of Chenango gravelly silt loam.

Otisville gravelly loam.—Otisville gravelly loam includes all the soil occurring on the gravelly mounds, ridges, and other low irregular elevations in the valleys (pl. 2, *B*). The basic materials are similar to those beneath Chenango gravelly silt loam, but, in many places they contain large boulders and many smaller stones of various kinds. In most places, the surface soil is coarse gravelly loam, but in many other places, it is coarse-textured loam containing considerable humus, and it has good moisture-holding properties. Most of the areas of this kind are not very stony. The subsoil is decidedly variable. Typically it is gravelly sandy loam to a depth ranging from 20 to 30 inches. Below this depth, the material is composed of layers of irregularly stratified coarse sands, gravel, and rubble, which extend to an undetermined depth.

The moisture-holding properties of this soil, in general, are poor, and nearly all the land is droughty, with the exception of that in sags and depressions between the ridges. In these lower spots, the soil retains moisture well, with a consequent better growth of grasses and small weeds. The areas in the upper parts of Cherry and Susquehanna Valleys are favorably influenced by the materials derived from limestone and shales, but elsewhere these gravelly soils show little indication of lime within several feet of the surface. They are strongly acid to a depth of several feet.

This soil, as mapped, includes many of the steep sides of the high terraces on which Chenango gravelly silt loam occurs. The areas mapped in the southwestern part of the county associated with the red uplands are Colchester gravelly loam, but they are included with the Otisville soil on account of their small extent.

Practically all of this soil was cleared many years ago, and more than 90 percent of it is now in pasture. This general use for grazing is due, in part, to convenience of location, with respect to croplands of better quality, and in part to inconvenience of tillage. All vegetation is soon affected by a marked deficiency in rainfall. Under normal precipitation, timothy, bluegrass, and the more common old field grasses and small weeds do well and afford considerable grazing throughout the growing season.

Unadilla fine sandy loam.—Unadilla fine sandy loam differs from the Chenango soils in its smoother relief and freedom from gravel and stones. It occupies terraces rising not more than 15 feet above the adjoining bottom lands. The areas are small, and most of them are in the lower Susquehanna Valley. The areas between Unadilla and Oneonta are representative of the soil in this county.

The surface soil is grayish-brown fine sandy loam with such a high proportion of silt that it has a slightly crumbly structure. With increase in depth, the brown color becomes more pronounced, and the texture may be a little coarser. Below a depth of 20 inches the soft rather loose fine sandy loam has a light color, suggestive of olive gray, which may be indicative of less leaching and oxidation than has taken place in the overlying materials. At a depth ranging from 40 to 50 inches, coarser sand, together with some fine gravel, is present, and at a greater depth the material is chiefly coarse gravel. The gravel may be alkaline, but some degree of acidity prevails in the surface soil and upper part of the subsoil.

The areas below Oneonta occur on the outer margins of the lower terraces. In such locations, the Unadilla soil is slightly higher than the adjoining Chenango gravelly soil and from 10 to 15 feet higher than Tioga silt loam. Here, the land is well drained, easily tilled, and adapted to a wide range of crops. Elsewhere, the areas occupy low undulating ridges and mounds associated with other terrace soils.

All this soil is in use for the production of corn, grasses, and clovers. Yields ranging from 10 to 15 tons of silage corn an acre are common, and, when planted early, corn will mature and yield from 40 to 60 bushels. Farmers state that, for best results, manure is absolutely necessary and lime beneficial. This soil has been in cultivation so long that the available plant nutrients have been much reduced. The soil affords good locations for gardens, and it is used to some extent for truck crops.

Unadilla silt loam.—Unadilla silt loam differs from Unadilla fine sandy loam in the heavier texture of the surface soil and greater average depth to the underlying sand or gravel stratum. This silty soil does not dry quite so rapidly after rains as does the fine sandy loam, and in local sags it grades into muck and very poorly drained spots of darker soils.

The areas in Susquehanna Valley below Oneonta occupy low benchland, and the soil is free from gravel and stones. Several small areas on low benchland in the lower Butternut Valley consist of heavy silt loam that includes poorly drained spots resembling Caneadea silt loam. The crop adaptations and fertilizer requirements are similar to those of Unadilla fine sandy loam.

ALKALINE SOILS OF THE WELL-DRAINED TERRACES

The soils of this subgroup include Palmyra sandy loam, Palmyra gravelly loam, and Groton gravelly loam.

Palmyra sandy loam.—The Palmyra soils are developed on terraces in which sandy or gravelly calcareous material occurs at a depth of about 48 inches. The surface soil of Palmyra sandy loam ranges from neutral to slightly acid, and the subsoil shows increased alkalinity with depth and may be calcareous at a depth of 40 inches. As mapped in this county, the soil is less gravelly than is typical of the Palmyra soils, and the land is somewhat smoother. The areas include but little wasteland, in fact almost every acre is in cultivation.

Palmyra sandy loam is characteristically developed on the wide benchland along the upper part of the valley of Unadilla River and north of Otsego Lake, and smaller areas are in the middle part of the valley of Unadilla River and along streams that originate in the limestone land. The tract of excellent agricultural land above Unadilla Forks is representative of Palmyra sandy loam. The smooth almost gravel free surface is undulating, and the elevation ranges from 20 to 50 feet above the Unadilla River bottoms.

The surface soil is sandy loam or fine sandy loam, containing enough silt and other fine-textured particles to cause the material to cohere when moist. In some places, it is gritty friable silt loam and in a few places gravelly loam. In general, the color is a shade of brown common to well-oxidized soils which do not contain enough

humus to impart a dark color. Below plow depth and continuing to a depth of 20 inches, the color is yellowish brown or brownish yellow. The lower part of the subsoil commonly is sandy loam, somewhat heavier and a little less friable than the surface soil but easily penetrated with a spade or soil auger.

Moisture conditions are excellent. The soil absorbs rainfall rapidly and allows the excess surface water to move downward easily and become well distributed through the subsoil layers. As a coarse-textured soil will yield most of its moisture to plants, this soil is less subject to drought than its appearance would indicate. In only a few places was any tendency to droughty conditions observed during the dry weather of 1933. Farmers state that this soil, if properly managed, will withstand seasonal extremes in rainfall better than the heavier soils of the bottom lands.

This soil is used for a wide range of crops. Corn, oats, clover, and timothy are the chief crops on the dairy farms. Yields depend on the amount of manure applied and the crop rotation that is maintained. They average about 12 tons of silage corn or 40 bushels of grain an acre. Although oats are not grown so extensively, acre yields ranging from 40 to 60 bushels frequently are obtained. Alfalfa does well, and each of the two cuttings is usually from 1 to 1½ tons an acre. Clover and timothy make heavier yields in rather wet seasons. Cabbage, peas, and sweet corn are grown commercially, and, in general the individual acreage of each does not exceed 5 acres. The preparation for crops requires liberal applications of manure or an increase in the organic-matter content by plowing under clovers. Commercial fertilizers are used, and frequent tillage is necessary, especially in dry seasons. Potatoes are grown on a somewhat extensive scale by a few farmers, and they yield from 150 to 250 bushels an acre. The farm orchards include some large old apple trees apparently in good condition. The scattered tree growth in the woodland contains fine specimens of hard maple, black cherry, and other native trees.

Palmyra gravelly loam.—Palmyra gravelly loam occupies uneven areas on terraces that present steep gravelly escarpments toward the stream edges and includes numerous mounds and sags that render the larger areas less conveniently tillable than those of Palmyra sandy loam.

The soil in freshly plowed fields is dark grayish-brown gravelly loam which becomes lighter brownish gray on drying. Below plow depth the material may be slightly heavier and, in general, has a rust-brown or yellowish-brown color, indicative of good oxidation and and a rather low content of organic matter. At a depth ranging from 20 to 30 inches, the subsoil consists chiefly of gravel and rounded pebbles in a matrix of dark-colored silty calcareous clay. The finer particles adhere to the surface of the gravel and stones, imparting a uniformly drab or dingy-gray color to this coarse material, irrespective of the size or character of the individual pieces. With increase in depth, the drab color of the highly calcareous gravel becomes less pronounced and, at a depth ranging from 4 to 5 feet, the usual irregular stratification of sand, gravel, and coarse glacial rubble is reached. This basal material and the drab material above are highly calcareous. The surface soil, in most places, is alkaline.

Practically all of this soil is used for the production of field crops. The moisture-holding capacity varies somewhat, according to local conditions, chief of which is the thickness of the zone in which silt, clay, and other products of rock decomposition form the finer soil constituents. In places where spots of loose coarse gravel lie within 20 inches of the surface, the land is droughty and crops soon show the effects of dry weather. Most of this soil is capable of enduring ordinary dry periods somewhat better than do the Groton and Otisville soils. Clovers and alfalfa do well. They yield from 1½ to 3 tons an acre. Timothy, millet, and other forage crops are a little more dependent on seasonal rains, and yields may be reduced considerably. This soil yields from 10 to 12 tons of silage corn, or 30 to 50 bushels of ear corn, an acre. Oats, buckwheat, and millet are grown successfully.

Groton gravelly loam.—Groton gravelly loam is similar to the Otisville soils in topographic position and surface appearance. The chief difference is the slight depth to calcareous materials in the Groton soil. At a variable depth, but generally less than 30 inches, the Groton subsoil material effervesces vigorously when hydrochloric acid is applied. Pieces of limestone and pebbles of the same material are present throughout the soil and in many places are abundant in the lower part of the subsoil and underlying gravel beds. The surface may be neutral or slightly acid to a depth ranging from 10 to 15 inches in some places, but the subsoil everywhere is alkaline.

The small isolated areas in the Unadilla, Susquehanna, and Cherry Valleys are gravelly mounds, on which the surface soil is thicker and darker than that of Otisville gravelly loam. The larger areas in these valleys are somewhat smoother. They consist of mounds and low uneven ridges, whereas the intervening depressions are shallow sags or rather deep "kettle holes." A few of the larger basins include several acres of dark silty soil comparatively free from stones. In all these depressions, tame grasses and clovers thrive much better than on the knolls. A few of them include a spot of wet ground in the center.

The largest area of Groton gravelly loam is north of Oaksville, forming an uneven hummocky bench between the Canadarago Valley and the high hills to the east. The surface soil ranges from dark sandy loam to silt loam, and gravel is strewn over the surface. The yellowish-brown subsoil changes, at a depth of less than 20 inches, to gravelly loam, in which the proportion of coarse material increases with depth. The thickness of the silt loam layer is sufficient in most places to retain moisture fairly well, but crops are affected adversely in prolonged dry weather. Grasses and clovers require rather frequent rains for a vigorous and continued growth. Corn, oats, and buckwheat thrive best in the depressions and on the thickest sandy loam spots which occur only on the knolls nearest the valley. All this land is considered by farmers as good grassland.

The conspicuous knolls near Oaksville, from which much gravel for roads is obtained, are typical areas of Groton gravelly loam. Those below Cooperstown have less abrupt slopes, and haymaking machinery can be used in caring for the clover and alfalfa crops. From 1½ to 2 tons of hay an acre are obtained in normal seasons on all the better areas of this soil. On knolls and exceptionally stony

areas elsewhere, the average returns are less, and the grazing value is correspondingly poor.

ACID SOILS OF THE WELL-DRAINED BOTTOM LANDS

A large proportion of the bottom lands consists of thick well-drained soils. The drainage is due chiefly to local elevation with respect to the stream channels, but it is favored by the silty texture of the upper soil layers and the general prevalence of sandy or gravelly substrata. In places where the substratum is gravelly, the soil materials partake very largely of the character of the soils of the adjoining terraces and uplands, especially those to the north. The streams originating in the limestone areas of this county or of Herkimer County have developed larger areas of alkaline soils than have those heading in the sandstone and shale areas of Otsego County. Within each of these two groups may be found all variations in drainage conditions, and, as drainage so largely governs agricultural use, the primary grouping of these soils is based on this characteristic.

With the group of well-drained alluvial soils, those soils that are predominantly acid well down to the underlying gravel are designated acid soils; and those in which a neutral or alkaline condition is present within a depth of 15 or 20 inches from the surface are termed alkaline soils. The well-drained acid soils of the bottom lands include Tioga silt loam; Tioga silt loam, high-bottom phase; Tioga gravelly loam; Barbour silt loam; and Barbour gravelly loam.

Tioga silt loam.—Tioga silt loam is an important alluvial soil having an extensive distribution throughout the southern half of the county. It is developed on deep silty deposits having sufficient local elevation to insure good drainage and effective aeration to a depth of several feet. Although most of the areas are subject to occasional overflow, the inundations are of short duration and generally occur in early spring. This soil has a rather wide range of crop adaptations, but most of it is now used for the production of tame grasses, clovers, and corn. Few farm improvements, other than fences, are on areas of this soil, but nearly all of the land is smooth open land extending to the banks of the streams, which are marked by a fringe of scattered trees.

The surface soil is yellowish-brown or grayish-brown silt loam, with a considerable content of fine sand. The material in most places is rather friable, and, where the soil is heavier, it is somewhat crumbly and is easily penetrated with a spade or soil auger. Below plow depth the color is yellowish brown, and the subsoil, to a depth ranging from 15 to 20 inches, may be a little heavier and more firm, but it is not compact. With increase in depth, the proportion of fine sand gradually increases and the color becomes somewhat lighter, but the typical soil contains no gray spots or other indications of prolonged saturation. In most places, friable sandy loam or loamy sand is reached at a depth ranging from 30 to 40 inches below the surface and continues to the underlying coarse gravel.

To the coarse loose substrata and to local elevation, this soil owes its excellent drainage. The finer textured surface soil and upper subsoil layers are capable of holding a high percentage of moisture, and the coarser textured subsoil layers are not far above the pre-

vailing level of ground water. All conditions are highly favorable for drought resistance, without the susceptibility to wet weather that marks areas of Middlebury silt loam. Innumerable gradations in local elevation and drainage conditions may occur between these two soils.

The foregoing description of Tioga silt loam applies to the soil as it occurs on the moderately well elevated parts of the first bottoms of the larger streams. These areas are free from stones and in but few places contain much gravel or loose sand, except in the immediate vicinity of the stream channel, but many of the areas in the smaller valleys are gravelly and include spots containing many small rounded stones.

All areas of Tioga silt loam are acid, but there may be a neutral or alkaline reaction in many places at a depth ranging from 40 to 50 inches. Owing to the freedom from prolonged overflows, not much fresh sediment is added to the areas of this soil, with the possible exception of those areas on the insides of bends of the larger streams. In such places both the surface soil and subsoil are darker colored, more or less variable in texture, and highly fertile.

