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Soil Survey (Reconnaissance)

of

Vermont

By

W. J. LATIMER, in Charge, S. O. PERKINS, F. R. LESH
L. R. SMITH, and K. V. GOODMAN

Bureau of Chemistry and Soils

In cooperation with the
Vermont Agricultural Experiment Station
and
Vermont Commission on Country Life

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SOIL SURVEY (RECONNAISSANCE) OF VERMONT

By W. J. LATIMER, in Charge, S. O. PERKINS, F. R. LESH, L. R. SMITH, and K. V. GOODMAN

STATE SURVEYED

Vermont is the northwestern State of the New England group, with its northern boundary adjoining Canada. It is roughly rectangular in shape, extending 160 miles from north to south, 90 miles from east to west on the northern boundary, and 40 miles along the southern boundary. The Connecticut River forms the entire eastern boundary and Lake Champlain two-thirds of the western boundary. The total land area is 9,124 square miles, or 5,839,360 acres. Montpelier, the capital, is located near the geographical center of the State. In an airline it is approximately 150 miles from Boston, Mass., 280 miles from New York, and 100 miles from Montreal, Canada.

The outstanding physiographic features are a well-defined mountain range, the Green Mountains, extending north and south through the center of the State; a fairly high plateau which occupies a broad belt east of the Green Mountains, extending the full length of the State and covering fully two-thirds of its total area; and a broad low valley lying along the northwestern edge of the State—the Champlain Valley (fig. 1). Other mountains, not so high nor so extensive as the Green Mountains, may be classed as less pronounced physiographic features. These mountains include the Taconic Mountains in the southwestern part of the State, the Essex Mountains in the northeastern part, a number of lower and smaller ranges that parallel the Green Mountains in places, and a number of scattered isolated peaks, such as Ascutney and Hogback Mountains in the southeastern part of the State and Snake and Philo Mountains in the northwestern part. Between the Green Mountains and the Taconic Mountains is a comparatively low and rather narrow limestone valley which reaches its greatest width in the southwestern part of the State. A narrow strip of low hills extends from the southern boundary of the central plateau three-fourths of the distance along the eastern edge. In places, these hills are separated from the plateau by a well-defined escarpment.

The Green Mountains comprise a ridgelike development extending north and south. The ridges stand above the level of the other mountain ranges and well above the general level of the central plateau. Many peaks stand out above the general level of the range. The sides of these mountains are steep, and the crests are narrow. North of Lamoille River, the mountains spread out more than they do to the south, where the formation is more nearly a single range.

The relief of the Taconic Mountains is irregular in pattern. The sides are steep, and the ridges and spurs extend in all directions.

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The Essex Mountains are more rounded or dome shaped. These mountains occur more generally in isolated peaks or short ridges than either of the other ranges, both of which have a tendency to develop hog-backed ridges. The central and southern parts of the

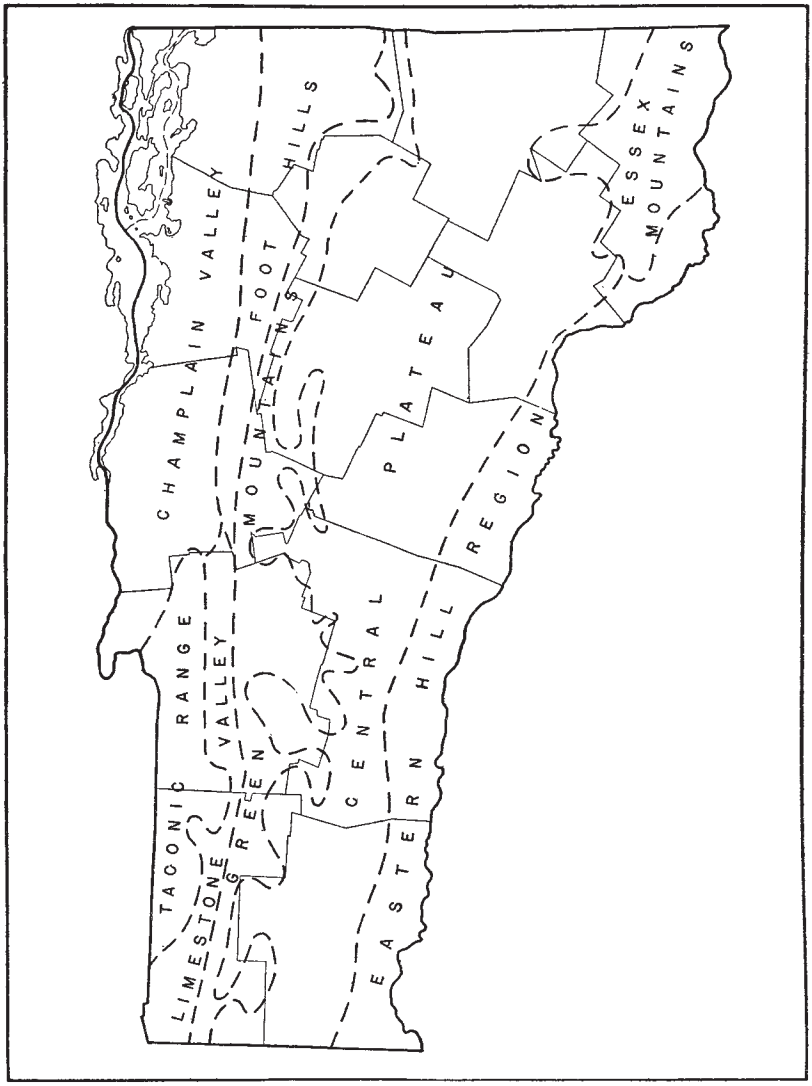

FIGURE 1.—Physiographic divisions of Vermont.

central plateau are severely dissected, with narrow and V-shaped stream valleys and somewhat flattened ridge tops which are remnants of the old plateau. These remnants vary from narrow ridges in the central part to fairly well defined flat ridges in the southern part. In the northern part, mainly north of Winooski River, the stream valleys are shallower and broader, and the remnants of the plateau are much larger and smoother than in the southern part. As the eastern hill region represents a lower plateau that has reached a

more advanced stage of erosion than the central plateau, the hills are smoother and the valley walls less precipitous. As might be expected the stream valleys are wider and have larger flood plains and terraces.

The Champlain Valley, taken in its entirety, has fairly smooth relief. The eastern half is broken by low hills and ridges, most of which have smooth or gently sloping sides. Some of the higher ridges break sharply on one side, whereas the other side is gently sloping. The western half of the valley is fairly level, broken mainly by shallow stream valleys, which in places are V-shaped.

The limestone valley is characterized by low smoothly rounded or rolling hills and ridges, containing many drumlin and drumloid forms. The other smooth-surfaced areas occur mainly along Connecticut River and to less extent along the other streams. They consist of fairly smooth or level terraces separated from the bottom land, which has a fairly large development, by a low but sharp escarpment.

Practically all the land is well drained except the marshland along Lake Champlain, certain muck-filled lakes and stream beds, and a number of stony swamps in the upland, mainly in the northeastern part of the State. Connecticut River drains the eastern two-fifths of the State through a dendritic system of lateral streams that have a general southeast direction. The northwestern two-fifths is drained by a number of streams into Lake Champlain. All but one of these streams—Otter Creek—which drains the southern part of the Champlain Valley, cut through the Green Mountains and drain the north-central part of the State. These streams have developed a decidedly trellislike drainage system. The southwest corner is drained into Hudson River through several small streams.

The highest point in the State, Mount Mansfield, 4,451 feet above sea level, is in the northern part of the Green Mountains. A number of knobs in the same range are a few hundred feet short of this elevation. Several peaks in the Taconic Mountains, in the vicinity of Manchester and Dorset, reach around 3,800 feet. This range slopes in all directions (abruptly to the east, gently north and south, and strongly to the west). The Essex Mountains are lower, and Burke Mountain, the highest peak in this group, is 3,000 feet above sea level. The general elevation of the central plateau ranges from 1,800 to 2,000 feet in the southern part and from 1,200 to 1,500 feet along the Canadian border. The average elevation of the hilltops of the eastern hill section is 1,000 feet in the southern part and 1,200 feet near the north-central part. The elevation of the limestone valley ranges from 1,000 to 1,200 feet in the vicinity of Bennington and from 600 to 750 feet in the vicinity of Rutland. The Champlain Valley, which in reality is the northern extension of the limestone valley, continues this drop in elevation above sea level, about 400 or 500 feet in the section between Middlebury and Burlington and about 150 or 200 feet in the vicinity of Swanton in the northwest corner of the State. The water level of Lake Champlain is 100 feet above sea level.

Elevations along Connecticut River are as follows: At the point where the river leaves the State 200 feet, at White River Junction 350 feet, at Guildhall 840 feet, and at the point where the river enters the State at the Canadian boundary 1,100 feet. Although the crest

of the Green Mountains descends gently to the south, the level of the central plateau and of the limestone valley descends gently to the north. The stream development and slope are opposite to the general trend of the plateau and valley levels. Drainage of by far the greater part of the State moves from the northeast to the south through the Connecticut River system and west by the Missisquoi, Lamoille, and Winooski systems. Drainage of the rest, which is a comparatively small part of the State, is divided between the two drainage systems, the Taconic Mountains acting as a divide, with half the drainage going north through Lake Champlain and the other half west to Hudson River.