The soil of the larger areas in the river valleys is benefited by light applications of manure, and in some places the low somewhat sandy ridges are in need of lime, as well as manure, to insure a stand of clover or alfalfa, but most of this soil in the river valleys is well adapted to these legumes and liming is not absolutely necessary. Timothy meadows will remain in good condition for many years with only occasional changes to a tilled crop for one season, but clover requires more frequent reseeding, and alfalfa generally does not maintain a good stand without considerable care. The average acre yield of mixed timothy and clover is about 2 tons. As a rule, only one cutting is obtained, but the second growth furnishes much fall grazing. Corn on old sod yields from 40 to 50 bushels an acre and may do better if preceded by light applications of manure. The greater part of the corn crop is put into silos. Yields of 10 or 12 tons of silage an acre are common but are often exceeded under favorable conditions.

Barring the possibility of damage from overflows, this soil is well adapted to small fruits and a great variety of vegetables. Some of the higher lying areas are used for the production of potatoes, sweet corn, cabbage, and other truck crops.

Many small areas contain sufficient gravel and small rounded stones to interfere to some extent with tillage. As a rule, the gravelly areas endure dry seasons very well, and their adaptation to tilled crops is similar to that of the high-bottom phase of Tioga silt loam, with such limitations as the more gravelly surface imposes.

Tioga silt loam, high-bottom phase.—The high-bottom phase of Tioga silt loam includes the low ridges and small moundlike elevations within broader areas of the lower lying Tioga soil. The local elevation is only a few feet and, as a rule, is not sufficient to insure complete immunity from floods. The larger areas of this soil occupy broad low second bottoms, many of which are several feet above the land along the streams. This soil, in most places, consists of brown silt loam containing more or less gravel and water-worn fragments of stone. In local depressions it is less stony and may be a thicker

and darker silt loam than that on the higher land where the ground-water level generally is below a depth of 40 inches.

Areas of this soil are along Oak Creek near Toddsville, at various places in Cherry Valley, and along Susquehanna River. The soil is not quite so fertile as is the lower lying Tioga silt loam. The lower part of the subsoil is gravelly loam and gives an alkaline reaction, but the surface soil commonly is acid. Crop adaptations are similar to those of typical Tioga silt loam, but the farming methods are similar to those practiced on the Chenango and Unadilla soils.

Tioga gravelly loam.—Tioga gravelly loam occupies gently sloping fan-shaped deposits in the larger valleys at the mouths of tributary valleys. These small areas of outwash materials from the hills are very gravelly and stony, especially along the streamways. Most of the stones are small flat pieces of somewhat rounded or water-worn sandstone. The interstitial material in most places is dark crumbly silt loam. Fresh deposits at the immedate mouth of the ravine, or valley, may be little more than a heterogeneous deposit of stone, gravel, and silt. Farther out, the surface soil is less stony and, in general, is dark silt loam containing much gravel but not enough to interfere with tillage. In nearly all places, the subsoil, below a depth ranging from 10 to 15 inches, is a rather closely packed mass of water-worn fragments of stone, extending to a depth of several feet. The interstitial material is silt and clay, with a smaller proportion of sand than would seem normal to such a deposit.

These areas range in size from a few acres to as much as 100 acres. Several of the larger alluvial fans are in Cherry Valley at Middlefield. The areas in the lower part of this valley are smaller. Many of those in Schenevus Valley, most of those in Susquehanna Valley, and those along all the small streams in the central and western towns include only a few acres.

The surface soil has an acid reaction, and this condition generally prevails in the upper part of the gravelly subsoil, but in areas adjoining alkaline soils, the material may be slightly alkaline at a depth ranging from 40 to 50 inches. In all places in the lower parts of the larger valleys, this soil is distinctly acid to a depth of several feet.

As mapped, this soil includes some small areas of gravelly and stony alluvial soil, much like Tioga silt loam, all which are subject to rather frequent overflows.

All the Tioga gravelly loam is under cultivation. Little or no manure, commercial fertilizers, or lime are used in connection with field crops, as the rather frequent additions of fresh materials from the hills seem to maintain the fertility. The physical characteristics of the soil are favorable to the deep rooting of plants, with consequent resistance to dry weather. Only the extremely stony deposit along the line of floodwater discharge is droughty and untillable.

Corn, oats, and potatoes do well on this soil, and yields are comparable with those on the best areas of Tioga silt loam. All tame grasses do well, and mixed stands of clover and timothy yield from 1½ to 2 tons of hay an acre. Alfalfa is successfully grown without lime or other amendments.

Barbour silt loam.—Barbour silt loam is characterized by the distinctly red or brownish-red color of the surface soil and subsoil.

It is the dominant soil in the valleys of some of the small streams in the southwestern corner of the county. The individual areas are mostly narrow strips of bottom land, variable with respect to content of stone and thickness of the soil mass, as gravel or bedded stone are only a few feet below the stream channels. In a representative body, the surface soil consists of an 8- to 15-inch layer of red silt loam or loam containing much fine grit and some gravel. The friability is increased by the tendency to a soft granular structure in the subsoil which may be a slightly lighter shade of red, depending somewhat on drainage, but in most places internal drainage and aeration leaves little to be desired. The lower subsoil layer is commonly a mass of gravel, with red sticky clay forming most of the interstitial material. In some places the total thickness of alluvial material may be 10 feet, but in most places it is less than 5 feet.

This soil is used for corn, oats, grasses, and clovers, and the yields are similar to those obtained on Tioga silt loam.

Barbour gravelly loam.—Barbour gravelly loam is the red soil equivalent of the corresponding Tioga gravelly loam. The areas of Barbour soil are small, in places somewhat stony, and slightly droughty. Nearly all of the land is regularly used for the production of corn, potatoes, and forage crops.

ALKALINE SOILS OF THE WELL-DRAINED BOTTOM LANDS

Genesee silt loam.—Genesee silt loam is the only soil in the subgroup of alkaline well-drained alluvial soils. It occurs in Unadilla Valley from New Berlin northward, and small areas are along the upper course of Cherry Valley Creek and other streams in the northern part of the county.

The surface soil, to a depth of about 10 inches, consists of dark granular silt loam, the darkness of the color being due to the moderately high content of organic matter and the slightly alkaline character of the soil material. It is freely penetrated by grass roots which extend well into the subsoil. The subsoil is somewhat lighter colored friable silt loam to a depth of about 30 inches. Below this depth, the material generally is silty clay loam, in which the body color is gray, or suggestive of olive gray, with faint-yellow iron stains. This material is not so friable or so well aerated as the surface soil and subsoil, but it favorably influences the moisture supply and may be an available source of lime for deep-rooted crops.

Some areas of this soil are subject to overflow, but floods are of short duration, and damage to crops is limited to the lowest parts of fields. Bluegrass and white clover thrive and form much of the cover in meadows and pastures. The common yields of timothy and clover are about 2 tons an acre. Although not safe for fall-sown crops, oats and corn are profitable crops, yields of which generally are higher than those obtained on the Tioga soils.

In a few places the texture of the surface soil is loam, but crop adaptations are practically the same as on the silt loam areas. Some bodies along the creek banks consist of well-drained fine sandy loam, as a result of the deposition of sand during overflows. Owing to the small extent of such areas, they are included with Genesee silt loam on the map.

ACID SOILS OF THE IMPERFECTLY DRAINED UPLANDS

An important group of upland soils includes soils that are characterized by slow or imperfect drainage. This is due in some measure to the gentle slopes, but the chief cause is a compact subsoil which farmers term a "hardpan." Although this subsoil cementation, in its most complete development, interferes seriously with underdrainage, it is, in most places, a rather feeble cementation of somewhat porous materials and, consequently, is not impervious to water. As a rule this zone is not present within a depth of 20 inches, and in most places it is below a depth of 30 inches. Therefore, there is considerable thickness of friable soil overlying it. After the early spring saturation is relieved by evaporation and drainage, these soils generally remain in good condition for field operations and give little trouble, unless exceptionally wet weather prevails. All, except a few along the southern border of the limestone soil belt, are acid. This subgroup includes Otsego gravelly silt loam, Mardin gravelly silt loam, Wellsboro gravelly silt loam, Culvers gravelly silt loam, and Volusia silt loam.

Otsego gravelly silt loam.—Otsego gravelly silt loam is the most important and best drained member of the subgroup of imperfectly drained acid soils. It is associated with the Lordstown soils and has an equally wide distribution throughout the county. Typically it occupies broad evenly rounded ridge tops and gentle slopes (pl. 2, *C*), although in places it extends well down hillsides having 15-percent slope. The larger areas are on the broad undulating ridge tops that slope gently to the south. As a rule, the surface soil is less stony than that of the Lordstown or Lackawanna soils, and outcrops of the underlying rock are comparatively few.

Nearly all of this soil was cleared many years ago, and most of it is now either included in farms or is used as semipermanent pastures. Some of it has reverted to forest, but by far the greater part remains open land with a grass cover. The grasses, in places where the effects of tillage and fertilization have disappeared, consist largely of redtop, sweet vernalgrass, and poverty grass, with more or less goldenrod, dewberry, cinquefoil, yarrow, and other weeds. In situations favorable for some accumulation of organic matter, the land supports a cover of bluegrass, timothy, and white clover.

The surface soil in old meadows and pastures is moderately dark gray or brownish-gray friable silt loam, with a soft granular structure in those places where some organic residues have accumulated. The surface soil in cultivated ground is lighter in color, generally a pronounced gray when dry. Below plow depth, the material has a crumbly or fine-granular structure to a depth ranging from 15 to 20 inches, and the color ranges from yellowish brown in the upper part to yellowish gray in the lower. Little gray or yellow mottling has developed, except in spots of heavier soil where obstruction to internal drainage is most pronounced. This subsurface layer has good moisture-holding capacity and is well aerated. The hardpan, which lies at a depth ranging from 20 to 30 inches, consists of light-colored loam or silty loam, containing much gravel and many stones of various sizes and kinds, but most of them are flaggy sandstone. When dry the material is cemented into a firm mass that is not easily penetrated with a pick or a spade. A moist sample crushes easily in the hand,

and the proportion of sand and coarse grit indicates a marked degree of permeability to water. The material seldom becomes so dry that no moisture is noticeable. With increase in depth the material is less firmly cemented, and, at the point of contact with the basal rock, it is gray gritty material forming a friable matrix for a large proportion of sandstone and shale fragments in the earlier stages of disintegration.

All this soil is strongly acid, with the possible exception of those areas adjoining the Langford and Honeoye soils. Here the parent materials have some inclusion of lime-bearing rocks, and the lower part of the subsoil, between depths of 20 and 40 inches, in some places, is alkaline. In the section immediately south of the Langford soils many areas of Canfield gravelly silt loam are included with Otsego gravelly silt loam. These areas are developed on mixed materials and have a well-developed mottled horizon above the hardpan.

Otsego gravelly silt loam is better adapted to oats, rye, buckwheat, potatoes, and grasses than to corn or clovers. In all areas the acre yields are so largely determined by cultural treatment and application of fertilizer that these factors must be considered, and crops are more likely to be injured in wet seasons than those on most of the well-drained soils.

Potatoes, under the usual tillage methods and an acre application of about 200 pounds of a complete fertilizer, yield about 200 bushels an acre and under favorable conditions may exceed 300 bushels. Dry fall weather is especially desirable for the harvesting of this crop. Acre yields of oats range from 20 to 60 bushels and of buckwheat from 20 to 25 bushels, under favorable seasonal conditions. Corn is seldom planted, except on well-manured ground. It yields from 10 to 12 tons of silage. In the harvesting of silage, the inconvenience caused by wet weather often is apparent. Timothy and redtop yield about 2 tons an acre for the first few years after the change from a well-tilled and well-fertilized crop, but yields diminish rather rapidly thereafter. Heavy fertilization and the liberal use of lime are necessary for good stands of red clover. On well-limed and heavily manured ground, alfalfa does well for one or two seasons, particularly if the rainfall is below normal.

Otsego gravelly silt loam is similar in crop adaptation to Canfield silt loam of Delaware County and other counties of the State. The Otsego soil differs from the Canfield soil in having a somewhat less compact subsoil with no well-defined mottled zone just above the hardpan.

Mardin gravelly silt loam.—In old meadows and pastures Mardin gravelly silt loam is a moderately dark colored soft crumbly silt loam. The dark color and crumbly structure are due in large measure to the organic matter that has accumulated under a grass cover for many years. The influence of this humus is apparent to a depth of 2 or 3 inches and is perceptible to a depth of 4 or 5 inches below the surface. Below the latter depth the material changes to yellowish-brown silt loam that is sufficiently friable to be easily penetrated with a spade. In many places the upper few inches of this subsurface material has a yellow-ocherous appearance suggestive of a rather high content of iron oxide, but with depth the yellow color becomes less pronounced and the material a little more compacted and mottled

with gray. At a depth ranging from 15 to 25 inches below the surface is the hardpan, consisting of rather hard gray silty loam containing much grit, gravel, and gray sandstone fragments of various sizes, in the earlier stages of disintegration and discoloration. This hardpan layer is not entirely impervious to water but does interfere with underdrainage. It has some porosity, other than that due to included coarse materials, but relief from excess water is slow, and the soil layers above remain wet for considerable time after heavy rains. The hardpan, when moist, is rather friable, but when dry, it is a hard firmly cemented mass extending well down to the underlying rock. Tree roots do not pentrate the more pronounced developments of this layer. In general the trees on this soil are shallow rooted. In all uncleared areas "cradle knolls" are numerous, and the surface is stony and uneven.

This soil is characteristically developed on the broad smooth ridge tops south of Schenevus Valley, but generally gives place to Otsego gravelly silt loam north and west of this section. The proportion of farm abandonment is greater on the Mardin soil than on the Otsego soil. The wide smooth areas south of Schenevus Valley were farmed 50 years ago, but now there are many unoccupied farms. Large tracts are used only for pasture or for the light cuttings of inferior hay they now afford. The difference in physical characteristics, compared with the Otsego soil, is not so marked, and the degree of acidity is practically the same, but the Mardin soil is not quite so desirable for general farming. A possible explanation is that the parent materials of the Mardin soil are almost exclusively of sandstone origin, whereas those of the Otsego soil may include materials from limestones and shales and possibly other sources.[6] The essential difference between these soils consists of a gray horizon in the Mardin soils which is absent in the Otsego soils where typically developed. Although not present in sufficient quantities to be evident in a chemical analysis, the influence of these lime-bearing rocks of varied composition still imparts somewhat better qualities to the Otsego soil.

The Mardin soil responds to applications of manure and fertilizer. Good crops formerly were obtained without much soil treatment, other than applications of manure or crop rotation. The influence of manure, however, rapidly declines, and fields thrown out of cultivation for 2 or 3 years have only a thin cover of redtop, poverty grass, and small weeds. The yields of hay from old meadows are light and of poor quality.

Wellsboro gravelly silt loam.—The areas of red upland soils include many small acreages in which drainage conditions range from imperfect to decidedly poor. Most of them are too small to indicate on the map, but the larger areas are shown as Wellsboro gravelly silt loam, regardless of some obvious differences other than those of drainage.

Most of the areas of Wellsboro soil associated with the Lackawanna soils occupy hillsides with numerous seepy spots which render much of

[6] The areas of Mardin soil are farther from the outcrops of limestone and shale than the areas of Otsego soil, but east of the areas of Mardin soil the high divides were scoured very severely by the ice, and the deposit of till thereon and on the divide between Schenevus and Charlotte Creeks is of sandstone origin.

the land between them more or less wet, unsuitable for bluegrass, and altogether unfit for tillage. In many places cultivation is impossible because of stones, some of which are large brown blocks from outcropping ledges higher on the hillsides. A few of these hillside areas are comparatively free from stones, and the deep friable dark reddish-brown soil is well adapted to grasses and affords some tillable ground. As a rule, this red soil affords better grazing than the imperfectly drained soils associated with the gray sandstones.

On the high divides are numerous flat or nearly level areas, in which the central, or lowest, parts are similar to Norwich silt loam, and the slightly higher margins consist of Culvers gravelly silt loam. The soil everywhere is more or less stony, and in most places the depth to bedrock is only a few feet. This slight depth to rock seems to be the chief cause of the poor drainage in most of these high mountain meadows. The vegetation in the wetter areas includes rushes, coarse grasses, ferns, mosses, and scattered alders; on the somewhat better drained areas, bentgrass and sweet vernalgrass form much of the cover, with some bluegrass and timothy, and an abundance of buttercups and Indian paintbrush. The pasture value of these flat areas depends largely on the proportion of better drained ground, and is also much affected by the seasonal rainfall. During the summer of 1934 a dry period of several weeks prevailed, and the coarser grasses on these flat lands contributed largely to the grazing on the upland pastures. Areas of this flat poorly drained red soil are on the high uplands in the vicinity of Gilbertsville, in the southwestern part of the county.

Culvers gravelly silt loam.—Culvers gravelly silt loam differs from Otsego gravelly silt loam in the color of the surface soil and character of the stony material, a large proportion of the stones being red sandstone, but gray fragments also are numerous. The lighter color of the soil material indicates a mixture of parent materials. The pinkish-red and grayish-yellow colors in the subsoil indicate an originally reddish-brown till modified by the imperfect underdrainage that generally prevails. In this respect the Culvers soil resembles Mardin gravelly silt loam.

In freshly plowed fields the soft crumbly friable silt loam has a light brownish-red color in many places, with a faint purple cast; but when the material dries, the color fades to brownish gray. In old meadows and pastures the topmost layer, a few inches thick, is dark colored, owing to accumulated organic matter, but normally the humus supply is low and the soil is strongly acid.

Between depths of 5 and 25 inches the crumbly structure prevails, and this rather loose permeable condition allows easy penetration with a spade. Less organic matter is present in this layer than in the surface layer, although some infiltration of humus-stained silt darkens the fissures and worm holes through the upper part. Plant roots penetrate it freely and the yellowish-brown body color has a slight red tint when wet. The material in the lower 6 inches of this layer in many places is mottled with gray and grayish brown, owing to rather frequent saturation. Just below the mottled layer the subsoil is compact and offers some resistance to downward movement of excess soil water. Although called hardpan by the farmers, it is not entirely impervious. When dry it is a hard firm mass of silt, clay,

and embedded stones to a depth of several feet. Ordinarily tree roots do not penetrate this compact material, and its dingy-gray and dull-chocolate color is indicative of lack of oxidation. In this respect, it is in marked contrast with the pronounced red color of the Lackawanna subsoils.

Culvers gravelly silt loam is characteristically developed on the broad smooth crests and gentle slopes of the upland in the central part of Unadilla Town. Practically all of this land is tillable, and nearly all of it was cultivated at one time, but now much is used only for pasture and the production of hay, due in part to its susceptibility to wet weather. On the somewhat better drained areas, corn, potatoes, and oats do well. These crops require manure and are benefited by applications of acid phosphate. Lime is necessary for success with clover. In old meadows, all the clover has disappeared, and timothy does not form much of the stand for more than 3 or 4 years after seeding. Bentgrass, sweet vernalgrass, and poverty grass form much of the cover, and buttercups and Indian paintbrush are especially abundant in the low places.

Volusia silt loam.—Volusia silt loam occupies broad gentle slopes and shallow sags at the bends of drainage lines, many of which are local flats and sags on the tops of wide divides. The imperfect drainage is due primarily to topographic position of the soil, but the structure of the subsoil is not conducive to good underdrainage. Drainage conditions and the thickness and color of the surface soil vary considerably.

In cultivated fields and meadows, the surface soil is dark brownish-gray granular silt loam to a depth of about 5 or 6 inches. The organic matter is in an advanced stage of decomposition and intimately mixed with the mineral constituents. With increase in depth, the organic matter decreases rather rapidly, the material is less crumbly, and the color is some shade of gray with faint yellow iron stains. At a depth ranging from 15 to 20 inches, the gray gritty silt loam is more or less cemented, rather than compacted, and, under ordinary field conditions, it is difficult to loosen with a spade. This hardpan layer extends to the underlying sandstone in places where the sandstone is less than 6 feet below the surface, but in the areas of deeper soil, the transition to the heavy unweathered till is more gradual; in either condition, however, underdrainage is slow, and excess water escapes either by evaporation or by lateral seepage. Springs and seepy spots are rather common features of the larger areas.

A very large proportion of this soil is used only for pasture, and only a small acreage is under a crop rotation, in which fresh seeding of timothy and clover is made regularly. Formerly, much of the better areas of this soil was used for the production of corn and oats, and on some farms it was included in hopyards. Some ditching was necessary, and fertilizers and manure were used with all crops. Such improvements are yet possible but hardly profitable under present economic conditions.

Many of the smaller areas are subject to such frequent saturation that the land is hummocky, or may include spots of permanently wet ground grown up to rushes, cattails, and other aquatic vegetation. These small areas are more numerous near the heads of drain-

age lines, in somewhat higher situations than the adjoining Chippewa silt loam. The individual areas range from seepy spots of less than an acre on the hillsides to areas including several acres of uneven poorly drained land with a general slope of 1° or 2° toward the nearby stream channel. Surface drainage may be sufficient to prevent accumulation of water, but internal movement of water is decidedly poor.

Practically all of the areas of Volusia silt loam include some areas of Chippewa silt loam, or soil very similar to the Chippewa soil.

ALKALINE SOILS OF THE IMPERFECTLY DRAINED UPLANDS

Langford gravelly silt loam.—Langford gravelly silt loam is the only soil type in this subgroup. It includes the imperfectly drained upland soil in which the lower part of the subsoil is alkaline at a depth of less than 40 inches, in most places. The imperfect drainage is due to the heavy subsoil and the character of the deeper substratum which, in most places, is heavy gray or drabbish-gray till containing more or less limestone, chert, and various other kinds of rock. In some places, dark-colored shales are exposed in ravines and evidently have contributed much fine silt to the materials from which the Langford soil is derived. Although limestone fragments generally are present in the basal materials, there are very few large limestone rocks and outcropping ledges associated with areas of this soil.

Under a grass cover, where the land has not suffered much erosion during previous periods of tillage, the surface layer consists of crumbly and friable dark-colored silt loam under ordinary field conditions. The subsurface material is heavier silt loam or silty clay loam, which has a rather coarse crumbly structure that improves the moisture relations. The color is rather dark or dingy gray, with faint yellow stains. Between depths of 15 and 35 inches, the gritty silt loam or silty clay loam, when wet, has a heavy dense appearance suggestive of impermeability to water; but when dry, the coarse granular structure becomes more apparent and, with included gravel and some stones, imparts a considerable degree of friability. Underdrainage is slow, but only in spots is drainage so poor as to render the soil unsuitable for the production of tame grasses and clovers. In most places surface drainage is good, as most of the land is rolling or hilly. Some areas in Susquehanna and Cherry Valleys form the lower gentle slopes at the bases of steep areas of the Lordstown soils.

The areas along the southern border of the limestone belt necessarily include spots of Honeoye and Ontario soils as well as areas of the Lordstown and Otsego soils, but it is impractical to indicate all the gradations among these various soils.

Langford gravelly silt loam is better adapted to grasses and legumes than to cereal crops and vegetables, although some areas of light-textured soil at the bases of gentle slopes afford some patches suitable for potatoes and vegetables. Corn is grown successfully on all areas of this soil, but it requires the rather liberal use of manure or other means of increasing the organic matter. The average yields of both grain and silage are below those obtained on the better areas of the Honeoye and Ontario soils.

This soil in old pastures has a rather large content of humus, and the soil may be very dark and granular to a depth of several inches. Bluegrass and white clover form a larger proportion of the grass cover than is common to the acid soils under comparable conditions. This was observable during 1933 and 1934, and the more vigorous growth of goldenrod, wild carrot, oxeye daisies, and other weeds, in many places, distinguishes the Langford soil from the adjoining Lordstown, Wooster, and Otsego soils. The yields of hay are more dependent on seasonal conditions than on well-drained soil, but this is not so noticeable in pastures which seems to be the most profitable use, under present economic conditions, to which this soil can be devoted.

ALKALINE SOILS OF THE IMPERFECTLY DRAINED TERRACES

The large valleys include considerable areas of imperfectly drained terraces or benchland. In all places, the imperfect drainage is due in part to the textural character of the parent soil material which includes a surface stratum of fine silt or silty clay. Wherever the thickness of this silty deposit exceeds 20 inches, it offers much resistance to the downward movement of soil water. This unfavorable condition has not been modified by oxidation, leaching, and other changes to the same extent as in the coarser textured materials in similar positions. As a rule, the lower part of this silty material still retains enough lime to be highly calcareous, whereas the surface soil, less than 30 inches above it, is distinctly acid. This subgroup includes only one soil—Caneadea silt loam—which is of rather small extent and not so important agriculturally as it is in other counties of the State.

Caneadea silt loam.—Caneadea silt loam occupies the low benches along the larger streams. It differs from the Chenango soils in the absence of coarse grit and gravel and may be identified in cultivated fields by the ash-gray color the surface soil assumes on drying. As the surface soil consists so largely of silt and extremely fine sand it is very friable when moist, and, when dry, it may have a soft feel and floury appearance not common to any other soil in this county.

From a depth of about 6 inches to a depth of 20 inches, the subsoil is stiff silt or silty clay loam, not easily penetrated with a spade. It is resistant to water and not well aerated, as is indicated by the pale yellowish-gray color and occurrence of yellow stains. Below a depth ranging from 25 to 30 inches, the proportion of sand perceptibly increases, and the material is more friable when moist and, when saturated, may be very soft and yielding at a depth ranging from 40 to 50 inches. Slightly deeper borings reveal strata of water-bearing sand and fine gravel but in very few places show coarse dry material.

Typical areas of Caneadea silt loam, as developed in this county, are between Milford and Portlandville. Both the surface soil and the subsoil, to a depth of about 20 inches, are strongly acid, and in most places alkaline material occurs at a depth of less than 40 inches below the surface. The somewhat deeper sandy or gravelly material is highly calcareous. The lime does not benefit crops in any marked degree because of the heavy upper layer of the subsoil.

Those areas adjoining the Chenango soils may have a coarser textured surface soil and subsoil, as indicated by the occurrence of gravel on the surface. These areas have somewhat better drainage and are more easily kept in good tilth than the areas of lighter colored soil, which require rather careful management, particularly in wet seasons.

Under clean tillage, the soil dries slowly and tends to form a firm but somewhat porous crust which, if allowed to become dry, breaks into hard clods under subsequent tillage. The tilth of the areas of heavier soil is greatly benefited by fall plowing. With care in cultivation and liberal use of manure, good yields of corn, oats, and timothy are obtainable. Clover does well if the soil is limed, and a stand of alfalfa may be established by the liberal use of lime and manure and will thrive throughout a number of seasons.

The area of Caneadea silt loam above Hyde Bay is a moderately dark colored soil inclined to be rather crumbly to a depth of several inches. Although sensitive to wet weather, this soil produces excellent crops of timothy and other grasses, and the better drained spots are suitable for tilled crops.

The areas at the head of Otsego Lake occur on undulating benchland lying from 10 to 40 feet above the lake. Here, the surface soil is grayish-brown or, in some places, yellowish-brown friable silt loam to a depth ranging from 10 to 20 inches, and the subsoil is rather heavy silt or silty clay loam. Drainage is somewhat slow, but the soil formerly was used for hops, and now such fields as are in cultivation give good returns of corn, oats, and tame grasses. Considerable parts of these areas are included in estates used chiefly for recreational purposes.

The small areas in the Wharton and Butternut Valleys are more variable with respect to elevation, surface configuration, and drainage than are the larger areas elsewhere. They generally are kept in grass but are used to some extent for the production of corn, oats, and forage crops.

ACID SOILS OF THE IMPERFECTLY DRAINED BOTTOM LANDS

The imperfectly drained bottom-land soils have sufficient local elevation to insure a firm dry surface soil the greater part of the time, but the prevailing level of the ground water causes frequent saturation of the subsoil, as indicated by the gray or mixed gray and yellowish-gray colors. These soils are tillable, in part at least, and practically all of them are well adapted to grasses. Differences in drainage conditions occur in all the valleys, and there is considerable variation in other respects, but all the soils of this subgroup are included in areas mapped as Middlebury silt loam and alluvial soils, undifferentiated.

Middlebury silt loam.—Middlebury silt loam includes the imperfectly drained acid soils occupying the first bottoms in the valleys. The larger areas are broad flat tracts, and the smaller bodies are irregularly shaped spots and strips within areas of Tioga soils. The difference in elevation in few places exceeds 4 feet, and in many places there is an almost imperceptible slope between adjoining areas of these Middlebury and Tioga soils.