Originally all Vermont was covered by forest, and the Green Mountains, even the highest peaks, are still practically covered with trees. At present there are approximately 3,719,000 acres of woodland in the State (*3*).[1] The forest flora is fairly well divided among the physiographic divisions, with some inevitable overlapping. The higher parts of the Green Mountains and other mountains are covered with red spruce, together with other conifers which gradually give way down the mountain sides to a mixed forest of hemlock, white pine, beech, yellow birch, sugar maple, and other deciduous trees. In the northern part of the central plateau there is much red spruce, arborvitae, balsam fir, rock maple (sugar maple), and yellow birch. Much hemlock grows in the rocky gorges and shady moist glens throughout the State, and rhododendron grows in similar portions in the southern part.

The eastern hill section contains much white (canoe) and gray birch; white, black, and red oak; ash; maple; linden; aspen (popple); white pine; and beech. The original forest of the Champlain Valley included much white pine, but this tree is not plentiful now. This section, together with the limestone valley, supports a mixed forest, in which white and red oak, white or canoe birch, beech, ash, white pine, red cedar, basswood, aspen, and elm are the dominant trees.

In swampy areas, white pine, black spruce, tamarack, ash, cedar, red maple, alder, and a variety of swamp willows are the leading trees. Blueberries are widespread in both swampy and high ground outside the limestone valley. Huckleberries grow in dry barren fields and sandy areas in the southern Connecticut Valley and Champlain Valley. Cattails and bulrushes grow in the marshes and other low areas.

Spiraea (*Spiraea tomentosa*), commonly known as hardhack, or steeplebush, invades most of the pastures in all parts of the State, but it is more common on the acid lands. Shrubby cinquefoil (*Potentilla fruticosa*) is common in the southwestern part of the State and is occasionally found in the western part. It is common in pastures in the limestone valley uplands. Sweetfern is common, especially in the southern part of the State.

Sumac, striped maple (in moist, rich, deciduous woodlands), chokecherry, sand cherry, and chokeberry are more or less common throughout the State. The Appalachian cherry and sand-bar willow grow mainly on the sandy lands such as those in the vicinity of Burlington. Ferns of a wide variety grow on moist hillsides in all parts. In pastures and open woods, bracken constitutes a prominent part of the undergrowth. Various species of ground pine

[1] Italic numbers in parentheses refer to Literature Cited, p. 80.

and clubmoss are to be found, especially on the hillsides. Sphagnum grows in the bogs. Mayapple, or mandrake, grows here and there in the open woodlands.

The following weeds are prevalent in pastures or fields, and may be found in various places throughout the State: Chicory, wild mustard, devils-paintbrush, wild carrot, common or running cinquefoil (*Potentilla canadensis*) silver cinquefoil (*P. argentea*), Canada thistle, vipers bugloss or blue devil, queen-of-the-meadow, oxeye daisy, plantain, and dandelion. A variety of berries, as blackberries, dewberries, raspberries, and thimbleberries, abound in all parts.

Grass is probably the most widespread and most common of all the flora of Vermont. Some of the following grasses are to be found in most pastures: Kentucky bluegrass, Canada bluegrass, annual or low spear grass, quack or couch grass (witchgrass), forked beardgrass, broom beardgrass, sweet vernal, sheep fescue, red fescue, bentgrass, poverty grass, and Indian grass. Timothy, redtop, and other grasses are generally sown for mowing, but they also grow wild in all sections, as does quackgrass and yellow foxtail. Dutch, or white, clover is a legume which grows in many pastures and occasionally in woodlands and along roadsides.

During the early part of its history, Vermont was disputed territory—first, between the powerful Indian tribes, the Algonquins of New England and the Iroquois of New York; later, between the French of Canada and the English colonists; and still later, by patent holders for land, from New York and New Hampshire, both claiming the territory. Champlain explored the lake which bears his name in 1609, and the French settled along Lake Champlain from 1666 to 1730. The first English settlement in Vermont was made near Brattleboro in 1724, and English settlements were made by way of the Connecticut River from 1753 to 1761. The French withdrew after the surrender of Canada to England, but a number of French Canadians settled in northern Vermont, at a later date, and a large number of their descendants still remain.

The colonists' dispute over Vermont came about through the rival claims of New York and New Hampshire to issue patents for the land. New York had excellent grounds on which to press her claims, as the territory in question was legally a county of that State, but most of the settlers came from the New England States, and, holding New Hampshire grants, resisted. The dispute was quieted by the Revolutionary War and was ended by the Vermont Declaration of Independence in 1777.

Vermont was admitted as a State of the Union in 1791. It now includes 14 counties, subdivided into 243 civil towns and 8 cities.[2]

According to the census, the 1930 population numbered 359,611, which shows an increase of 2 percent over the 1920 figures and a total gain of 29,000 people during the last 50 years. Of the 1930 population, 99.5 percent is white and 0.5 percent colored. Native-born whites represent 85.5 percent of the total population, and foreign-born whites 14 percent. Most of the people are descendants of native New Englanders, and many people in the northern part of the State are French Canadians, some of whom are recent immigrants. Some Irish, Scotch, Italian, and other Europeans have come in during the last 50 years, but they have not come in large

[2] Town corresponds to township in Middle Western and Southern States.

numbers, as they have in the industrial States south of Vermont. The rural population represents 67 percent of the total, and the density is 26.5 persons a square mile. The most thickly populated areas are in Chittenden, Franklin, Rutland, and Washington Counties adjacent to the industrial towns. The most sparsely settled areas are in Essex County and the rougher sections in the southern part of the State. An estimate places the actual farm population at 50 percent of the total for the State. The farms of southern Vermont are located within 300 miles of one-eighth of the population of the United States.

Montpelier, the capital, with 7,837 inhabitants, is located near the geographical center of the State. Burlington, the largest city, with 24,789 people, is located on Lake Champlain. It is a manufacturing center and distributing point, the seat of the University of Vermont, and a summer resort of some note. Rutland, with 17,315 people, is in the south-central part of the State and is the center of the marble-quarrying industry. Barre, with 11,307 people, is the center of the granite-quarrying industry. St. Johnsbury, St. Albans, Bennington, and Brattleboro are smaller but important cities and villages in their respective counties.

Railway transportation facilities are afforded by two main lines, the Central Vermont and the Rutland, both of which pass through the full length of the State. Branch lines and shorter lines serve as feeders and reach nearly all sections. Ferry lines ply Lake Champlain, and barge cargoes are shipped through the Hudson-Champlain and Richelieu Canals. Traffic is maintained from the Hudson through to the St. Lawrence.

The main State road system is good and rapidly becoming better through surfacing with cement, tar binder, and gravel. Following the disastrous flood of 1927, several thousand modern bridges were built as replacements, materially improving the State road system. Most of the secondary or main county roads are gravel surfaced and are in good shape in the summer, but they are not so good in winter and spring. Most of the third-class roads are not well worked and are consequently poor. Telephone lines reach nearly all parts of the State, except the rougher mountain sections, and even here many timber-processing plants and summer homes are equipped with telephones.

The leading industries of Vermont are quarrying marble, granite, and slate, and the sale of the finished products from the quarries. Lumbering ranks second. The manufacture of woolen goods, paper, scales, organs, and machinery, and the processing of maple sirup and sugar, although important, are minor industries.

CLIMATE

The climate of Vermont is humid or oceanic. The winters are long and cold, accompanied by heavy snowfalls. The summers are short and inclined to be cool, with short warm spells, particularly at the lower elevations. There are, however, wide variations in both temperature and precipitation in the different physiographical sections. Lake Champlain has a strong influence in tempering the atmosphere in the surrounding territory. The annual average temperature for this section is 45° F., and the average for the winter months is 20°. In the hill section southwest of Rutland, away from the

tempering influence of the lake, and at an altitude of only 750 feet, the mean annual temperature is in the neighborhood of 44°.

The rainfall is well distributed throughout the year, which is in contrast with some other sections of the United States where most of the rainfall occurs during the summer. The islands in Lake Champlain have an average annual precipitation of about 30 inches; the rest of the Champlain Valley and northern part of the central plateau, from 30 to 35 inches; the foothills of the Green Mountains, the southwestern valley, the Taconic Mountains, and the south-central part of the central plateau and eastern hill section, from 35 to 40 inches; and the Green Mountains and southern part of the central plateau, from 40 to 50 inches. In fact the entire area along the southern boundary falls within the belt of heaviest precipitation.

The snowfall is heaviest in the northern part of the State. North of a line from the northwest corner, east of Champlain Valley, and north of a line through the Mount Holly basin east to Connecticut River, near White River Junction, the snowfall ranges from 80 to 100 inches, annually. The rest of the State, south and west of this line, except the southwest corner, has from 60 to 80 inches of snow, and the southwest corner has from 50 to 60 inches. The snow cover remains in the Champlain Valley, southwestern valley, and the southern part of the State from 90 to 120 days, and over the rest of the State longer.

The average length of the frost-free season at the Burlington station is 164 days, which is representative for the Champlain Valley. The record at Wells, 142 days, is fairly representative of the southwest valley, and the average of about 121 days for the Northfield, Enosburg Falls, and Woodstock stations is fairly representative of the rest of the State which lies below an elevation of 1,200 feet.

In the Champlain Valley the last killing frost ranges from May 1 to May 11; in the limestone valley, low belts west of the foothills of the Green Mountains, and the eastern hill section, from May 11 to May 21; in the central plateau and foothills of the Green Mountains, from May 21 to June 1; and in the Green Mountains and Essex Mountains the date is later than June 1. The average date of the first killing frost in the Champlain Valley ranges from October 1 to October 11; in the low hills and limestone valley, or southwest valley, and the eastern hill section, from September 21 to October 1; in the central plateau, from September 11 to September 21; at the base of the Green Mountains, from September 1 to September 11; and in the Green Mountains, earlier than September 1 (*12*).

These climatic conditions are favorable to the accumulation of organic matter on the surface of the soil; as the ground remains frozen throughout a large part of the year, there is little leaching, and the summer sun is not hot enough and the warm season not long enough to destroy the organic matter. Under such conditions the soil and climate are favorable to a rather heavy forest growth and to grass. All but the higher areas are well suited to the production of apples. The Champlain Valley is suited to such crops as corn, oats, buckwheat, and alfalfa. Areas of meadow, muck, and peat are so situated that damage from frost would preclude their use for crops even if drainage could be obtained.

Tables 1, 2, 3, and 4 give the more important climatic data for different sections of the State.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Burlington, Chittenden County, Vt.*

[Elevation, 404 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1881)	Total amount for the wettest year (1833)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	24.4	63	−25	1.88	1.89	1.79	13.1
January	18.8	64	−27	1.76	.88	1.26	15.3
February	19.4	55	−28	1.63	1.79	2.53	14.6
Winter	20.9	64	−28	5.27	4.56	5.58	43.0
March	29.1	71	−17	2.04	1.56	1.48	14.4
April	43.3	85	6	2.15	.62	1.28	3.5
May	56.5	92	26	2.85	2.27	9.85	.1
Spring	43.0	92	−17	7.04	4.45	12.61	18.0
June	65.7	94	34	3.38	1.89	4.28	0
July	70.3	100	44	3.50	2.22	7.54	0
August	67.9	98	38	3.37	2.69	7.34	0
Summer	68.0	100	34	10.25	6.80	19.16	0
September	60.3	92	25	3.48	2.34	4.17	0
October	49.2	82	20	2.97	1.54	6.01	.3
November	36.3	70	0	2.66	1.30	1.91	7.7
Fall	48.6	92	0	9.11	5.18	12.09	8.0
Year	45.1	100	−28	31.67	20.99	49.44	69.0

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at Wells, Rutland County, Vt.*

[Elevation, 750 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1894)	Total amount for the wettest year (1897)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	21.3	60	−26	2.65	1.91	3.33	10.3
January	18.3	58	−34	2.56	1.96	3.41	13.7
February	17.1	58	−34	2.67	1.61	1.55	15.0
Winter	18.9	60	−34	7.88	5.48	8.29	39.0
March	28.8	68	−15	3.13	1.54	3.88	12.9
April	41.6	80	8	2.45	1.35	3.19	3.2
May	54.5	90	24	3.25	2.70	5.60	(1)
Spring	41.6	90	−15	8.83	5.59	12.67	16.1
June	62.8	94	29	3.32	3.25	5.26	0
July	68.6	98	36	3.96	2.37	10.07	0
August	65.6	95	37	4.00	2.41	5.74	0
Summer	65.7	98	29	11.28	8.03	21.07	0
September	58.7	90	24	3.83	3.31	2.38	0
October	47.2	80	18	3.12	3.67	1.28	.1
November	33.8	66	−2	2.61	2.62	6.59	5.7
Fall	46.6	90	−2	9.56	9.60	10.25	5.8
Year	43.2	98	−34	37.55	28.70	52.28	60.9

[1] Trace.

TABLE 3.—*Normal monthly, seasonal, and annual temperature and precipitation at Northfield, Washington County, Vt.*

[Elevation, 876 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1899)	Total amount for the wettest year (1888)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	20.4	61	−41	2.49	2.31	2.46	14.6
January	15.2	61	−33	2.35	1.77	4.99	18.6
February	16.4	59	−35	2.34	1.69	2.73	19.4
Winter	17.3	61	−41	7.18	5.77	10.18	52.6
March	26.4	75	−22	2.56	4.03	4.81	17.2
April	40.3	85	−1	2.28	1.20	2.87	5.4
May	52.8	93	18	2.75	1.52	3.51	.5
Spring	39.8	93	−22	7.59	6.75	11.19	23.1
June	61.3	96	28	3.19	1.60	6.17	0
July	65.9	98	34	3.58	3.41	1.30	0
August	63.4	95	31	3.53	.77	3.43	0
Summer	63.5	98	28	10.30	5.78	10.90	0
September	56.1	92	20	3.07	4.19	6.27	0
October	45.5	83	12	2.86	2.49	3.53	.4
November	32.8	70	−14	2.93	2.38	3.82	9.1
Fall	44.8	92	−14	8.86	9.06	13.62	9.5
Year	41.5	98	−41	33.93	27.36	45.89	85.2

TABLE 4.—*Normal monthly, seasonal, and annual temperature and precipitation at Enosburg Falls, Franklin County, Vt.*

[Elevation, 601 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1914)	Total amount for the wettest year (1901)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	20.9	68	−32	2.68	1.43	5.25	19.6
January	15.4	58	−41	2.45	1.78	5.17	22.4
February	15.6	56	−39	2.45	.47	3.65	22.9
Winter	17.3	68	−41	7.58	3.68	14.07	64.9
March	28.3	74	−27	2.72	1.74	5.97	17.9
April	41.9	84	−7	2.64	3.79	2.72	4.8
May	54.0	93	15	3.34	.64	2.88	.1
Spring	41.4	93	−27	8.70	6.17	11.57	22.8
June	63.0	95	29	4.25	3.22	5.35	0
July	67.7	98	35	4.60	3.63	3.84	0
August	64.9	96	32	3.69	4.94	5.74	0
Summer	65.2	98	29	12.54	11.79	14.93	0
September	58.1	92	20	3.82	3.99	2.76	0
October	47.4	86	12	3.62	2.34	3.26	.3
November	34.3	70	−11	3.33	2.48	5.71	11.6
Fall	46.6	92	−11	10.77	8.81	11.73	11.9
Year	42.7	98	−41	39.59	30.45	52.30	99.6

AGRICULTURE

The early agriculture of Vermont, like that of most of the eastern part of the United States, consisted of the production of subsistence crops and the raising of some livestock including cattle, sheep, and hogs. About the year 1800 (*14*), such crops as wheat, barley, rye, corn, oats, beans, peas, hemp, flax, red clover, white clover, timothy, and other grasses were grown rather extensively, and sheep, cattle, horses, and some hogs were kept on most farms. Butter, cheese, beef, and pork were plentiful. Grain was grown for home use, both for human and livestock consumption. Potatoes furnished the cash crop of this period, and sufficient maple sugar for home needs was produced. Tanneries and lumber mills were numerous. Cattle, sheep, lambs, wool, horses, pork, butter, and cheese were sold. Cattle were driven to markets in Boston, New York, and even as far south as Philadelphia. Sheep were kept mainly for wool. This type of farming developed and reached its climax about 1850, when the advent of the railroad changed the established order within the next two decades.

The era of railroad building, which brought Vermont in closer touch with markets in the East, within a few years also brought competition from the West. With the opening of the prairie region and the free range of the West, the number of beef cattle and sheep raised in Vermont rapidly declined. By 1880 dairy breeds of cattle began to replace beef breeds and dual-purpose breeds, and butter became an important article of sale outside of the State (*8*). During the 30 years following 1850 butter production trebled, and the output of cheese shrunk to small proportions, until now cheese making has practically been abandoned. At the same time the dairy animals were being improved. Jerseys began to replace Shorthorns which had displaced the earlier cattle described as "black cattle" in the early chronicles. As Vermont began to ship fluid milk, Holstein-Friesians became popular on the farms devoted wholly to this type of dairying, whereas Jersey remains the leading breed on the farms selling butterfat or cream. Some Guernseys and Ayrshires are used. About 25 years ago Vermont began to ship whole milk to Boston. In 1915 butter production began giving way to fluid-milk production, and this tendency is still increasing. However, very little butter is made on the farms, except for home use. Large numbers of dairy cattle are kept in the Champlain Valley, in the foothills along the northwestern part of the Green Mountains, and in the northern part of the central plateau. The number of cows comprising the average dairy herd ranges from 20 to 30, and a few of the larger herds in the Champlain Valley have more than 100 cows. The dairies located near or convenient to transportation facilities ship whole milk, and those in the less advantageous sections sell cream on a butterfat basis. Vermont ships to Boston, southern New England, and New York 150 carloads of milk daily, which is equivalent to 1,000,000,000 pounds annually. The milk is delivered mainly by truck to milk depots and creameries. Much of the cream separated on the farm is collected by trucks following certain routes. This is a common practice in sections where hog raising is a side line. In other sections the entire output is bought by milk or creamery companies who pay on the basis of butterfat content. By comparing the sales of dairy products in selected towns, the wide variations in practice of disposal of milk

and dairy products is noticeable. From Greensboro, 4,888 gallons of whole milk and 332,095 pounds of butterfat were sold in 1925; from Calais, 10,646 gallons of whole milk and 101,902 pounds of butterfat; from Colchester, 367,726 gallons of whole milk and 126,138 pounds of butterfat; and from Guilford, 142,136 gallons of whole milk and 2,042 pounds of butterfat. The first two towns are in butterfat-producing sections and the last two in sections where whole milk is the principal dairy product sold. Some milk and cream are disposed of locally in Burlington, Rutland, Barre, and other cities and towns. The number of dairy catle has not greatly increased during the last four decades. There has been a marked increase in the amount of whole milk shipped, however, and a corresponding decrease in butter sold. Census reports show milk shipments increased about 33⅓ percent from 1909 to 1929, and butter shipments decreased from 12,000,000 pounds to 1,778,781 pounds during the same period.