Middlebury silt loam consists of grayish-brown or dark yellowish-brown silt loam containing enough fine sand to impart a gritty feel and to increase the friability of what otherwise would be somewhat heavy and cohesive material. Indications of good internal drainage and effective aeration are apparent to a depth ranging from 10 to 20 inches, but below this depth the gray, drab, or mottled gray and yellow color indicates the frequency with which the subsoil is saturated. Saturation of the subsoil prevails during early spring when the streams are at high stage and often occurs during rainy periods in the summer and autumn. The texture of the subsoil is variable, ranging from heavy silt loam to very friable fine sandy loam. The gravel substratum nowhere lies at a depth of less than 40 inches, and in most places it is several feet below the surface. All the soil materials above the substratum are, in most places, of such texture and structure as to allow comparatively free movement of soil water. The frequent saturation of the subsoil is owing chiefly to the low position of this soil with respect to the adjoining areas of Tioga, Chenango, or other higher lying soils. All the land is subject to rather frequent flooding. In many places backwaters cover the land, and considerable silt and clay are deposited on it at each overflow. Frequently grass suffers some injury, but the soil is benefited.

Nearly all areas of Middlebury silt loam were cleared many years ago and are now clean meadows or pastures. Yields of hay frequently exceed 2 tons an acre. Timothy and redtop form most of the growth in old meadows, and clovers persist for several years after seeding. In pastures a mixed stand of redtop, timothy, bluegrass, white clover, and many different small weeds form the cover. The value of this soil for grazing is somewhat higher than that of the Tioga soils.

A few small areas of imperfectly drained red land occur near the village of Otego and in a few other places in the valleys in the southwestern part of the county. All these areas are used as pasture, and the adaptation to grasses is similar to that of the Middlebury soil. Therefore they are included with this soil in mapping.

Alluvial soils, undifferentiated.—Those areas of bottom land in which the soil material is so variable that separation into types is impractical are indicated on the map as alluvial soils, undifferentiated. Throughout the greater part of the county the better drained parts of these small areas consist of Tioga silt loam. Although frequently overflowed and subject to injury by rapidly flowing water, most of these areas are well sodded with grasses and afford as much pasturage as do the best uplands. They are not safe for tilled crops or for fall-sown grain.

Much of the less well drained land is Middlebury silt loam, and in many places spots of Holly silt loam and small areas of muck and peat are included. On the muck and peat areas, the vegetation consists in part of coarse grasses, rushes, and trees. Some of the narrow strips forming the heads of drainageways are in part Chippewa silt loam, with Tioga and Middlebury soils developed in the section where a channel has formed and the ground water level is generally a foot or more below the surface.

Along the upper courses of Unadilla River and Cherry Valley Creek, alluvial soils, undifferentiated, consist of alkaline materials.

Where these soils approach such a well-drained soil as Genesee silt loam, the land is excellent for bluegrass, clovers, timothy, redtop, and other grasses.

Much of the bottom land along the small streams within the red lands is gravelly, and the stony stream channels are wide compared with their depth. Grasses do well on the better drained areas.

ALKALINE SOILS OF THE IMPERFECTLY DRAINED BOTTOM LANDS

Eel silt loam.—The surface soil of Eel silt loam, the only soil in this subgroup, is dark soft crumbly silt loam. The upper part of the subsoil is lighter colored heavier silt loam which, at a depth ranging from 10 to 20 inches, in most places is mottled with yellow and rust-brown stains. The lower part of the subsoil is still lighter colored, and in most places it consists of silty clay loam below a depth ranging from 30 to 40 inches. The gravel substrata lie at considerably greater depth. The entire soil mass consists of rather fine textured materials with no compaction or occurrence of an impervious clay. The imperfect drainage is due to the low position of the land with respect to the stream channel.

In most places the surface soil is neutral or only slightly acid, and an alkaline reaction can be obtained below a depth ranging from 20 to 30 inches.

This soil is associated with the Genesee and Palmyra soils in the upper part of Unadilla Valley and in a few other locations. Timothy, bluegrass, and white clover thrive and form much of the excellent pasturage this soil affords. Although very little of the land is safe for cultivated crops, on account of overflows, a few of the higher spots are used for the production of cabbage, sweet corn, beans, and other garden crops.

ACID SOILS OF THE POORLY DRAINED UPLANDS

A common feature of the smoother areas of the uplands are the small patches and narrow strips of low ground supporting a dense growth of alder bushes or covered with such other vegetation as indicates very poor drainage. The drainage is much poorer than that of the imperfectly drained soils and somewhat better than in the areas of muck and peat. In these poorly drained areas, the ground-water level fluctuates considerably and surface conditions change frequently—from saturation to comparative dryness. The soils in these situations are of the same origin as are the surrounding soils, but they are greatly modified by the drainage conditions. The surface layers are dark colored, owing to a large accumulation of organic matter, but the subsurface layers are light colored and otherwise indicate lack of oxidation. Within the sandstone sections, these soils are acid, whereas those in the limestone sections retain some degree of alkalinity. The soils included in this subgroup are Chippewa silt loam and Norwich silt loam.

Chippewa silt loam.—Chippewa silt loam is associated with the Lordstown and Otsego soils. Most of the areas are at the heads of local drainageways, where no well-defined channel has developed.

The surface soil is very dark colored silt loam or silty clay loam with a very high content of organic matter, which is well decomposed and so intimately mixed with the mineral constituents that

when dry, it is a friable or loose soil—not a muck or peat—and its adaptability, under suitable drainage, to dry-land vegetation, is much better than that of peat. The depth to which this black soil extends differs considerably, even within small areas, but in most places does not exceed 15 inches. Below this depth, the light-colored material may be silty clay but more commonly is a mixture of silt, grit, and stones, which, with depth, passes into unmodified till much like that at a somewhat less depth on the adjacent higher ground.

On many areas the present cover consists of coarse grasses and rushes, with bentgrass, buttercups, and other wet-ground weeds along the margins. Many areas support a cover of alders, with a consequent exclusion of grasses that might be of some value as pasture. As mapped, the larger bodies include some exceptionally wet areas of Volusia silt loam and open spots of peat, on which much sphagnum moss and other bog vegetation grow. As a rule, the tree growth is of little or no value.

In some places, partial reclamation is practicable through the use of shallow ditches which would lower the ground-water level sufficiently to allow desirable pasture grasses to supplant the worthless vegetation that so generally occupies this potentially productive soil.

Norwich silt loam.—Norwich silt loam is the red soil equivalent of Chippewa silt loam. It is associated with the red soils in the southwestern part of the county. The surface soil, under comparable conditions of drainage, is similar to that of Chippewa silt loam, but the subsoil retains some of the original red color, and the included rock consists of red sandstone fragments.

The present vegetation is similar to that on the Chippewa soil, but the better-drained parts of the land are slightly superior for desirable pasture grasses.

ALKALINE SOILS OF THE POORLY DRAINED UPLANDS

Lyons silt loam.—Lyons silt loam, the only soil in this subgroup, is a poorly drained soil associated with the Honeoye and Ontario soils. It occurs at the bases of slopes, on the narrow strips of flat wet land that in many places form part of a local drainage system. The surface soil, to a depth ranging from 10 to 20 inches, is very dark colored granular silt loam or, in places, heavy silty clay loam. The subsoil, in most places, is gray or brownish-gray silty clay to a depth ranging from 30 to 40 inches, which may be very heavy but in few places is impervious. This material cracks on drying, and its permeability is increased by the stony material it generally contains. Below a depth ranging from 40 to 50 inches, comparatively unmodified highly calcareous glacial material is present.

The surface soil is neutral, or may be slightly acid, but available lime seems to be within reach of the roots of grasses and weeds, that flourish on this low land. In pastures, bentgrass, bluegrass, and timothy form much of the cover, and the somewhat better drained areas support some white, red, and alsike clovers. Only a small proportion of the land is so wet as to be occupied by rushes, cattails, or other aquatic vegetation.

The areas southeast of Salt Springville are more or less mixed soils derived from limestone and shales. In this locality the soil generally is alkaline, and grasses and clovers do well. Some of the

springs in this section are so charged with lime that a soft porous calcareous rock resembling tufa is abundant around them.

ALKALINE SOILS OF THE POORLY DRAINED TERRACES

The soils included in this subgroup are Lorain silty clay loam and Lorain silt loam.

Lorain silty clay loam.—To a depth ranging from 10 to 15 inches, Lorain silty clay loam is dark grayish-brown or black crumbly silty clay loam. The subsoil is bluish gray or drab, and the grainy structure is less pronounced than in the surface soil. In most places, it consists of stiff tenacious silty clay not easily permeable to water and air. At a depth ranging from 20 to 30 inches, the material grades into silty or very fine sandy material, and, at a slightly greater depth, water-bearing sands or fine gravel form the substratum. The material in the lower layers is alkaline, but the surface soil is neutral or slightly acid.

In many places the soil material is gradational between this soil and Lorain silt loam and the Caneadea soils, but everywhere Lorain silty clay loam is darker, more granular, and free from all gravel and stones. The poor drainage is due chiefly to topographic position, but the stiff fine-textured subsoil also contributes to this condition. Although not impervious, it allows very slow movement of water, both laterally and vertically. The granular surface soil dries rather rapidly and assumes a coarse-granular structure which is conducive to good tilth, provided the ground has not been trampled previously or plowed when wet.

The largest areas are near the village of Schuyler Lake in the flat land along Oaks Creek. The higher lying areas are used for the production of corn and to some extent for gardens, but the greater part of the land is used as semipermanent pasture. Redtop and timothy form most of the grass cover, but some bluegrass, alsike clover, and red clover grow. The soil is fairly well adapted to these legumes, and alfalfa persists as scattered plants in the better drained situations in old pastures. In low spots, coarse grasses, rushes, and weeds thrive.

The areas in Cherry Valley are small, and many of them are associated with Caneadea silt loam. They have poor natural drainage and are generally used as pasture.

In many places this rich soil can be improved by means of open ditches which would provide run-off for surface water and lower the ground-water level to sufficient depth to allow deeper rooting by tame grasses and clovers, thereby providing better grazing and increased yields of hay.

Lorain silt loam.—Lorain silt loam is similar in color to and occupies similar topographic situations as Lorain silty clay loam. The silt loam is not so sticky when wet, and, as a rule, the dark-colored surface layer is only a few inches thick. In most places the subsurface layer is light-gray or yellowish-gray friable silt loam with a soft fine crumbly structure when dry or slightly moist. The subsoil is very light colored tight silt loam or silty clay loam which may contain some faint yellow stains indicative of the slow movement of water and lack of efficient aeration. At a depth ranging from 40 to 60

inches is the sandy or gravelly material which so generally underlies all the Caneadea and Lorain soils.

The small spots and strips of this dark-colored soil that occupy slight depressions within areas of Caneadea silt loam are about the only parts in tillage. Silage corn does well, if the rainfall is rather light and well distributed during the growing season. The same conditions are essential for oats and for other crops requiring tillage, as wet seasons are detrimental to tilled crops.

The larger areas in Cherry Valley have somewhat uneven relief In the slight sags, the dark-colored surface soil grades into spots of shallow peat over light-colored tight silty clay. On the slight elevations the humus-filled surface soil is only a few inches thick, and on the "cradle knolls" may be so thin that the light-gray silty subsoil is much in evidence.

The large areas have not been cleared. Large hemlock, white pine, and tamarack formed much of the original forest, but now poplar, maple, ash, and birch are the predominant species, with much alder and swamp vegetation in the lowest places. The areas south of Canadarago Lake support more tamarack and less hardwoods than the adjoining forested areas of Lorain silty clay loam.

Profitable reclamation seems impractical. The elevation in most places is sufficient to afford outlets for ditches, but many laterals would be necessary. Under tillage, the surface soil would assume a light color within a few years and become a cold slow-draining soil requiring lime and fertilizers for tilled crops. Redtop and timothy would do well, but clovers would require lime. The most profitable use of this land is for forestry.

ACID SOILS OF THE POORLY DRAINED BOTTOM LANDS

The areas of low and almost constantly wet land, exclusive of peat and muck, are similar to the Holly soils which occur extensively in other parts of the State. Owing to its small extent in this county and to its comparatively low agricultural value, all the acid soil of this character is mapped as Holly silt loam, heavy phase.

Holly silt loam, heavy phase.—The bottom lands include rather numerous small spots and narrow strips of low ground which frequently are flooded, and at all times are too wet to allow satisfactory tillage or even the growth of tame grasses. The surface soil in most of these small areas is dark-colored silt loam or silty clay, and the subsoil is much lighter colored. The difference in color of the surface soil and subsoil is due to the high content of organic matter that extends to a depth ranging from 6 to 10 inches. Regardless of origin or texture, the subsoil is bluish gray or light drab—colors common to soil materials in which saturation prevents oxidation of the iron that may be present.

The areas in the lower part of Susquehanna Valley are abandoned river bends. They range from 100 to 200 yards in width, and few of them are more than one-half mile long. The surface is several feet below that of the adjoining bottom land, and at the foot of a terrace the gravelly slope may rise from 10 to 20 feet above the Holly soil.

The surface soil of Holly silt loam, heavy phase, in general is dark-colored coarse-granular silty clay which is very hard when dry, with

deep cracks extending well down into the subsoil. The subsoil, below a depth ranging from 10 to 15 inches, is drab silty clay of variable depth. In most places the underlying sand or gravel is not less than 5 feet below the surface.

The bodies of this soil fill with water when the river is high but are dry at other times. The vegetation consists of coarse tall grasses in those sections of the old bends that are flooded most frequently, and in the areas less frequently flooded, tall varieties of redtop flourish. On included slopes and slight elevations, which resemble Tioga silt loam, bluegrass, timothy, white clover, and weeds are well established and afford good pasture.

Most of the areas along the smaller streams are wooded. The forest cover ranges from a dense growth of alders to virgin forests, in which large hemlock, pine, and numerous kinds of hardwood trees find a congenial soil. The surface soil in these small areas is, for the most part, dark-colored silty loam, but spots of shallow peat are numerous. The moisture conditions range from constant saturation to comparative dryness, but all the land is subject to overflow. The best use for such areas is forestry, together with such pasture as the open parts afford

ALKALINE SOILS OF THE POORLY DRAINED BOTTOM LANDS

Wayland silt loam.—Wayland silt loam, the only soil in this subgroup, is a dark-colored alluvial soil subject to frequent saturation, owing to its slight elevation above the stream channel.

The surface soil is dark-colored silt loam containing much organic matter. Below a depth of 4 or 6 inches the material contains numerous rust-brown stains and partly decayed plant remains, indicative of its wet condition. The fibrous parts of the plant remains resemble peat, and decayed rootlets have been replaced by bog iron. The lower part of the subsoil is more or less variable in texture and consistence, but in most places it is dark bluish-gray soft sticky sandy loam. The depth to ground water depends on the stage of the nearby stream. Saturation may be caused by seepage from adjoining higher ground, as this soil occurs at the bases of terraces and upland slopes.