Table 5 gives the number of the different kinds of livestock on the farms of Vermont in stated years.

TABLE 5.—*Number of livestock on the farms of Vermont in 1880, 1890, 1900, 1910, 1920, and 1930*

Kind of livestock	1880	1890	1900	1910	1920	1930
Horses	72,215	89,969	85,531	80,781	77,231	52,279
Mules	283	313	331	429	601	524
Cattle	403,105	395,288	501,950	430,314	435,480	472,183
Sheep	439,870	333,947	296,576	118,551	62,756	51,175
Swine	76,384	92,083	95,090	94,821	72,761	29,432
Goats			102	261	124	702
Chickens		789,278		[1] 938,524	799,797	749,203
Turkeys		72,164				28,549

[1] All poultry.

As a whole, there has been a decline in the percentage of land in farms throughout the State during the last 50 years. In 1880, 83.6 percent of the State was reported in farms, with 67.3 percent improved land, and in 1930, only 66.7 percent was in farms, of which 36 percent was classed as improved land, that is, crop land and plowable pasture. This decline is more noticeable in some sections than in others. The actual decline in crop acreage is due to abandonment of the poorer and less accessible lands. There has been a change in some crops and a greater change in the methods of handling these crops. The changes have been brought about mainly by the change from livestock raising to dairying. Table 6 illustrates changes in land use between 1850 and 1920.

TABLE 6.—*Land use in Vermont from 1850 to 1920* (9)

	1850	1860	1870	1880	1890	1900	1910	1920
Farms reporting--number	29,763	31,556	33,827	35,522	32,573	33,104	32,709	29,075
Increase or decrease percent		6	7.2	5	−8.3	1.6	−1.2	−11.1
Land in farms--acres	4,125,822	4,274,414	4,528,804	4,882,588	4,395,646	4,724,440	4,663,577	4,235,811
Increase or decrease, all land percent		3.6	6	7.8	−10	7.5	−1.3	−9.2
Improved land--acres	2,601,409	2,823,157	3,073,257	3,286,461	2,655,943	2,126,624	1,633,965	1,691,595
Increase or decrease, improved land--percent		8.5	8.9	6.9	−19.2	−19.9	−23.2	3.5
Average area per farm:								
All land--acres	138.6	135.5	133.9	137.5	134.9	142.7	142.6	145.7
Improved land--do	87.4	89.5	90.9	92.5	81.5	64.2	50.0	58.2

NOTE.—In 1920 "improved land" was defined to include land in pastures, which had been cleared or tilled, whereas in 1910 the only pasture land included with improved land was that pastured and cropped in rotation.

Table 7 gives the acreage and yield of the principal crops grown in Vermont in 1929.

TABLE 7.—*Acreage and yield of the principal crops in Vermont in 1929*

Crop	Acres	Yield	Crop	Acres	Yield
Corn:		*Bushels*			*Bushels*
Harvested for grain	5,598	259,170	Potatoes	13,874	1,727,684
		Tons	Sweet corn for sale	2,198	----------
Cut for silage	44,566	425,624	Other vegetables for sale	1,312	----------
Cut for fodder	8,572	----------			*Quarts*
Hogged off	831	----------	Strawberries	349	580,599
Hay (all hay)	913,911	1,141,206			
Timothy and/or timothy and clover mixed	680,707	884,258			*Pounds*
			Tobacco	138	233,066
Clover	14,532	25,263			
Alfalfa	6,805	13,675			*Vines*
Other tame grasses	183,665	172,491	Grapes	7,275	67,450
Wild grasses	5,744	4,928			
Small grains	20,692	38,567			*Trees*
Annual legumes	1,716	2,024	Apples	870,883	*Bushels* 975,014
			Cherries	16,718	3,863
Oats:		*Bushels*	Pears	13,910	10,631
Threshed for grain	33,123	1,010,660			
Cut and fed unthreshed	15,780	----------	Maple products:		*Gallons*
Wheat	658	13,248	Sirup	----------	999,390
Barley	3,239	83,149			
Buckwheat	1,281	24,178			*Pounds*
Dry beans	----------	20,457	Sugar	----------	627,325

The following tabulation gives the value of agricultural products, by classes, in Vermont in 1929:

Cereals	$1,161,438
Other grains and seeds	116,044
Hay and forage	14,674,451
Vegetables (including potatoes and sweetpotatoes)	2,884,705
Fruits and nuts	1,649,808
All other field crops	2,231,369
Farm garden vegetables for home use	981,974
Livestock and products:	
Domestic animals	36,135,993
Dairy products	29,182,220
Poultry and eggs	4,689,227
Wool, mohair, and goat hair	100,180
Total	93,807,409

The decrease in the acreage planted to corn for grain since 1910 is offset in some measure by that devoted to corn cut for silage. The hay acreage has not changed perceptibly since 1890, but the potato acreage and the oat acreage have decreased about one-half. The decline in the oat acreage is due mainly to the smaller number of borses used. Acreages of alfalfa and dry beans have increased within the last two decades. It is very evident that there has been a sharp decline in the acreage of cultivated crops. Although the hay acreage is slightly less, the acre yield is slightly higher. The land devoted to mowing is given more attention than formerly.

The number of farms decreased from 33,104 in 1900 to 24,898 in 1930, and the area in farms has decreased 17.5 percent since 1900. The value of all farm property increased up to 1920, but there has been a slight decrease since that time. The total number of cattle has decreased slightly, but the proportion of dairy cattle has increased. There has been a marked decrease in the number of swine,

associated with the shift from the production of butter to that of whole milk for market. Pork production is still an important side line in the sections where butterfat is sold and the skim milk used at home.

The State may be divided into five agricultural sections which owe their differences largely to differences in physiography, climate,

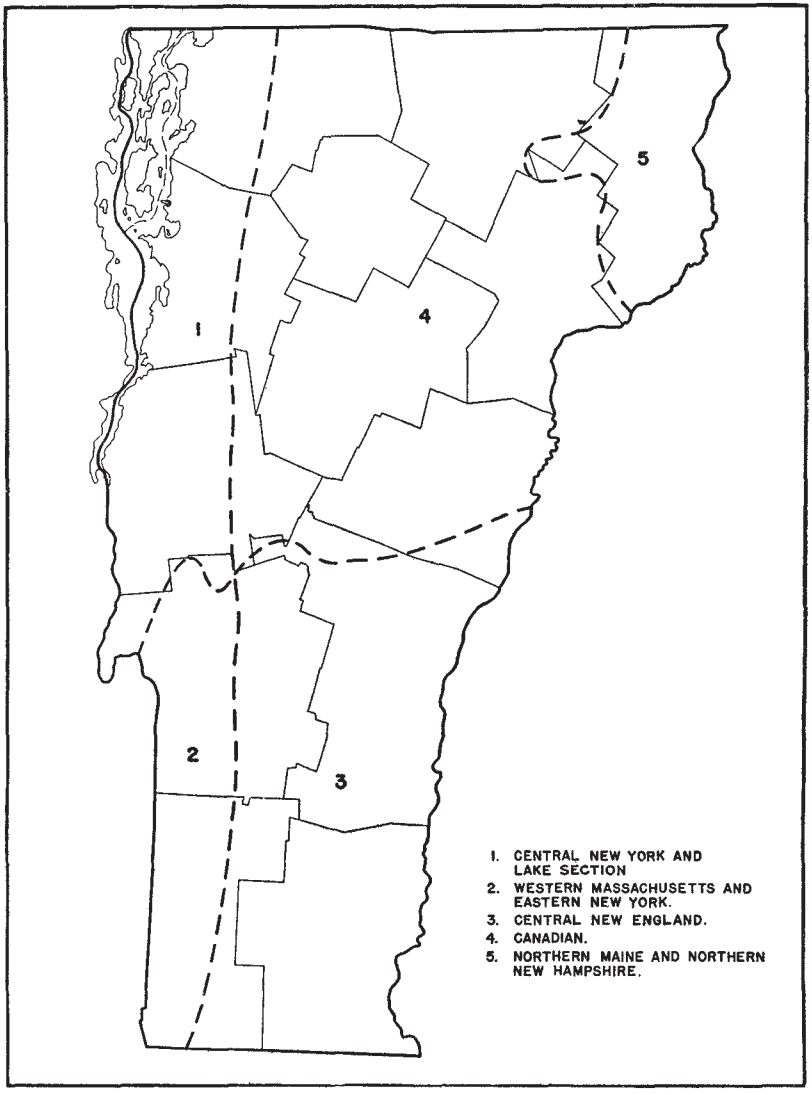

FIGURE 2.—Agricultural sections of Vermont.

and soil (fig. 2). With the exception of the northeastern corner, which differs from other parts, the State is divided into four agricultural sections by a north-and-south line following the Green Mountains, and an east-and-west line extending from Fair Haven

to a point near the mouth of White River. The southeast corner, including Windham and Windsor Counties, resembles central New England; the southwest corner, including Bennington and Rutland Counties is like western Massachusetts and eastern New York; the northwest corner, including Addison, Chittenden, Franklin, and Grand Isle Counties, is like the Mohawk Valley in central New York and the lake region; the north-central part, including Orleans, Lamoille, Washington, Caledonia, and Orange Counties, is essentially Canadian; and the northeast corner, included in Essex County, is like northern New Hampshire and northern Maine.

The Fameuse (Snow) apple was introduced into the Champlain Valley by the French settlers from Canada about 1730. The McIntosh belongs to the same family. The old orchards indicate that a great number of seedling apples were planted at one time. At present, however, most of the home orchards consist of improved varieties, and the large commercial orchards consist entirely of improved varieties—mainly McIntosh and Northern Spy, with some Rhode Island Greening and Northwestern Greening. The same varieties are grown in the home orchards, in addition to Yellow Transparent, Red Astrachan, and a few minor varieties. The commercial orchards are mainly in Grand Isle County, in the western part of Addison County, in the western part of Rutland County, in the southern part of Bennington County, in the eastern part of Windham County, and in the southern part of Windsor County. Most of the commercial apple crop is sold on the tree or shipped promptly to New York. Some apples are sold at roadside stands.

Improved methods for making maple sugar and maple sirup were rather generally used by 1850, with some gradual improvement since that time. The areas of the heaviest production of maple products are in the northern part of the State in Franklin, Orleans, Caledonia, and Lamoille Counties. It is estimated that 36 percent of the maple sugar produced in the United States comes from Vermont.

During the season of 1925, there were 10,511 sugar-maple orchards in the State, with a total of 5,554,000 trees tapped (*9*). According to the 1930 census there was a total production of 627,325 pounds of sugar and 999,390 gallons of sirup in 1929. These products are disposed of, for the most part, outside the State. The sugar-producing farms are equipped with sugar houses, in which to boil down the sap after it is collected in sap buckets from the maple trees. St. Johnsbury is the center for the marketing of maple-sugar products, and some sugar and sirup is disposed of to tourists through roadside stands. The proportion of the crop disposed of as sirup in 1919 was 46 percent and in 1929 was 64 percent, the increase being caused by improved methods of marketing the sirup in steel drums. At present some maple groves are being cut for timber.

The principal varieties of potatoes are Irish Cobbler and Green Mountain. Of the 27 varieties of silage corn planted in 1922, in the Randolph-Royalton area (*14*), eight varieties, Pride of Nishna, Golden Ensilage, Leaming, Gold Dollar, Sanford, Gold Nugget, and Flint, were planted on nearly 50 percent of the silage-corn acreage. The Leaming produced the highest yields—14.8 tons an acre. Flint varieties succeed better in Vermont than dent corn, and only the smaller flint varieties will mature at elevations higher than 1,000

or 1,200 feet above sea level. Golden Bantam is the leading variety of sweet corn. Utilization of the crop land, as reported in the Randolph-Royalton area (*14*), is more or less applicable to the northern part of the central plateau. It is as follows: Corn for grain 2.3 percent, silage corn 11.7 percent, sweet corn 0.7 percent, oats for grain 5.2 percent, grain hay 4.2 percent, timothy and clover hay 69 percent, millet and Sudan grass hay 1.3 percent, potatoes 2.7 percent, garden crops 0.5 percent, and miscellaneous crops 2.4 percent.

The average number of acres required to maintain one cow, in the vicinity of Enosburg (*10*) ranges from 4 to 9 acres of crop land and open-pasture land, with an average of 6 acres. From 2 to 4 acres of crop land and from 2 to 5 acres of open pasture is the general rule.

Although erosion is not a serious problem in Vermont, owing to the prevailing climatic conditions and the generally forested condition of sod cover of nearly all parts of the State, some damage has resulted from floods, such as the flood of 1927. In some places bottom land was damaged to some extent by washing of sand and gravel onto the meadows to a depth ranging from a few inches to several feet. In places these deposits have been removed for road material, but where the deep deposits remain the land is virtually ruined. Fortunately the total area affected was not great, as it occurred mainly where the streams emerge from the mountain areas to the plains. Small areas of bottom land and terraces were cut away by this flood.

On the steep sides of drumlins, especially where the soil texture is heavy and comparatively uniform, there have been some slips or slides, caused by saturation of the heavy material with water. This was induced by heavy grazing or removal of all roots which seemed to hold the soil in place. This condition is not so prevalent where shrubs or brush grow. Small areas of wind-blown sand can best be checked by planting the land to forest. Sheet or gully erosion (*1*), so common to the South, is a negligible factor here. Sheet erosion is noticeable on some of the soils of the Champlain Valley, particularly on soils derived from shale.

The average quantity of fertilizer used on certain crops in the Randolph-Royalton area during 1922 and 1923 (*14*), as shown in table 8, is applicable to the entire upland section of Vermont. Fifteen percent of all crop land is fertilized with an average application of 401 pounds an acre.

TABLE 8.—*Quantity of fertilizer used and percentage of crop fertilized*

Crop	Quantity of fertilizer per acre	Crop fertilized	Crop	Quantity of fertilizer per acre	Crop fertilized
	Pounds	*Percent*		*Pounds*	*Percent*
All corn	286	67.2	Potatoes	1,143	75.1
Oats	277	18.0	Miscellaneous crops	261	23.9
Millet	257	7.0	Hay	298	1.3

The use of barnyard manure in the same area, as shown in table 9, illustrates the use of manure in the dairy sections where the supply is plentiful. Twenty-eight and four-tenths percent of

all crop land is manured with an average application of 14.1 tons an acre.

TABLE 9.—*Quantity of manure used and percentage of crop manured*

Crop	Quantity of manure per acre	Crop manured	Crop	Quantity of manure per acre	Crop manured
	Tons	*Percent*		*Tons*	*Percent*
Silage corn	17.5	96.4	Potatoes	17.0	66.4
Other corn, including sweet corn	17.3	85.2	Garden and miscellaneous crops	11.2	28.3
Oats and oat hay	10.5	21.1	Hay	9.6	13.7
Millet and Sudan grass	16.1	25.6			

The reported sales of fertilizer in 1927 amounted to 15,663 tons, in 1928 to 16,911 tons, and in 1929 to 14,905 tons (*13*). The grades reported in 1929 are given in table 10. The use of higher grades is increasing.

TABLE 10.—*Grades and quantities of fertilizer used in Vermont in 1929*

Fertilizer constituents			Quantity of plant nutrients per 100 pounds	Quantity bought	Total quantity bought	Fertilizer constituents			Quantity of plant nutrients per 100 pounds	Quantity bought	Total quantity bought
Nitrogen	Phosphoric acid	Potash				Nitrogen	Phosphoric acid	Potash			
Percent	*Percent*	*Percent*	*Pounds*	*Tons*	*Percent of total*	*Percent*	*Percent*	*Percent*	*Pounds*	*Tons*	*Percent of total*
0	14	6	20	27	0.2	5-6	6-10	4-5	18	240	1.6
1	9-10	3-4	14	700	4.7	6	18	6	30	43	.3
2	8-10	2-4	14	902	6.0	7-8	8	5-6	21	392	2.6
2	12	4	18	438	2.9	7-8	11-16	8-16	33	159	.9
2	8	10	20	1,188	8.0	8-10	16	14-20	42	391	2.6
3	8	3-4	15	1,252	8.4	10	3.5	8	21.5	90	.6
3	10-12	3-4	17	52	.4	Superphosphate			16	2,935	19.7
3-4	5-10	4-10	18	884	5.9	Nitrates and ammonia salts				407	2.7
4	8-10	4	17	1,404	9.4	Bone and tankage				120	.8
4	8	7	19	499	3.4	Muriate, sulphate, and kainit				82	.6
4	16	20	40	27	.2	Sheep and poultry manures				202	1.4
4	6-10	10	22	1,331	8.9						
4	16	4	24	18	.1						
5	8	7	20	1,024	6.9						

According to the 1930 census report, $681,259 were expended for fertilizer in 1929, on 11,945 farms, an average of $57.03 a farm.

Although Vermont is a grass country, rather large quantities of feed are bought by the dairy farmers. The quantity bought ranges between wide limits in different parts of the State, depending on the acreage suited to cultivated crops, and it also varies on the different farms from season to season. Most of the home-grown grain for dairy cattle is produced on the farms of the Champlain Valley. In 1919, $11,546,995 were expended for feed used on 21,900 farms, an average expenditure of $527.26 a farm.

The amount of feed purchased ranges from a low value per head of livestock in Grand Isle County and counties of the Champlain Valley to a high value in some of the hill and plateau sections. Grand Isle County dairymen are situated in a section having a large proportion of fertile soil on which alfalfa can be grown as well as other feed

crops. Such farmers, as would be expected, need to purchase less feed than others less fortunately situated. The Vermont Agricultural Experiment Station gives the following data as to the cost of feed purchased per animal unit for the various counties (*4*) in 1925: Caledonia, $31.10; Windham, $30.20; Orange, $28.50; Washington, $28; Windsor, $26.10; Orleans, $24.50; Lamoille, $24.50; Essex, $24; Rutland, $23.70; Chittenden, $20.40; Bennington, $20.20; Franklin, $20.10; Addison, $14.10; and Grand Isle, $8.30.