Both the surface soil and subsoil are alkaline, a condition which favors the growth of bluegrass and white clover on the slightly better drained spots. Practically all of the areas near streams are suitable only for pasture.

Small areas of Wayland sandy loam, included with the silt loam in mapping, occur on the east side of Unadilla Valley above the village of Unadilla Forks. These areas are flat imperfectly drained parts of the first bottoms and lie a little lower than the adjoining Palmyra sandy loam. The surface soil ranges in texture from silty loam to loamy sand. The subsoil, to a depth ranging from 20 to 30 inches, is rather coarse loamy sand which is sticky when wet but barely coherent when dry. The lower part of the subsoil includes a layer of stiff tenacious clay that is nearly impervious to water. This may be only a few inches thick, but it seems to be the chief cause of poor drainage. These sandy areas include some patches of tillable ground which seem well adapted to the production of cabbage, onions, celery, and other leafy vegetables requiring a moist soil.

PASTURE LAND

The soil types and phases classified as pasture land have such surface configuration or are so encumbered with stones as to be difficultly tillable. The use of simple farm implements is not impossible, but the employment of modern labor-saving machinery is decidedly unsatisfactory on such land, and most of the cleared parts are now used as permanent pasture. The soils are not so well adapted to grasses as are the smoother upland soils and are much inferior to most of the alluvial soils.

ACID PASTURE SOILS

The soils included in the subgroup of acid pasture soils are Lordstown stony silt loam, steep phase; Manlius shale loam, steep phase; Wooster gravelly silt loam, steep phase; Lackawanna stony loam, steep phase; and Culvers gravelly silt loam, steep phase.

Lordstown stony silt loam, steep phase.—The steep phase of Lordstown stony silt loam is the prevailing soil on the high narrow ridges and steeper slopes of the main divides. It embraces much of the present forest land and those comparatively smooth but steep hillsides on which, in many places, neglected pastures are reverting to brushy woods. Characteristic features are the abundance of hard flaggy gray sandstone fragments on the surface, and the shallow surface soil and subsoil. Exposures of the underlying rock are numerous along all roads, even on the smoother benches, and outcropping ledges and great detached masses of rock are conspicuous features on hillsides, where the thickness of the soil material ranges from a few inches to several feet. There is considerable local variation in the depth of soil material, also in the content of stone. In many places the variation is due to the fragmental condition of the upper layers of sandstone, and in many places interbedded layers of thin brittle sandy shale are more or less disintegrated to a depth of several feet.

The steepness of the slope varies greatly but in only a few places equals 45°. Most of the longer slopes range from 15° to 30°. The soil on these steep slopes, that still retain a forest cover, is similar to that under a corresponding cover on smooth land. Under the forest litter is a very dark colored mat, 1 or 2 inches thick, of black soft organic residue so filled with fine rootlets of the living vegetation that it is separable from the lighter colored mineral soil just below it. In a few places a trace of gray silty material is between the mat and the rather loose yellowish-brown silty loam that extends well down to broken and disintegrating sandstone. A thin layer of gray gritty soil, evidently the residue of the decaying rock, is present at the point of contact with the underlying rock. In most places, the total thickness of the soil mass does not exceed 30 inches. It is less on steep slopes and near outcrops of the heavy ledges. Trees root rather deeply, but most of the feeding rootlets are in the immediate surface layer. This is a forest soil preeminently and is not inherently suitable for grasses.

The contrast between the soil in virgin forest and that in old pastures is marked. Under a grass cover, the dark-colored surface layer is only 2 or 3 inches thick and consists chiefly of mineral matter.

The organic accumulation has been slow. In grassland unplowed for 25 years the humus affects the color and structure to a depth of only a few inches. The soil under forest cover is invariably moist, but in old pasture lots on steep hillsides it is comparatively dry during the summer. The tame grasses and clovers do not thrive very long after cultivation is discontinued, and the grass cover over most areas consists of poverty grass, with some bentgrass and small weeds.

All the Lordstown soil on hillsides includes numerous springs, many spots of seepy ground, and even patches of imperfectly drained soil similar to the Otsego and Mardin soils. Where these areas are cleared, the vegetation includes more coarse grasses, sweetfern, rushes, and weeds partial to wet ground. The marginal part of these wet spots may support more sweet vernalgrass, bluegrass, timothy, and white clover than grow elsewhere, but the difference in grazing value is not marked. The forested land affords some browse but no grass grows.

The forest cover includes much hard maple, beech, and hemlock, but ash, birch, oak, wild cherry, and nearly all deciduous trees common to this section grow. White pine is not abundant, but in many places it forms part of the young tree growth in old pastures, where haw and wild apple are among the first invaders, followed by poplar (popple), birch, and hard maple. Close grazing retards the growth of brush, but tame grasses give way, especially on thin stony southern slopes and other droughty situations, to the forest vegetation.

Manlius shale loam, steep phase.—In old fields and pastures the characteristic color of the surface soil of the steep phase of Manlius shale loam is rather light gray, becoming pronounced ash gray when dry. It presents a hard firm surface in pastures and is very cloddy in cultivated fields. The susceptibility to erosion is evident in the numerous small gullies and patches of shallow soil, in which the underlying shale is more or less exposed. In such places the cover of grasses and weeds is thin or entirely lacking. On hillsides, where the forest remains in about its original condition, the surface soil is dark grayish-brown friable silt loam. Although not so crumbly as a limestone soil, the desirable crumb structure is not entirely lacking, and the material has the appearance of a fertile easily tilled soil. Between depths of 4 and 15 inches the soft friable silt loam is yellowish brown, indicative of good drainage and aeration. At a depth ranging from 15 to 20 inches the material changes sharply to heavier and more compact silty clay loam resembling a claypan. The included fragments of undecomposed shale and harder gravel and a few small stones are rather firmly held in this gray matrix, and the mass offers much resistance to downward movement of water. At a depth of about 30 inches, loosened and slightly disintegrated shale is reached, and at a slightly greater depth the material is impervious to water. The entire soil mass is strongly acid.

This description of the soil on a slope that has never been cleared indicates the original condition of the soil on areas of smooth land which includes a few wood lots. Practically all of this soil has suffered more or less injury from erosion during the period it has been in cultivation. This change is most apparent on hillsides and accounts for the poor adaptation of the land to tilled crops and its low value for pasture. The removal of the trees and brush without subse-

quent tillage would have left the soil in much better condition for grasses. The usefulness of this steep land, as well as much of the smoother areas, depends on its value for grazing. Prevention of erosion by abandoning all tillage and maintaining a cover of grasses is recommended. The application of lime at prevailing prices is impractical. Timothy, redtop, and most of the wild grasses and small weeds that grow on such acid soils as the Lordstown and Otsego, will do well on this soil in places where it is 18 or more inches thick over the loose shale.

Wooster gravelly silt loam, steep phase.—Numerous small areas of Wooster gravelly silt loam occupy short steep slopes at the base of the uplands, and somewhat larger areas form uneven mounds and ridges considerably above the neighboring terraces but below the middle slopes of the adjoining uplands. In such places the soil generally is more stony than that of the smoother areas, but it consists essentially of the same kind of materials. The surface soil on these slopes is low in organic matter and strongly acid. As a rule, the subsoil is sufficiently heavy to retain moisture well, except on the gravelly knolls, which are, for the most part, droughty.

These steep areas are not readily tillable but are used to some extent for the production of oats, buckwheat, and millet. More favorable patches for corn, pumpkins, potatoes, and garden crops are on the less stony slopes and in the intervening depressions. Most of the land is used for pasture. As it seldom receives much manure and is rarely treated with lime or commercial fertilizers, the stand of grasses is thin and does not include much timothy or clover. The response to fertilizers and crop rotations is good, as is apparent in the fine stands of grass and clover that follow truck crops.

Lackawanna stony loam, steep phase.—The steep phase of Lackawanna stony loam occurs only on the steeper slopes of the high ridges in the extreme southwestern part of the county. The soil is essentially the same as that of typical Lackawanna stony loam, with such variations in thickness, content of stone, and degree of slope as the steep phase of the Lordstown soil presents in areas of similar relief.

Much of this steep land is still forested, but the less stony slopes are more or less open pastures. The agricultural value is similar to that of Lordstown stony silt loam, steep phase.

Culvers gravelly silt loam, steep phase.—Culvers gravelly silt loam, steep phase, is the reddish-brown soil on the hillsides and rolling areas associated with Culvers gravelly silt loam. The soil profile resembles that of typical Culvers gravelly silt loam, but there is greater variation in the depth at which the mottled gray layer occurs. Most of this soil is less steeply sloping than the steep phases of the Lackawanna, Lordstown, and Wooster soils. Much of the land, in spite of its position on steep slopes, could be tilled, but the high content of stone, numerous seepy spots, and the tendency of the soil to become waterlogged during periods of wet weather limit its use to grazing and forestry.

ALKALINE PASTURE SOILS

This subgroup includes Langford gravelly silt loam, steep phase; Honeoye silt loam, steep phase; Ontario silt loam, steep phase; and Farmington stony silt loam.

Langford gravelly silt loam, steep phase.—Langford gravelly silt loam, steep phase, occupies slopes too steep for convenient tillage, but it is sometimes used for the production of oats, buckwheat, and other forage crops. The soil is similar to that of the smoother areas of the typical soil, and alkaline material is present at a depth of less than 30 inches, although this condition varies considerably, as well as the degree of slope and the quantity of loose stones on the surface and in the soil mass. The ability of this soil to endure dry weather is less, perhaps, than that of the typical soil, as is apparent on southward-facing slopes where the heavy subsoil material now forms the surface layer, or only a thin layer of the original silty surface soil remains.

Those areas associated with Honeoye silt loam, heavy-subsoil phase, are more susceptible to drought than are those associated with the Lordstown and Otsego soils. All this steep Langford soil is fairly well suited to grasses. Bluegrass, timothy, white clover, and a number of different weeds form most of the cover in old pastures. In general, red clover does not survive for more than a year or two after being sown. This land is used almost exclusively for pasture.

Honeoye silt loam, steep phase.—Only a small proportion of Honeoye silt loam is so hilly or so rough as to be designated a steep phase. The areas form narrow strips of steep land below areas of Manlius shale loam and along the lower slope of hills on which typical Honeoye silt loam occurs.

In most places the surface is strewn with large pieces of limestone, and ledges of this rock are exposed in the channels of nearby streams. The surface soil is dark crumbly silt loam overlying a heavy yellowish-gray subsoil. Both surface soil and subsoil are alkaline. Clovers, bluegrass, and timothy thrive in old pastures, and, excepting on the spots of shallow soil, all this land affords good grazing throughout the summer and autumn.

Ontario silt loam, steep phase.—The steep phase of Ontario silt loam occupies hillsides that have a slope of 100 feet in one-eighth of a mile—in some places a steeper slope. The surface is rather smooth and not greatly encumbered with large stones. Practically all of this soil was cleared many years ago and has been used for tilled crops. The soil is almost identical with typical Ontario silt loam, except in those places where erosion has removed much of the surface soil. In such places the yellowish-brown silt loam surface layer may be rather susceptible to dry weather. The soil is neutral or slightly alkaline in reaction, and grasses and clovers do well. The pasturage is better than on most of the steep phases of acid soils. This soil occurs only in the northern and eastern parts of the county, where it is associated with the Honeoye and Manlius soils.

Farmington stony silt loam.—Farmington stony silt loam differs from Farmington silt loam in the uneven thickness of the soil mantle and the many exposures of the underlying rock. The soil material ranges from a few inches to several feet in thickness but averages less than 30 inches. In many places large blocks of stone are on the ground, many of them partly buried and tilted at various angles causing the rough uneven surface to be difficult to traverse. Deep fissures are numerous in some of the comparatively level areas, and not all of them are filled with soil. The tree growth consists chiefly

of hard maple, and there are many other kinds of deciduous trees and shrubs. The cleared land affords considerable grazing, as grasses and clovers do well on all except the most shallow areas.

NONAGRICULTURAL LAND

The land classed as nonagricultural is limited to those areas on which not only is tillage impossible but the value for grazing is low. Much of the surface is bare rock, and the rest consists of steep stony slopes on which the soil is shallow, variable in texture, and generally poorly adapted to meet the requirements of grasses which, even if established, could not long survive the competition of the numerous trees and shrubs that thrive on these soils and in these topographic situations.

Rough stony land embraces the steepest parts of the high ridges that overlook the larger valleys. Viewed from the valleys the average inclination of the wooded slopes appears to be as much as 45°, with a few vertical exposures of rock that the forest fails to conceal. As a rule, the rock outcrops are horizontal ledges only a few feet or yards thick, but some are stony escarpments 50 feet or more high. The more prominent ledges may extend a fraction of a mile or more midway along the hillside or form a part of the ridge crest. Most of these rough areas are densely wooded steep stony slopes. As previously mentioned, the soil material is shallow and most of the large roots of the trees reach well down into the disintegrating mass of subsurface rock. The finer surface roots bind the topmost 2- or 3-inch layer of black humous soil into a mat that is distinct from the lighter colored subsurface layer. This concentration of feeding roots near the surface is especially noticeable on seepy hillsides and on spots of better drained ground where some depth of good soil has accumulated. On many steep slopes, the stony soil is so thin and patchy that it hardly covers the rock. It supports a scattered growth of bushes and trees. Rough stony land is divided into three classes of material designated as Lordstown soil material and Lackawanna soil material, both of which have an acid reaction, and Farmington soil material which has an alkaline reaction.

Rough stony land (Lordstown soil material).—Throughout that part of the county in which gray sandstone is the dominant rock the soil material is strongly acid. Springs and seepy spots are numerous, and the conditions with respect to available soil moisture are more variable than are indicated by the surface appearance. This variability and the direction toward which the slopes face are factors of some importance in the distribution of the vegetation, as it seems to be more dense on the steep northern slopes than on southern slopes. The original plant associations have been much modified by removal of the larger trees. Grazing and occasional forest fires have not affected the vegetation on these rough lands so much as has the constant cutting of usable timber. The land supports practically all species of trees common to this section, and the size of such mature trees as remain indicates favorable conditions for their growth.

Rough stony land (Lackawanna soil material).—In those parts in which red sandstone occurs and red soils predominate, the areas

of similar topographic features are designated as red land. This land presents similar soil variations and has about the same kind of forest cover as have the areas of Lordstown soil material. All have some value for summer pasture and as sources of water supply for farms on adjoining lower lands. The forest growth consists chiefly of trees more suitable for fuel and fence posts than for lumber.