According to the 1930 census, 15,364 farms, or 61.7 percent of the total number, reported an expenditure of $5,495,428 for labor, or an average of $357.68 a farm. Many dairy farmers hire but one extra man, and on a number of farms the work is done entirely by the farmer and his family. On the fruit farms a large number of laborers are hired during the picking season, and in the larger orchards many helpers are hired the year round. On the dairy farms the wages paid range from $30 to $45 a month and are somewhat lower by the year, especially where board is furnished. Day wages range from $2 to $2.50. They are slightly higher near cities and lower in the back country.

The average size of farms in 1930 was 156.5 acres. The average size did not change greatly between 1880 and 1925, but there has been a decided increase since the latter date. This is due to the abandonment of farms and would show a much larger average-sized farm were it not for the division of farms into smaller units in sections where the population is increasing, and even this is offset by the expansion of the dairy farms. The size of farms in the different counties varies rather widely. In Essex County, where the population is sparse and the tendency is toward abandonment, the average size is 200.6 acres, whereas in Grand Isle County the average is 105.3 acres. The average of 175.4 acres in Addison County is probably owing to the large units comprising dairy farms.

According to the 1930 census, there are in Vermont 2,697 farms of less than 20 acres, 2,268 from 20 to 49 acres, 4,129 from 50 to 99 acres, 7,396 from 100 to 174 acres, 4,535 from 175 to 259 acres, 3,195 from 260 to 499 acres, 590 from 500 to 999 acres, and 88 larger than 1,000 acres.

There has been a slight increase in tenancy between 1880 and 1930. In 1920, 86.4 percent of the farms were operated by owners, 11.6 percent by tenants, and 2 percent by managers. In 1930 9.7 percent of the farms were operated by tenants, a decrease from 12.3 percent in 1910. In 1930, of the 2,409 tenant-operated farms, 1,171 were rented for cash and 1,238 on shares. The percentage of land rented varies considerably with the counties. In Chittenden County the percentage is 12.7 percent, in Addison County 13 percent, in Franklin County 16.6 percent, and in Grand Isle County 30.6 percent. It is only 6.6 percent in Caledonia County, 9.3 percent in Essex County, 7.2 in Windham County, and 6.3 percent in Windsor County. There should be a correlation between these low figures and abandoned farms. Although the ratio is 1 cash tenant to 1½ share tenants, in 8 of the 14 counties cash tenants predominate. Tenants pay about 4 or 5 percent interest on the land. The terms of tenure vary between wide limits, considering the high proportion of tenants related to the landowners.

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Over most of the State the farm homes are good and are kept in repair. Only in some of the more remote sections, where the farms are in the course of abandonment, are the buildings dilapidated. As most of the dwellings were built by a former generation, the farmers can use any surplus cash in improvements. The barns and outbuildings are adequate for the type of farming followed. A number of modern dairy barns are located in the sections where dairying is carried on, and most of the dairy farms are equipped with silos. The apple farms have ample packing and storage houses.

Table 11 gives the value of farm property in census years.

TABLE 11.—*Value of farm property in Vermont in 1920, 1925, and 1930*

Year	Land	Buildings	Machinery	Livestock
1920	$82,938,253	$76,178,906	$21,234,130	$41,151,827
1925	63,864,783	73,406,066	18,129,968	25,510,828
1930	63,619,063	82,316,178	20,767,500	36,135,993

The farm equipment differs according to the type of farming practiced—ranging from that used on the better developed dairy farms and fruit farms to that on the small farms where only a few cows are milked, a few other animals and some chickens kept, and a patch of potatoes and a garden planted. According to the 1930 census, there are 2,426 tractors on the farms of the State. A large number of farmers in the Champlain Valley section use tractors, but on most of the farms horses are depended on for hauling. The Morgan horse was developed in Vermont about 1800, and horse raising was relatively important until the advent of the automobile and tractor. In 1906 the United States Government, in cooperation with the Vermont Agricultural Experiment Station, established a stud of Morgans with the view of maintaining the breed at its best. Shortly afterward, the Federal Government established the Morgan Horse Farm at Middlebury, and this institution is now carrying on the work. The farm horses are draft, semidraft, and Standardbred types that are well suited to the prevailing farm practices. A large number of farms have automobiles and depend on trucks for hauling, even where horses are used for the farm work. Nearly every farm has a mowing machine and hayrake, two-horse turning plows, and an assortment of plows and cultivators common to this section. The better farms of the Champlain Valley have reapers and binders, side-delivery hayrakes, hay tedders, hay loaders, manure spreaders, grain and fertilizer drills, disks and sulky turning plows, gang plows, disk harrows, disk or corrugated rollers and cylindrical soil packers, two-horse sulky plows, corn planters, and cultivators. The cultivators are shovel, sweep, disk, and spike-tooth. Many farms have spike-tooth, spring, and cutaway harrows, and many are equipped with weeders. The orchard farms have spray, pump, and tank equipment.

The cattle are mainly of dairy breeds, with only a few cattle kept for beef. Jerseys and Holstein-Friesians, and grades of these animals, are most common. The number of sheep is small compared with the number in former years. Merino sheep introduced from Spain formed the nucleus of the sheep breeds of the early days, when sheep were kept for wool. During recent years, owing to market

demands, the sheep are sold for lamb and mutton, and dual-purpose or mutton breeds predominate, mainly Shropshires, with a few Southdowns, Dorsets, and Hampshires, and a mixture of these breeds. The purebred hogs are mainly Chester Whites, with a few Poland Chinas, Duroc-Jerseys, and Berkshires. The chickens are mainly Rhode Island Reds, White Leghorns, Barred Plymouth Rocks, and White Wyandottes.

The value of land in Vermont has not decreased since 1920 to the extent that it has in other sections of the United States. The average assessed value of land and buildings in 1930 was $37.46 an acre and in 1920 was $37.56. The average price of land (without buildings) in 1910 was $12.52 an acre; in 1920, $19.58; and in 1930, $19.13. There was a decrease of nearly 8 percent in the amount of land in farms between 1920 and 1930 and a little more than 9 percent between 1910 and 1920.

Land values vary considerably, according to the physical features of soil and relief, and according to the location with respect to markets. The relative proportion of the various kinds of land is important in determining the potential productivity (and lease value) of the farm unit. For example, stony pasture land in combination with cultivable land can be worked into a productive, valuable farm unit, whereas such stony land, isolated from plowable acres, is much less valuable. Near the cities and towns, some land sells at a much higher price, partly due to its possibility for urban development. Some abandoned farms may be purchased at an exceedingly low figure.

Table 12 gives the average acre value of farm land and buildings and of farm land alone by counties, according to the 1920 and 1930 censuses, also the percentage of the different counties in farms in 1930.

TABLE 12.—*Average acre value of farm land and buildings and percentage of different counties of Vermont in farms, 1920 and 1930*

Section and county	1920		1930		
	Land and buildings	Land alone	Land and buildings	Land alone	Land in farms
					Percent
Champlain Valley:					
Addison	$41.60	$18.74	$45.10	$22.76	73.3
Chittenden	53.11	23.29	56.02	31.30	79.9
Franklin	47.22	22.38	54.92	31.85	86.5
Grand Isle	88.32	43.22	82.69	45.31	86.0
Southwest valley:					
Rutland	36.87	15.40	32.00	15.06	65.6
Bennington	49.11	19.59	36.77	30.34	38.3
North-central plateau:					
Caledonia	33.91	15.10	36.39	18.22	76.1
Orleans	37.96	16.53	42.53	23.96	81.7
Lamoille	29.97	13.43	35.32	18.90	71.7
Washington	35.42	14.84	37.03	18.15	66.0
Orange	25.71	10.98	25.69	12.84	81.2
South-central plateau and eastern hills:					
Windsor	31.47	12.21	27.54	13.29	66.0
Windham	28.70	12.79	26.04	13.66	55.4
Mountain section:					
Essex	25.82	11.79	24.36	12.80	28.1

Most of the hay and cereals are fed on the farm where produced, to work animals and dairy cattle. Silage and other forage crops are fed to the dairy cattle. Some grain, mainly buckwheat, is used for

feeding poultry. The pasture grasses are consumed largely by dairy animals. Potatoes and vegetables are grown for home use and for sale, and beans are grown for market.

SOILS AND CROPS

Economic conditions are partly responsible for the development of dairying, following an era of cattle, sheep, and horse raising, but the fact that Vermont has always been a livestock country is due in a great measure to the large area of good grassland. Although the land is not naturally so highly suited to the exclusive growth of grass as the Plains or prairie regions of the West, it is equivalent to the best grassland in the East.

The shift of farming from the rougher hill land and less productive soils to the land capable of producing not only grass but other crops necessary to the feeding of dairy cattle has been accelerated by the shortening of the distance for transporting the leading farm product—fluid milk. Transportation, although important, cannot be considered the only reason for the shift as there are large areas of abandoned land and undeveloped areas within easy reach of transportation. There are also sections being farmed, where farming is not particularly successful, owing mainly to poor land.