Rough stony land (Farmington soil material).—Rough stony land in the extreme northern part of the county is associated with limestone ledges, and the soil material generally is alkaline. All this broken land associated with the limestone measures is indicated on the map as rough stony land (Farmington soil material). The narrow areas north of Springfield and East Springfield include the abrupt marginal slopes from the higher lying areas of Farmington silt loam to the smoother land at lower levels. On these steep slopes the massive gray limestone formations outcrop as long horizontal ledges, and there is more or less loose rock on the slopes below. In many places the slopes form vertical escarpments 20 feet or more in height, or they may occur at several different levels with flat benches between, on which the soil is a thin patchy phase of Farmington silt loam. Many deep fissures, a foot or more wide, open near the edge of the bench but are filled with black soil some distance back from the margin. On steep stony slopes the soil is more variable, as regards thickness and character of material. In such places most of it is dark-colored crumbly silt loam possessing good physical characteristics.

A great variety of shrubs and trees grow on this rough limestone land. Black locust and white cedar are more common than on the acid soils, but hard maple, birch, beech, and elm form most of the forest growth. On open ground, the grass cover in places includes white and yellow sweetclover, white or Dutch clover, and much bluegrass. Timothy and the more useful wild grasses form most of the cover, with much goldenrod, wild carrot, mullein, and many other kinds of field weeds. These steep slopes include fewer seepy spots than do corresponding slopes on the sandstone hills, and springs are not so numerous.

The Helderberg escarpment east of the village of Cherry Valley includes much rough stony land with many outcrops of the massive limestone beds, which lie below the base of the hill on which United States Highway No. 20 is located near the county boundary. The steep slopes above the road are shale soils similar to Manlius shale loam. Most of the remaining trees are small and of poor quality. Summer grazing is better than that on the acid soils. An almost inexhaustible supply of limestone suitable for agricultural purposes and road building is within easy transportation by rail and highway.

ORGANIC SOILS

Many small areas of muck and peat occur on the uplands and in the bottom lands, but very few such deposits are on the terraces. All this material consists of the remains of plants, accumulated under conditions of almost constant saturation; and the areas show much varia-

tion in color, textural character, and depth of the deposits, as well as in kinds of vegetation now growing on them. Those areas in which the surface materials are well decayed and very dark to a depth of 20 inches or more are indicated on the map as muck; and those in which the materials are only partly decomposed and are coarse textured are indicated as peat.

Muck.—Muck consists of very dark brown or nearly black finely divided organic remains, so well decomposed that not much of the original plant tissue is discernible. In most places the color becomes lighter with depth, and at a depth ranging from 30 to 40 inches is brown or reddish-brown fibrous peat or a soft macerated material which, at a little greater depth, passes into clay or marl, the latter being an impure sort of lime.

Some of the small areas of muck between Cooperstown and Milford are of this character. Several have been reclaimed by open ditches and are in a good state of tilth, as artificial drainage and cultivation tends to darken the color and render the mass a little more compact. The moisture relations are good so long as the ground-water level is held below a depth of 30 inches. The surface layer does not become so dry that seeds fail to germinate or young plants are injured. All these cultivated patches seem to be alkaline, a condition caused by the calcareous clay, or plant-made marl, and small shells of mollusks that form the substratum at a depth of less than 4 feet. Tillage also tends to increase the alkalinity in the shallow areas. These characteristics are important with respect to tillage qualities and general adaptation to market-garden crops. Many small areas of unreclaimed muck are in the valleys, but not all are so likely to prove suitable for the growing of vegetables as are those now in cultivation.

In selecting a patch of muck for the production of crops, provision for adequate drainage is of first importance. Fine-textured rather than coarse-textured material is desirable. The thickness is not of great importance, but clay or marl is preferable as a substratum to sand or sandstone materials. In this county the dark-colored muck over lime-bearing clay is more common in the valleys than on the uplands. As a rule, areas on which elm, ash, maple, and other hardwoods are growing will prove suitable for celery, onions, potatoes, and cabbage, if adequate moisture control is provided. The application of manure is beneficial; in fact, may be necessary for some crops. This is also true as regards commercial fertilizers. A deficiency in potash is more common to deep deposits of muck and peat over sand than to shallow deposits resting on clay or marl.

The Black Ash Bog south of Gilbertsville consists of soft muck several feet deep, but it is so full of buried logs that reclamation, if otherwise feasible, would hardly result in a tillable soil. The present cover includes hemlock, black birch, hard maple, and some pine and post oak. The dense and varied undergrowth includes some mountain-laurel. In June 1934 the material was comparatively dry to a depth of about 3 feet.

The area 2½ miles northwest of Oaksville is mostly an impure muck because so much clay and silt have washed on what probably was peat before the surrounding hills were cultivated. This area supports a dense growth of redtop and affords much good pasture.

Peat.—Those areas of organic soil, in which coarse-textured partly decomposed vegetal remains form most of the deposit are shown on the map as peat. The forest cover in most places includes much tamarack and some pine. Maple, ash, hemlock, elm, and other hardwoods are less numerous than on areas of muck. The ground-water level of peaty areas generally is high, often at the surface. Therefore, saturation is frequent and prolonged. Decomposition of the submerged material has not progressed so far as it has in muck. The plant remains include much identifiable material, chiefly reedlike grasses in the lower layers where the deposit is several feet thick. The surface layers more commonly consist of woody peat, and the areas may contain many buried logs.

Shallow deposits are extremely variable with respect to drainage and character of the mineral soil immediately below the organic material. The organic material in the valleys may be neutral or alkaline, but on the uplands it commonly is acid. For this reason, the upland bogs and swamps support a growth of sphagnum moss, blueberries, pitcherplant, cranberries, Venus flytrap, and other bog plants that prefer a highly acid soil.

A few areas, in which the deposits are chiefly brown fibrous peat, have a cover of grasses and weeds, with only a few larch and hemlock trees. The old reservoir, 4 miles northeast of Decatur, is of this character. The central parts of many of the open areas of Chippewa and Norwich soils consist of shallow peat.

In many areas, a shallow central ditch would improve conditions sufficiently to allow desirable pasture grasses to displace the present almost worthless cover of bushes, coarse grasses, and aquatic vegetation. Similar improvement of densely forested patches seems less promising, as such areas would require several years for the coarse materials to become sufficiently settled and well enough oxidized to allow redtop, bluegrass, and other pasture grasses to become well established.

PRODUCTIVITY RATINGS

Table 5 gives a rating of the soil types, phases, and miscellaneous land types, according to their productivity for each of the important crops grown.

TABLE 5.—*Productivity ratings of soils in Otsego County, N. Y.*

Soil	Crop-productivity index [1] for—											Productivity grade according to—		Principal crop or type of farming
	Corn (grain)	Corn (silage)	Oats	Buckwheat	Timothy hay	Red clover	Alfalfa	Potatoes	Vegetables [2]	Apples	Permanent pasture	Current practices [3]	Inherent productivity [4]	
Honeoye silt loam	60(80)	70(100)	80(100)	100	80(100)	80(100)	80	50(80)	60(80)	60(70)	90	1	3	General.[5]
Ontario silt loam	50(70)	60(100)	70(100	90	80(100)	80(100)	70(80)	50(80)	60(80)	60(70)	90		3	Do
Palmyra sandy loam	50(80)	50(100)	50(80)	90	60(90)	60(90)	45(80)	50(100)	50(90)	60(90)	50	2	5	General, truck, potatoes.
Palmyra gravelly loam	50(80)	50(100)	50(90)	90	60(90)	60(90)	70(80)	50(80)	50(80)	60(90)	60		4	General.
Tioga silt loam, high-bottom phase	70(90)	70(100)	80(90)	80	80(100)	70(90)	45(80)	50(80)	70(90)	50(60)	80		3	Do.
Unadilla fine sandy loam	60(90)	60(100)	60(90)	80	70(100)	50(90)	45(80)	50(90)	60(90)	60(70)	70		4	General, truck.
Unadilla silt loam	60(90)	60(100)	60(90)	80	70(100)	50(90)	45(80)	50(80)	60(70)	50(60)	80		4	Do
Genesee silt loam [6]	90	100	80	90	100	100	70	50	80	-------	100		2	Corn, hay, pasture
Chenango gravelly silt loam	40(70)	50(100)	50(80)	70	50(100)	40(80)	25(70)	50(90)	50(80)	40(70)	40		6	General
Tunkhannock gravelly silt loam	40(70)	50(100)	50(80)	70	50(100)	40(80)	25(70)	50(90)	50(80)	40(70)	40		6	Do.
Barbour silt loam [6]	80(90)	90(100)	80	90	90	70(100)	45(70)	50	80	-------	80		3	Do
Tioga silt loam [6]	80(90)	90(100)	80	90	90	70(100)	45(70)	50	80	-------	80		3	Hay, corn, truck.
Walton gravelly silt loam	50(80)	50(90)	50(80)	70(80)	60(90)	40(70)	(45)	60(80)	60(80)	40(60)	70	3	5	General.
Wooster gravelly silt loam	50(80)	50(90)	50(80)	70(80)	50(90)	40(70)	(55)	60(80)	60(80)	50(80)	60		5	Do.
Barbour gravelly loam	80	80	90	60	90	70	45	60	70(80)	40	80		3	Do.
Tioga gravelly loam	80	80	90	60	90	70	45	60	70(80)	40	80		3	Do.
Honeoye silt loam heavy-subsoil phase	30(40)	40(80)	60(80)	60	70(90)	60(80)	35(70)	40	70(80)	50	80		4	Do.
Otsego gravelly silt loam	40(50)	40(80)	50(70)	60(80)	50(90)	40(70)	(55)	50(90)	50(60)	30	60		6	Pasture, general.
Caneadea silt loam [7]	30(60)	60(80)	50(70)	70	70(80)	60(70)	2[illegible](35)	30(40)	40(60)	40	70	4	5	General, hay
Genesee silt loam [8]	60	70	50	60	90	50	35	30	60	-------	100		4	Hay, corn, pasture.
Langford gravelly silt loam	30(60)	40(70)	50(70)	70(80)	50(80)	40(60)	25(45)	30(50)	40(50)	30(40)	60		6	General. hay, pasture
Mardin gravelly silt loam	30(50)	30(60)	50(70)	60(80)	50(80)	40(60)	(45)	50(70)	40(50)	20	50		6	Pasture, timothy, general.
Manlius shale loam	30(50)	40(80)	40(80)	40(70)	30(70)	20(70)	(35)	40(70)	40(70)	40	40		7	General
Chenango sandy loam	30(60)	40(60)	40(60)	50	30(60)	30(60)	20(55)	40(80)	40(80)	40(70)	30		7	Truck, general.
Barbour silt loam [8]	70	70	50	40	80	60	35	20	40	-------	80		4	Hay, corn, pasture.
Tioga silt loam [8]	70	70	50	40	80	60	25	20	40	-------	80		4	Do
Farmington silt loam	30(40)	40(60)	50(60)	60	50(60)	50(70)	45	20	50(70)	30	60	5	6	Forest, pasture, general.
Culvers gravelly silt loam	30(40)	30(50)	40(60)	50(70)	50(60)	20(40)	(35)	30(50)	40(50)	20	60		6	Pasture, timothy, general.
Lackawanna stony loam	30(40)	30(50)	40(70)	40(80)	30(40)	20(40)	(20)	40(100)	30(60)	30	50		7	Pasture, potatoes, timothy, buckwheat.
Lordstown gravelly silt loam	20(70)	30(50)	40(70)	40(80)	30(40)	20(40)	(20)	40(100)	30(60)	30	40		7	Do.
Groton gravelly loam	30(50)	30(50)	30(50)	30(50)	30(40)	40(50)	45(70)	40(50)	30(50)	40(60)	40	6	7	Hay, pasture, general.
Lorain silt loam [7]	-------	40(60)	-------	60	60	50	-------	-------	50(70)	-------	70		7	Forest, pasture, corn.
Lorain silty clay loam [7]	-------	40(50)	-------	60	60	50	-------	-------	50(70)	-------	70		7	Pasture, corn, vegetables.

Canaadea silt loam, undrained	20	40	30	60	50	40		20	30	20	60		7	Hay, pasture.
Eel silt loam [6]					70				70		90		7	Hay, vegetables.
Volusia silt loam	20(30)	20(40)	30(50)	40(50)	40	10(20)		10(20)	20(40)		40	7	7	Pasture.
Eel silt loam [6]					60				30		90		7	Pasture, hay.
Otisville gravelly loam	30	30	20	30	30	10	(45)	20(40)	20(50)	40(60)	30		8	Pasture.
Middlebury silt loam, undrained					60						80		8	Hay, pasture.
Lyons silt loam, undrained					50	30					80		8	Do.
Muck, drained	10(60)	10(0)						10(60)	[9] 20(100)		20(80)		10	Vegetables.
Ontario silt loam, steep phase					40	40	35				50	8	8	Pasture, hay
Wayland silt loam [7]					40				[10]60(80)		50		8	Pasture, vegetables.
Lorain silt loam, undrained				30	40						60		8	Forest.
Lorain silty clay loam, undrained				30	40						60		8	Do.
Wellsboro gravelly silt loam					40						50		9	Pasture.
Wooster gravelly silt loam, steep phase		20	20	20	20	10			30(70)		30	9	9	Pasture, general.
Langford gravelly silt loam, steep phase		20	20	20	20	20					40		9	Pasture.
Alluvial soils, undifferentiated											80		10	Do.
Farmington stony silt loam											60		10	Do.
Honeoye silt loam, steep phase											60		10	Do.
Holly silt loam, heavy phase											40		10	Forest, pasture.
Culvers gravelly silt loam, steep phase											40		10	Pasture, forest.
Lackawanna stony loam, steep phase											30		10	Forest, pasture.
Lordstown stony silt loam, steep phase											30		10	Do
Manlius shale loam, steep phase											30	10	10	Pasture, forest.
Norwich silt loam											30		10	Pasture.
Chippewa silt loam											20		10	Do.
Rough stony land, Farmington soil material											10		10	Forest, pasture.
Muck, undrained											5		10	Forest
Rough stony land, Lackawanna soil material													10	Do.
Rough stony land, Lordstown soil material													10	Do.
Peat													10	Do.

[1] The productivity of each of the various soil types for each specific crop is compared to a standard—100—which stands for the inherent productivity of the most productive soil (or soils) of significant acreage in the United States for that crop. Figures without parentheses indicate the inherent productivity of the soils for the specified crops, whereas figures in parentheses indicate the productivity under current practices which include the use of soil amendments, such as lime, commercial fertilizers, and manure from concentrated feeds not grown on the land.

[2] This is a generalized rating which refers to vegetables not requiring highly organic soils Exceptions are noted in footnotes 9 and 10.

[3] This classification indicates the comparative general productivity of the soils under the current farm practices. Refer to the text for further explanation.

[4] The inherent productivity grade refers to the relative inherent ability of the soil to produce without amendments

[5] General farming, as used here, refers chiefly to the growing of hay, oats, and silage corn for the feeding of livestock, principally dairy cows. A comparatively small acreage is also used for growing cash crops, as potatoes, apples, or vegetables.

[6] Refers to the higher lying areas which are less frequently overflowed, although not protected. With protection and drainage, as in some areas in other counties of New York, Eel silt loam rates much higher.

[7] Refers to areas naturally better drained, although not artificially drained. Ratings for productivity under artificial drainage would place such soils as the Wayland much higher.

[8] Refers to the lower lying areas which are more frequently overflowed

[9] These indexes refer to vegetables doing best on highly organic soils, as celery, spinach, lettuce, and onions.

[10] These indexes apply about equally well for vegetables doing best on highly organic soils as for vegetables not requiring highly organic soils.

Note: Leaders indicate either that the crop is not commonly grown because of poor adaptation, or that amendments are not commonly used.

The rating compares the productivity of each of the soil types, or other mapping separations, in the county for a given crop to a standard—100. This standard represents the inherent productivity of the most productive soil type (or types) of significant acreage in the United States for the specified crop. These standards of reference are based on yields obtained (without amendments) on the best soils in the more widely known crop regions. The exceptional and inextensive soil types which are especially well adapted to a particular crop receive indexes above 100. In this way, standards are not established so high that large areas known for their production of a particular crop receive very low relative ratings. A soil estimated to be about one-half as productive for a specified crop as a soil with a rating of 100 receives an index of 50.

The inherent productivity indexes are based on the ability of the land to produce under a system of management capable of maintaining the inherent level of productivity without the use of soil amendments. The inherent level of production is conceived to be the level at or near that existing when the virgin condition became adjusted to tillage practices. In those instances where phases are mapped to show present conditions of erosion, shallowness, relief, or other modifications which have resulted from continued tillage, the rating applies to the present production (without amendments) rather than to the inherent productivity as defined.

Under current farming practices in Otsego County, amendments, such as lime, phosphate, complete commercial fertilizer, and manure produced from concentrated purchased feeds are commonly used. The use of manure produced from feed grown on the land is not considered an amendment. Because the index of inherent productivity does not express the responsiveness of soils to fertilizer and also because, in many instances, it does not represent production as obtained by current practices, a second index is used in parentheses to show the productivity of the soil with amendments as they are used under the current practices of the average to better-than-average farmers of the county. In this way the influences of management and techniques are roughly evaluated. The same standard of reference is used as for the inherent crop-productivity index.

The factors influencing the inherent productivity of land are mainly those of climate, soil, including drainage and relief, or lay of the land. All are concerned in the determination of the productivity ratings, and low ratings for a particular crop may as likely be due to an unfavorable climate or to unsuitable conditions of slope as to lack of fertility in the soil. As long-time crop yields furnish the best available summation of the factors contributing to soil productivity, they have been made the basis, so far as such information is available, for the determination of the indexes.

In many instances the same soil type as mapped may express a range of drainage conditions. Therefore, ratings are assigned to both the more favorable and the less favorable conditions, although no artificial drainage has been installed. Footnote 7 of table 5 illustrates this use of a rating on the naturally better drained areas of Lorain and Wayland soils.

Two sets of indexes are given also to the soils of the bottom lands that contain areas naturally better protected. Footnotes 6 and 8 of table 5 refer to the overflow conditions of the bottom lands in this county.

In addition to productivity indexes for each important crop, each soil type, phase, or miscellaneous land type is assigned two general productivity ratings, or grades of agricultural quality. These ratings are based on the ability of the soils to produce the crops of the general agricultural region in which they occur. The rating, "Current practices," in the left-hand column under "Productivity grade," is obtained from a weighted average of the crop indexes in parentheses, whereas the rating in the right-hand column is obtained from a weighted average of the inherent-productivity indexes. These averages have been obtained by weighting each crop-productivity index according to the approximate percentage of the cropland occupied by the specified crop in the general agricultural region. Allowances have been made for variations in acreage trends in the county and, to some extent, for differences in crop-acre values. The making of a general rating involves many considerations, and certain arbitrary assumptions have been made to obtain a reasonable result. If the weighted average for the crop-productivity indexes falls between 90 and 100, the soil type is assigned a productivity grade of 1; if the weighted average falls between 80 and 90, a grade of 2 is given; and so on. In the instances of those soils which are not amended under practices of current management, the grade for current practices is the same as that for inherent productivity. Although a soil may be the most productive in a county or region, it does not necessarily receive a rating of 1, since that rating is given only to those soils obtaining a weighted average of 90 or more. In Otsego County, Honeoye silt loam and Ontario silt loam are rated 1, under current practices, and 3 according to inherent productivity. The higher lying areas of Genesee silt loam are given a rating of 2 for general inherent productivity (the highest in the county), although under current practices these areas also rate 2.

The soil types are listed in the order of their general productivity under current practices instead of being placed in the order of their general inherent productivity, as it is believed that most people think of productivity in terms of current practices. It should be remembered, however, that the inherent-productivity grade is an attempt to evaluate a more stable characteristic of the soil than may be true of productivity according to current practices of management. It is to be noted also that, although the placement of soils into grades is an attempt to group the soils, a soil type whose weighted average places it in the lower part of a group may be more closely akin in productivity to the soil listed first in the following group than it is to the foremost members of its own group.

Productivity tables do not present the relative roles which soil types, because of their extent and the pattern of their distribution, play in the agriculture of a county. The tables give a qualitative characterization to the productivity of the individual soil types. They cannot picture the quantitative production of crops by soils without the additional knowledge of the acreage of the individual soil types devoted to the specified crops.

It must be stated clearly that these productivity ratings are not to be interpreted directly into specific land values. The table presented here is not based on enough of the factors which influence land values to warrant such an interpretation. The intention is to confine attention to the essentially permanent factors of inherent productivity and to the responsiveness of soils to fertilization and management, with little consideration given to the economic factors involved. In some instances the information on which to base the ratings is not so complete as desired, and further study may suggest changes.

The following tabulation gives the more important crops of the county and the acre yield that has been set up as a standard of 100 for each crop. These yields have been selected to represent long-time production averages of the inherently most productive soils of significant acreage in the United States for products of satisfactory quality and are obtained without the use of soil amendments other than those produced directly or indirectly from the soil.

Crop:			Crop—Continued		
Corn (grain)	bushels	50	Corn silage	tons	12
Oats	do	50	Timothy hay	do	2
Buckwheat	do	25	Red clover	do	2
Potatoes	do	200	Alfalfa	do	4
Apples	do	200	Pasture	cow-acre-days [1]	100

[1] Cow-acre-days is a term used to express the carrying capacity of pasture land. It is the numerical equivalent of the number of animal units supported by 1 acre during a given number of days. Examples: (*a*) A soil type supporting 1 animal unit per acre for 360 days would rate 360; (*b*) a soil type supporting 1 animal unit per 2 acres for 360 days would rate 180; (*c*) a soil type supporting 1 animal unit per 2 acres for 180 days would rate 90; and (*d*) a soil type supporting 1 animal unit per 4 acres for 160 days would rate 40.

AGRICULTURAL METHODS AND MANAGEMENT

The methods of maintaining soil fertility are simple. The common crop rotation consists of corn, 1 year; oats, 1 year; and grass, several years. Buckwheat, potatoes, or some other tilled crop occasionally takes the place of oats, but timothy, or mixed timothy and clover, follow the 2 or 3 years of grain, and on many farms the surviving timothy, with other grasses, occupies the land for a number of years. Farmers recognize the need of more frequent changes to grasses, especially on the upland soils, but on many farms it is impractical to shorten the grass period. Exclusive of the acreage in permanent pasture, the grassland exceeds the acreage in grain, silage, and potatoes, in a ratio of about 4 to 1 for the entire county, but, on many of the larger dairy farms, the present ratio is probably nearer 7 to 1.

Manure from the dairy barns forms by far the greater part of the soil amendments used in this county. On the basis of the 1930 census returns, the livestock in Otsego County is equivalent to about 82,000 animal units.[7] The annual production of manure probably exceeds 620,000 tons. A ton of manure contains about 10 pounds of nitrogen, 5 pounds of phosphorus, and 10 pounds of potash. Accepting the above estimates as to tonnage of manure, the annual return to the soil is more than 6,000,000 pounds of nitrogen, the same quantity of potash, and 3,000,000 pounds of phosphoric acid.

[7] An animal unit is represented by 1 horse, or 1 cow, or 5 hogs, or 7 sheep, or 100 hens. Due allowance must be made for young animals.

The prevailing practice of hauling manure from the barns about as fast as it accumulates and spreading it upon the grassland reduces loss by leaching and oxidation to the lowest possible point.

This large return of organic matter and plant nutrients to the soils accounts for the increased carrying capacity of the pastures and the larger acreage production of hay, compared with 25 years ago. Of course, this statement applies to well-managed farms and not to those on which only a few head of livestock are kept.

In recent years the use of complete commercial fertilizers has greatly declined, a compensating factor with respect to the large annual outlay for concentrated feeds. The greater part of all the high-protein feeds comes from sources outside the county.

The tendency now is to apply complete fertilizers only to potatoes and truck crops. Such use as is made of commercial fertilizers with field crops is limited to rather light applications of 12- to 16-percent superphosphates.

No exact figures are obtainable concerning the quantity of lime applied to the soils in recent years. A conservative estimate is 5,000 tons a year applied to about 6,000 acres.[8] The use of lime is increasing. Most of it is applied to the Wooster, Chenango, and Otsego soils for the benefit of new seedings of clover and alfalfa. For alfalfa, lime is also applied on some farms on the Ontario, Honeoye, and Tioga soils. Ground limestone is preferred by most farmers to the burnt lime. The prevailing price in 1933–34 was about $5 a ton for ground limestone.

In this soil survey report the description of each soil type indicates the character of the materials composing it, the prevailing moisture conditions, the amount of humus or decaying vegetable matter it contains, and the normal degree of acidity or alkalinity. From this discussion the main soil requirements in the way of plant nutrients may rather easily be inferred. This is also true with respect to cultural practices which each soil, or group of related soils, demands for best results. As the soils range from a few types rich in lime to many that are strongly acid, considerable attention has been given to this important feature. It is evident that economy in the use of lime may be effected by a consideration of the reaction of the surface soil and the depth at which free lime occurs in the subsoil.

The principal questions that arise concerning soil requirements are answered by the descriptions of the soil types, but for the greatest economy in farm management, the crop rotations and fertilizer practices must be considered in considerable detail for each soil or group of related soils. This is beyond the limits of a soil survey report. These agronomic problems have been made the subject of exhaustive study in Chenango County, and the results have been recorded in Bulletin 514[9] issued by the Cornell University Agricultural Experiment Station. In the report for Chenango County the following groups of soils are fully discussed: Lackawanna, Wooster, Lordstown, Volusia, and Ontario areas. The recommendations concerning the above soil groups apply equally well to the corresponding soils in Otsego County.

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[8] Estimate by county agricultural agent.

[9] GUSTAFSON, A. F., BUCKMAN, H. O., and COOPER, H. P. SOIL AND FIELD-CROP MANAGEMENT FOR CHENANGO COUNTY, NEW YORK. N. Y. (Cornell) Agr. Expt. Sta. Bull. 514, 82 pp., illus. 1930.

EROSION

Notwithstanding the strong relief of most of the land in this county, erosion is not a serious problem, as soil wastage from forested land, however steep, is negligible, and the same is practically true of grassland. Grassland now forms such a large proportion of the uplands that likelihood of injury by erosion is limited to a very small percentage of the total acreage of cropland and plowable pasture. The land in tame or cultivated grasses in 1929, according to the 1930 census, was 130,443 acres, and that in crops requiring tillage or some precrop plowing was about 35,000 acres. This is a ratio of nearly 4 to 1, but only the ground planted to corn and potatoes suffers much loss of soil. These two crops covered about 15,000 acres in 1929, and much of this acreage was on smooth alluvial and terrace soils which are practically immune to injury by erosion.

The practice of planting potatoes in straight rows irrespective of the slope could be modified on many farms without causing inconvenience in cultural operations. The customary hilling up of rows leaves the surface in such condition that interrow soil washing was very noticeable in 1934 in fields of potatoes on the Lordstown and Otsego soils.

Practically all steep phases of the cleared upland soils were used, for a few years at least, for crops requiring tillage, and it was during these cultural periods that most of the loss of surface soil took place. Under a grass cover the soil slowly accumulates some organic matter in the topmost few inches, with some consequent improvement of moisture relations between soil and cover. The process, even under the most favorable conditions, seems to be a slow one, as may be observed in old hillside pastures that have not been plowed for 20 years or more. Comparison of these pasture soils with adjacent woodland indicates a wide difference in capacity for absorption of rainfall. This is not only apparent in the surface soils, but the subsoil in the woodlands, between depths of 6 and 20 inches, is structurally more open and includes more organic debris, aside from living roots, than is in the subsoil in pastures. The difference is decidedly noticeable in the Lordstown, Lackawanna, Otsego, and Mardin soils.

Comparisons on the limestone soils are less easily made because of the small acreage of these soils remaining in forest.

It is apparent that if forest land is cleared and grasses established thereon, the soil will be in better condition for the grasses if the change is made without any interval of cropping. The improvement of some of the hilly upland pastures seems entirely practical by close grazing with sheep. A light application of lime and of acid phosphate would greatly improve conditions with respect to the fertilizer requirement of grasses, but it is equally important to retain the accumulated organic matter.

MORPHOLOGY AND GENESIS OF SOILS

Well-developed well-drained soils of Otsego County belong to the Gray-Brown Podzolic and Brown Podzolic groups. These soils, as described in the Atlas of American Agriculture,[10] in Development

[10] MARBUT, C. F. SOILS OF THE UNITED STATES. U. S. Dept. Agr., Atlas of American Agriculture, pt. 3, Advance Sheets No. 8, pp. 1–95, illus. 1935.

and Significance of the Great Soil Groups of the United States,[11] and in the 1938 Yearbook of Agriculture,[12] have developed chiefly under a deciduous forest with a moist, temperate climate. Although they differ from one another in certain details, all these soils are developed under a podzolization process similar to but not identical with that giving rise to the Podzol. Deciduous trees tend to return the bases to the surface layer of the soil more rapidly than do coniferous trees, but they are not so effective in this respect as are grasses. Most of the Gray-Brown Podzolic soils are naturally more fertile for crop plants than are those of the Podzol group, but less so than the Chernozems. Brown Podzolic soils are intermediate in character between the Gray-Brown Podzolic soils and the Podzols, and occur at relatively high altitudes in Otsego County. Considering their medium fertility, however, together with the desirable climate, which allows the growth of a wide variety of plants, these soils are admirably adapted to the development of stable agricultural communities of the general-farming type. It might be added that, although these soils are only medium in natural fertility, most of them are responsive to good farming practices, including some fertilization and liming, and will produce as well or better than the more fertile Chernozems of the subhumid grasslands.