From the point of view of present agricultural development the State may be divided into seven sections (fig. 3) which in general are physiographical. Owing to the small scale of the map each section includes a group or several groups of soils which dominate the agriculture of the physiographic division. The group is dominated by the soil having the group name. The grade to which a group is assigned is, however, governed by the proportion of other soils included. For example, Worthington loam segregated would rank higher than the Worthington group, because the Worthington group includes, besides Worthington loam, other members of the Worthington series, some Greensboro soils, and some Calais soils. These soils are of slightly lower grade, which has the effect of lowering the grade of the entire group. The groups as shown on this map may contain soils listed under other groups. These, however, are not dominant, although some of them may be fairly extensive. The following tabulation sets forth in greater detail the agricultural classification of the soils of Vermont:

Agricultural classification of soils in Vermont

Class 1. Smooth, well-drained, highly productive land suitable for all crops grown in State. Occupies approximately 10 percent of total area.

A. Addison group: Smooth to undulating land containing no stone, derived from limy lacustrine material.
   (*a*) Major soil types: Addison clay loam; Addison loam.
   (*b*) Minor soil types: Addison clay loam, shallow phase; Addison loam, shallow phase; Vergennes clay loam; Suffield silt loam; Sheldon fine sandy loam.

B. Pittsfield group (less stony areas): Gently undulating to rolling land containing some stone. Parent material rather high in lime.
   (*a*) Major soil types: Pittsfield loam; Madrid loam; Cossayuna loam; Stockbridge loam.
   (*b*) Minor soil types: Pittsfield loam, stony phase: Madrid loam, stony phase; Cossayuna loam, stony phase; Stockbridge loam, stony phase.

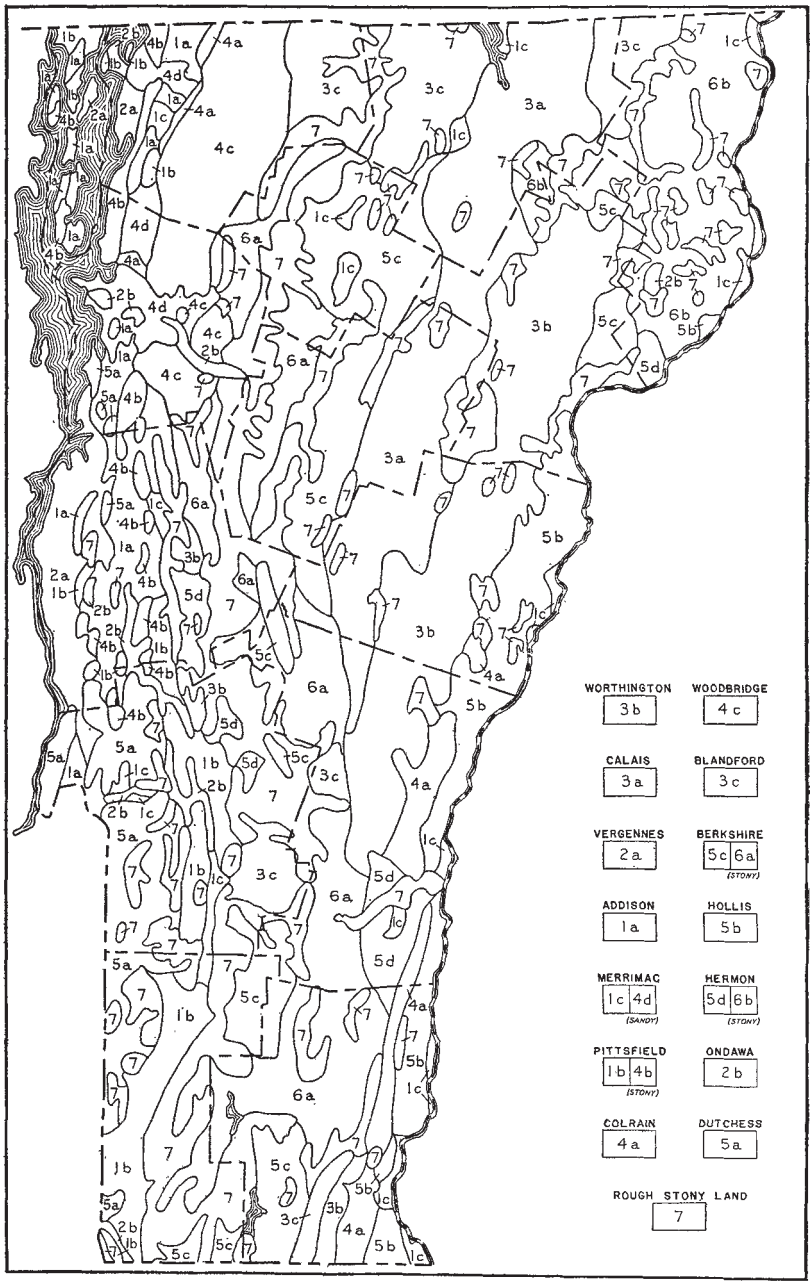

FIGURE 3.—Land classes of Vermont.

C. Merrimac group (medium textured): Light-textured soils, containing no stone, developed from acid materials. Not so productive as 1–A or 1–B, but otherwise desirable for farming.
(*a*) Major soil types: Merrimac fine sandy loam; Copake fine sandy loam; Colton fine sandy loam; Agawam fine sandy loam; St. Albans silt loam.
(*b*) Minor soil types: Danby gravelly fine sandy loam; Hinckley gravelly sandy loam; Schodack gravelly fine sandy loam.

Class 2. Highly productive land, imperfect drainage, subject to overflows. Smooth, contains no stone. Potentially the most productive land in State, but has inhibiting characteristics debarring it from first class. Occupies approximately 5 percent of total area.
A. Vergennes group: Smooth to rather flat, heavy textured, difficult to till, as land lacks best drainage conditions.
(*a*) Major soil type: Vergennes clay loam.
(*b*) Minor soil types: Addison clay loam; Livingston clay loam.
B. Ondawa group: Bottom land subject to overflow, which, although productive, is limited in crop range.
(*a*) Major soil types: Ondawa fine sandy loam; Genesee silt loam; Hadley very fine sandy loam.
(*b*) Minor soil types: Ondawa fine sandy loam, imperfectly drained phase; Ondawa silt loam, imperfectly drained phase; Hadley very fine sandy loam, low phase; Saco silt loam; alluvial soils, undifferentiated; muck; peat.

Class 3. Medium productivity but limited in crop range. Smooth to rolling upland containing some stone but located at elevations limiting crop use. Good grassland but not suited to fruit. Occupies approximately 20 percent of total area.
A. Calais group: Smooth to undulating land containing little stone.
(*a*) Major soil types: Calais loam; Greensboro loam; Greensboro loam, stony phase.
(*b*) Minor soil types: Worthington loam; Worthington loam, stony phase.
B. Worthington group: Developed from material containing some limestone.
(*a*) Major soil types: Worthington loam; Worthington loam, stony phase; Greensboro loam; Greensboro loam, stony phase.
(*b*) Minor soil types: Calais loam; Calais loam, stony phase; Worthington fine sandy loam; Worthington fine sandy loam, stony phase; Greensboro fine sandy loam; Greensboro fine sandy loam, stony phase.
C. Blandford group: Smooth to gently undulating. Developed from material containing no limestone.
(*a*) Major soil type: Blandford loam.
(*b*) Minor soil types: Blandford loam, stony phase; Berkshire loam; Berkshire stony loam; Woodbridge loam; Woodbridge loam, stony phase.

Class 4. Medium productivity. Undulating to steeply rolling land containing considerable stone. Located at elevations allowing a wide range of crops including fruit. Occupies approximately 15 percent of total area.
A. Colrain group: Derived from material containing some limestone. Good grassland, located at lower elevations, well suited to fruit.
(*a*) Major soil types: Colrain fine sandy loam; Colrain fine sandy loam, stony phase.
(*b*) Minor soil types: Colrain loam; Colrain loam, stony phase; Shelburne loam; Shelburne loam, stony phase.
B. Pittsfield group (stony areas): Soils rather high in lime, but contain too much stone for profitable cultivation. Excellent grassland.
(*a*) Major soil types: Farmington stony loam; Pittsfield loam, stony phase.
(*b*) Minor soil type: Madrid loam, stony phase.
C. Woodbridge group: Smooth to strongly rolling land containing some stone. Compact substratum derived from acid material.
(*a*) Major soil types: Woodbridge loam; Woodbridge loam, stony phase.
(*b*) Minor soil type: Berkshire loam, shallow phase

D. Merrimac group (light textured): Smooth sand plains and kames. Low productivity. Easily tilled and otherwise desirable for home sites.
(*a*) Major soil types: Adams loamy fine sand; Colton loamy coarse sand; Merrimac loamy sand.
(*b*) Minor soil types: Hinckley gravelly sandy loam, light-textured phase; Danby loamy sand.

Class 5. Smooth to strongly rolling land containing varying quantities of stone. Low productivity. Crop range depending on elevation. Soils derived from acid materials. Occupies approximately 15 percent of total area.
A. Dutchess group: Smoothly rolling, comparatively shallow soils containing little stone. Suited to small grains and fruit.
(*a*) Major soil types: Nassau shale loam; Dutchess loam; Dutchess stony loam.
(*b*) Minor soil types: Nassau slate loam; Nassau stony loam.
B. Hollis group: Smooth to strongly rolling land containing more stone than 5–A. Occurs at elevations allowing fruit culture.
(*a*) Major soil types: Hollis fine sandy loam; Hollis stony fine sandy loam.
(*b*) Minor soil types: Charlton loam; Charlton loam, stony phase.
C. Berkshire group: Smooth to strongly rolling land containing considerably more stone than 5–A or 5–B. Occurs at elevations limiting its use to narrow range of crops. Fair grassland.
(*a*) Major soil types: Berkshire fine sandy loam; Berkshire loam; Berkshire stony loam; Becket loam; Becket stony loam.
(*b*) Minor soil types: Blandford loam; Blandford loam, stony phase; Woodbridge loam; Woodbridge loam, stony phase; Becket fine sandy loam.
D. Hermon group: Smooth to strongly rolling land containing more stone than 5–C and occurring mainly at elevations similar to 5–C and limited to same range of crops. Fair grassland. Stoniness interferes to some extent with use of machinery.
(*a*) Major soil type: Hermon stony fine sandy loam.
(*b*) Minor soil type: Gloucester stony fine sandy loam.