Otsego County embraces a section of the State in which much soil diversity exists. The soil types derived from the Helderberg limestones and Hamilton shales, so much in evidence in the extreme northern and northeastern parts of the county, have outstanding characteristics directly traceable to those rocks. Throughout the central and southern parts, sandstones of Devonian age have supplied most of the parent soil materials, and the soils developed thereon retain important characteristics showing their close relationship to these arenaceous formations. In the extreme southwestern part, the conspicuously red rocks of the Chemung and Catskill formations impress their color on the soils of the uplands, terraces, and local stream valleys. In all the main valleys, the soils developed on the terraces differ from those of the first bottoms, as the respective parent materials present important differences in textural character and lithological composition.

All these soils have one feature in common—they are geologically young. The parent materials, for the most part, are glacial deposits of late Wisconsin age. The soil-forming processes have not affected these deposits so deeply, nor have they operated so vigorously as they would have done under somewhat warmer and more humid climatic conditions.

The glaciation of this region was feeble, and the ground moraine is shallow, consisting chiefly of such material as the underlying rocks contributed. This is especially true throughout the central and southern uplands of the county, where gray and red sandstones are so much in evidence. Here the till on the eastern and northern slopes averages only a few feet in thickness. The prevailing depth to rock is somewhat greater on the tops of broad divides, especially

[11] KELLOGG, CHARLES E. DEVELOPMENT AND SIGNIFICANCE OF THE GREAT SOIL GROUPS OF THE UNITED STATES. U. S. Dept. Agr. Misc. Pub. 229, 40 pp., illus. 1936.

[12] UNITED STATES BUREAU OF CHEMISTRY AND SOILS, SOIL SURVEY DIVISION. SOILS OF THE UNITED STATES. U. S. Dept. Agr. Yearbook 1938: 1019–1161, illus. 1938.

on gentle southern and western slopes. Along the lower slopes, facing the larger valleys, patches of deep till are associated with the higher terraces, and these, as well as the many mounds and piles of gravel in the valleys, are outwash materials representing the final stage of the ice retreat. From the highly calcareous till of southern Herkimer County and the northern part of Otsego County, the glacial waters derived so much limestone debris, that these valley deposits remain more or less alkaline as far south as the latitude of Cooperstown and New Berlin, but below this line, the influence of the limestone decreases rapidly. The coarse-textured outwash materials have lost the free lime they may have had originally and now are acid to a depth of many feet, although this is not true of some fine-textured lacustrine deposits. Below the superficial weathered layer, which in few places exceeds 30 inches in thickness, these silty deposits retain their original highly calcareous character.

The changes, which these various surface materials have undergone through weathering, have taken place under an average annual 40-inch rainfall. The large proportion of cloudy and part-cloudy days each year is of some significance in connection with the rate of evaporation, which is slow in comparison with areas farther west and south in the United States. Farmers express the opinion that the plowed ground usually freezes to a depth of 2 or 3 feet. The minimum depth of frost penetration doubtless occurs under the accumulated leaf litter of heavily forested land. Compared with the present diversified surface conditions, the former universal cover of a mature forest reduced the run-off and tended to a higher proportionate absorption of the rainfall and melting snow; and the summer loss of soil water by evaporation and transpiration doubtless was more uniform over large areas than it is now. The great extent of imperfectly drained soils, involving diverse kinds of materials on many strong slopes, suggests the importance of the above factors in this development. These same imperfectly drained soils under cultural conditions now show changes in moisture content much in accord with the current rainfall.

The heavier areas of calcareous till in well-drained situations have lost their carbonates to a depth of about 20 inches, but in coarse-textured material free lime is present in few places above a depth of 40 inches.

Throughout the upland sections dominated by gray or red sandstones, the till almost everywhere is acid throughout its entire thickness. Oxidation, as indicated by a brown or brownish-gray color, extends to a depth ranging from 30 to 40 inches in most of the heavy till and to a much greater depth in the gravelly and sandy deposits.

These soils contain little or no concretionary material. Even the gray layers in the imperfectly drained soils are only faintly mottled as a result of a partial segregation of the iron oxides. These soils are podzolic, but true Podzols have not developed. Rarely is a gray leached zone developed beyond a mere occurrence of scattered soil aggregates of ash-gray color and extreme friability.

In well-drained situations on the uplands, where the depth to gray sandstone does not exceed 40 inches, a profile normal to this section occurs in virgin woodland. Beneath the loose forest litter is a 2-inch layer of dark-brown or nearly black decomposed organic residues,

with but little silt or fine sand. This layer is so well filled with living rootlets that it forms a mat distinct from the brownish-gray silt loam beneath. The silt loam layer has some development of a granular structure, evidently due to the influence of the organic matter that is intimately incorporated with the mineral constituents. This layer is only a few inches thick and changes with depth to yellowish-brown friable silty loam. At a depth ranging from 10 to 15 inches, the proportion of clay particles shows some increase, but no well-defined line of demarcation between the A and B horizons exists. The structure is more or less granular, with no tendency to cementation or compaction. The permeability is increased by included coarse material consisting chiefly of sandstone fragments of all sizes and in various stages of disintegration. Just above the contact with the underlying rock (in place), the interstitial material is gray or drab silt and clay, containing considerable fine grit. This material, when dry, may feebly cement the coarser materials into a heterogeneous mass.

The profile of an imperfectly drained soil on the gray sandstone differs from that of a well-drained soil in two important particulars. At a depth ranging from 15 to 25 inches, the friable yellowish-brown silty loam changes to lighter colored and more compacted material which, when dry, has a considerable degree of cohesion and is also adhesive. It so firmly cements the coarse materials as to require a pick to loosen the mass. The fragments, when dry, are decidedly porous, and in some places the lower part of this gray layer has a somewhat vesicular structure. Many of the minute openings and the joint planes have a film, or varnishlike coating, of colloidal material. This suggests that resistance to the movement of water is due to these colloids which, on absorption of moisture, swell and fill the pore spaces. As acidity tends to deflocculation of clay and silt particles, this is highly probable. The initial tendency to restricted drainage is due to slight relief, but the development of a cemented zone is the result of the factors just mentioned.

The black surface mat of living roots and decomposed vegetable residues, mentioned in connection with the well-drained soils, has a different development on these imperfectly drained soils. This layer includes much soft carbonaceous material having a greasy feel and so lacking in grit that it probably consists of organic colloids, with very little admixture of mineral matter.

These imperfectly drained soils associated with the gray sandstone present numerous modifications, but all have the outstanding characteristics of meager organic accumulation, strong acidity, and a well-developed gray hardpan layer. These features are not quite so well developed in the soils owing their origin to the red sandstones and are almost entirely lacking in soils associated with the limestones and highly calcareous till. The soils derived from limestone material have the distinctly granular structure, common to all alkaline soils; and, in addition, the accumulation of organic matter in these calcareous soils is somewhat greater and is well incorporated with the mineral constituents to a depth of 6 or 8 inches. The imperfectly drained limestone soils closely resemble the soils on wet prairies in the West.

The coarse texture of the soils on the terraces and the sandy substrata at slight depths under the soils of the first bottoms, insure both good drainage and deep aeration, except in low topographic situations. The frequent high level of the ground water is responsible for the gray poorly drained subsoils of both alkaline and acid soils of the first bottoms.

A common surface feature in woodlands, and also in pastures that have never been plowed, are so-called cradle knolls. These are mounds, composed of silty materials and fragments, from 1 to 2 feet high and several yards wide, with a corresponding depression at one side. They owe their origin to overturned trees that were shallow rooted because of the slight depth to impenetrable rock or to hardpan. Although a high average level of the ground water is a potent cause of shallow rooting, the mounds formed in such situations usually do not persist in the loose humus-filled soil, as they do in the lighter colored highly acidic soils. These mounds render much of the forested areas of Lordstown gravelly silt loam very uneven, and tend to accelerated drainage and aeration in the mound, with more or less saturation in the depressions.

In imperfectly drained soils and seepy areas, the differences in this respect are very pronounced and noticeably affect the distribution and growth of grasses, mosses, ferns, and weeds in pastures. Some indication of the influence on the moisture content is apparent in the marked podzolization of some of these mounds. The light-gray or ash-colored subsurface layer is several inches thick with a decidedly bright yellowish-brown development immediately below, which fades into duller shades of gray or brownish gray a foot or two below the surface. In the depressions, several inches of black humus-filled soil changes with depth to the characteristic blue-gray color of a permanently wet soil.

Table 6 gives the mechanical analyses of samples of Volusia silt loam and Mardin gravelly silt loam.

TABLE 6.—*Mechanical analyses of two soils from Otsego County, N. Y.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Volusia silt loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1649132	0–6	0.5	0.3	0.3	1.0	7.1	61.3	29.5
1649133	6–10	.7	.7	.8	2.7	7.6	54.5	33.0
1649134	10–13	1.1	1.2	.7	1.7	7.7	67.9	19.7
1649135	13–30	1.7	2.4	1.3	2.0	5.5	60.0	27.1
1649136	30–38	3.5	3.9	1.6	2.4	5.2	55.0	28.4
Mardin gravelly silt loam:								
1649191	0–3	2.4	2.1	1.3	6.9	12.2	45.1	30.0
1649192	3–6							
1649193	6–15	1.6	2.0	1.3	6.6	12.6	45.6	30.3
1649194	15–25	3.4	4.6	2.6	10.0	17.1	45.0	17.4
1649195	25–33	5.5	5.2	2.2	7.9	14.2	46.9	18.0

The pH determinations in table 7 represent fairly well soil-reaction conditions in this county. These determinations were made by E. H. Bailey, Bureau of Chemistry and Soils, using the hydrogen-electrode method. The following terms apply to the reaction of soils of known pH: Extremely acid, below 4.5; very strongly acid, 4.5 to 5; strongly

acid, 5.1 to 5.5; medium acid, 5.6 to 6; slightly acid, 6.1 to 6.5; neutral, 6.6 to 7.3; mildly alkaline, 7.4 to 8; strongly alkaline, 8.1 to 9; and very strongly alkaline, 9.1 and more.

TABLE 7.—*pH determinations of samples of several soils mapped in Otsego County, N. Y.*

Soil type and sample No.	Depth	pH	Soil type and sample No.	Depth	pH
Wooster gravelly silt loam:	*Inches*		Ontario silt loam:	*Inches*	
164939	0–5	4.7	164994	0–6	5.2
164940	5–25	4.6	164995	6–13	5.5
164941	25–40	4.7	164996	13–20	5.7
164942	40–50	4.6	164997	20–33	6.5
164943	50+	4.7	164998	33–40	6.8
Honeoye silt loam, deep phase: [1]			Otisville gravelly loam:		
163487	0–7	5.9	164900	0–5	4.9
163488	7–18	5.4	164901	5–12	4.6
163489	18–36	6.3	164902	12–25	4.7
163490	36–58	8.2	164903	25–40	4.9
163491	58–65	8.3	164904	40–50	4.7
Honeoye silt loam: [2]					
1643287	0–4	6.5			
1643288	4–7	6.3			
1643289	7–18	6.7			
1643290	18–25	6.8			
1643291	25–40	7.7			

[1] Sample from Wyoming County, N. Y.
[2] Sample from Orleans County, N. Y.

SUMMARY

Otsego County has an area of 1,009 square miles in the south-central part of New York. It is a part of the Allegheny Plateau and is much diversified with respect to surface features and character of the soils. Broad divides and the deep and rather narrow valleys separating them are the two outstanding and contrasting physiographic forms. Both upland and valley everywhere present much variety of topographic detail. No extensive areas are uniform in relief, and no large acreages of land consist of one kind of soil.

The flanks of the divides, wherever steep or broken, are wooded, but the less rugged parts of the uplands and nearly all of the valley lands are comparatively open pastures and well-kept meadows. In comparison with the grassland, the total acreage in crops is patchy and scattered, owing to the fact that on most of the farms the cropping system and general plan of management centers around the production of milk. Milk is the principal cash product, and a very important activity is the collection and transportation of milk for shipment from local points to eastern cities.

This specialized type of agriculture succeeded a well-diversified and self-sufficient type that developed during the early settlement of the State and prevailed until about 50 years ago. Under those conditions, nearly all of the land topographically tillable was occupied, and the population was evenly distributed throughout the county. With increasing competition from the Western States, in the production of grain and livestock, and the increasing demand for milk, this type of farming has developed in this part of the State. In this county, soils, climatic conditions, and geographic location are highly favorable to this branch of agriculture, and of hardly less importance was the

previous experience of the people in handling cattle for the production of butter and cheese.

Although not all the soils are the best of grasslands, the less favorable ones may be used profitably in combination with those soils adapted to the growth of tame grasses, legumes, and other forage crops. The original lay-out of most of the farms included both kinds of land, so that a desirable balance between summer grazing and the winter supply of forage did not require extensive reorganization of fields and farmsteads. Much of the abandonment of farms on some of the high uplands is due in part to their lack of even a small acreage of soils suitable for the production of clovers and silage corn.

On comparatively few of the farms is all the feed for the dairy herds produced, and most of the large tonnage of concentrated feeds annually consumed comes from sources outside. This has increased the productivity of all soils on which the usual crop rotation of corn, oats, and grasses is maintained, and also has benefited to some extent the semipermanent pastures. The large outlay for feeds has resulted in a markedly reduced use of commercial fertilizers, and most farmers use none at all or only a little high-grade superphosphate on field crops. The use of lime is increasing as an amendment that must contribute more largely to the production of clover and alfalfa on acid soils.

The chief field crops, independent of those required for the dairies, are potatoes and buckwheat. Poultry receives much attention on most farms and is the chief enterprise on many of the smaller farms.

Although Otsego County is considered outside the fruit belt, apple trees and a considerable variety of small fruits thrive well on many of the soils. The local demand for fruits is largely supplied from the small acreages of cultivated land.

The soils are grouped in two main divisions—tillable land and pasture land. These are subdivided into a number of subgroups. In addition there is a large acreage of nonagricultural land.

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