Class 6. Strongly rolling land of low productivity, containing much stone. Limited in crop use, but can be used for pasture and is well suited to forest. Occupies approximately 20 percent of total area.
A. Berkshire group (stony areas): Soils derived from schist; outcrops of ledges numerous.
(*a*) Major soil type: Berkshire stony loam.
(*b*) Minor soil types: Becket fine sandy loam; Berkshire loam; Becket loam; Becket stony loam; Peru stony loam.
B. Hermon group (stony areas): Soils derived from granites. Contain much bouldery rock material.
(*a*) Major soil type: Hermon stony fine sandy loam.
(*b*) Minor soil type: Whitman stony loam.

Class 7. Steep stony land having little or no agricultural value. Can be used to limited extent for pasture but is best suited to forest. Occupies approximately 15 percent of total area.
A. Rough stony land group:
(*a*) Major soil type: Rough stony land.
(*b*) Minor soil types: Becket stony loam; Berkshire stony loam; rough stony land, mountain phase.

The highest agricultural development is mainly in two belts—one west of the Green Mountains, occupying the Champlain Valley; and the other east of the Green Mountains in the northern part of the central plateau. Outside of these two belts, the agriculture is sparsely distributed over the rest of the State. There are, of course, spots of highly developed farming in other sections, but they are small as compared with the surrounding territory. The third division is represented by the hills and valleys, which form a broad belt on each side of the northern extension of the Green Mountains, covering about 15 percent of the total area of the State. The fourth and smallest division is the area in the southwestern valley and the Ta-

conic Mountains and adjacent hills, which occupies about 8 percent of the State. The fifth, the eastern hill section, including the southern two-thirds of the Connecticut Valley, contains slightly more than 10 percent. The sixth, the southern or high part of the central plateau, represents about 12 percent, and the seventh is the mountain section which, in addition to the Green Mountains, includes the mountains of Essex County. This last division covers about 20 percent of the total area.

The Champlain Valley, which includes the islands of Lake Champlain and the low smooth hills west of the foothills of the Green Mountains, north from Winooski River, is the most important of the seven agricultural sections. This section, although covering only 15 percent of the State, contains 25 percent of the crop land and 30 percent of the plowable pasture, a factor related to the distribution of the soils. It contains 40 percent of the silage-corn acreage, 50 percent of the oat acreage, 35 percent of the timothy and clover (mixed) acreage, 25 percent of the potato acreage, 45 percent of the buckwheat acreage, 40 percent of the clover acreage, 60 percent of the alfalfa acreage, 65 percent of the barley acreage, 70 percent of the wheat acreage, and 75 percent of the bean acreage. It also supports one-third of the milk cows, and contains one-third of the apple trees.

The northern part of the central plateau extends from the Canadian line in a broad wedge-shaped area about 20 miles across the base and with the point reaching as far south as the town of Reading. This division, occupying about 20 percent of the State, contains 25 percent of the crop area and 35 percent of the pasture land. It includes 20 percent of the acreage of silage corn, 25 percent of the oat acreage, 35 percent of the timothy and clover (mixed) acreage, 20 percent of the other hay acreage, 30 percent of the potato acreage, and 20 percent of the barley acreage. It supports 35 percent of the dairy cows.

It may be noted that these two divisions, representing 35 percent of the total area, include 50 percent of the crop land and 65 percent of the pasture. The value of the crops produced is 50 percent of the total crop value. This area produces 55 percent of all dairy products. It also represents 50 percent of the farm wealth of the State. There are certain areas having highly developed farms, such as the southwestern valley, the orchard districts of the Taconic Mountains and hill section, the eastern hill section, the bottom lands and terraces of Connecticut River, and the Mount Holly Basin.

The third division, comprising the low hills and valleys flanking the northern part of the Green Mountains on both sides, covers about 15 percent of the State. The crop area is approximately 15 percent of the total crop land, and the proportion of pasture is comparatively high—10 percent of the open pasture and 15 percent of the woodland pasture. The agricultural development of this division is about normal for the State.

The section included in the southwest valley and the Taconic Mountains occupies only about 8 percent of the State and includes about 10 percent of the crop land. Although it contains a comparatively small proportion of the farms, the production ranges high. It has 16 percent of the silage-corn acreage, 12 percent of the clover acreage, 20 percent of the alfalfa acreage, 20 percent of the potato

acreage, and 32 percent of the buckwheat acreage. It also contains 17 percent of the apple trees.

The eastern hill section occupies about 10 percent of the State and includes 12 percent of the crop land, 10 percent of the open pasture, and 15 percent of the woodland pasture. In it are about 30 percent of the apple trees.

The south-central plateau embraces about 12 percent of the State but has only 8 percent of the crop land, 10 percent of the total pasture, 7 percent of the open pasture, and only 3 percent of the plowable pasture.

The agriculture of the mountain section is the least developed. This section covers about 20 percent of the State and includes only 5 percent of the crop land.

The soil group embracing the Addison and Vergennes soils dominates the agriculture of the Champlain Valley. These soils are similar in that they are calcareous at comparatively slight depths, ranging from 15 to 40 inches. They are also alike in that they have smooth surface relief and carry little or no stone. Of the two series, the Addison is the most extensive. These soils are composed mainly of clay loam with a heavy calcareous substratum at a depth of 2½ or 3 feet. The surface relief is gently rolling or undulating, which provides better drainage and aeration than is common for the soils on the clay deposits.

The Vergennes soil has the same texture as the Addison soils, but the land is more level, and underdrainage is not quite so good. In the Vergennes soil, the calcareous material lies within a depth ranging from 15 to 24 inches below the surface. These features render the soils of both series suitable for the production of grass, small grains, and legumes, especially clover and alfalfa. As these soils are difficult to till, more land is in pasture and mowing than would otherwise be the case. Grass has a tendency to remain longer in the rotations than on most of the upland soils, even where the land contains considerable stones. These soils are used for wheat, oats, barley, buckwheat, beans, and silage corn.

The Vergennes soil is not used so extensively for crop production, except grass, as the Addison soils, as it remains cold late in the spring and during wet seasons is extremely difficult to cultivate. Crop yields are somewhat lower, except of alfalfa, in the better drained locations. The lower crop production of the Vergennes soil is not due to lack of inherent productivity, but rather to poor management which, in turn, is due to the difficulty of handling the land. Vergennes clay loam is the only member of the Vergennes series mapped, but it includes areas of Vergennes soils of different textures.

The shallow phases of the Addison soils are calcareous at slight depths, ranging from 20 to 36 inches. They occur on smooth or gently undulating ridges. The texture is inclined toward a silt loam, and the soil mass contains many fragments of shales which, together with the relief, afford good drainage. The land is easy to cultivate, and the freedom from stone facilitates cultivation. This land is used for the same crops as the rest of the Addison and the Vergennes soils, but to a greater extent for cultivated crops.

The Addison soils occupy the eastern side of the Champlain Valley, the main body occurring south of Winooski River. The Vergennes

soils occur in a belt about 5 miles wide to the west of the Addison soils, lying between the Addison soils and Lake Champlain, the largest areas being in Addison County. The shallow phases of the Addison soils are in the northwestern corner of the Champlain Valley, occupying most of the islands of Lake Champlain and the low smooth country along the northern end of the lake in Franklin County, and in the vicinity of Fair Haven in Rutland County.

In the northern part of the central plateau, soils of the Calais, Greensboro, and Worthington series dominate. These soils occur on smooth ridge tops and smoothly sloping hillsides that afford uniformly good drainage. About half the area of this section is occupied by the stony types of these soils which, in general, are stonier than the soils of the Champlain Valley or the soils of the southwestern valley and the Taconic Mountains. These soils show the influence of limestone.

The Calais soils, derived from impure limestone and schist, contain less lime or carbonates than the soils of the Champlain Valley and the southwestern valley, but they are more highly impregnated with lime than the Worthington or Shelburne soils, both of which contain much schist material besides the limestone. These two soils occur mainly on the southeastern side of the belt where the soils of this group are developed, whereas the Calais soils occur along the western side. The Calais soils are darker and contain less stone than the Greensboro soils. They are invariably of loam texture and are more or less compact in the substratum. Owing to their elevation, moisture-holding capacity, and composition, they are good grass soils, and the smooth surface relief and comparatively stone-free condition favor their use for mowing. They are used for the general-farm crops, but to less extent for cultivated crops than the soils of the Champlain Valley. The Calais soils lie too high for the best success with corn—a climatic condition that also applies to all the upland soils of the central plateau. The Calais, Worthington, and Greensboro soils are not alkaline enough for the production of alfalfa without the addition of lime, but clover succeeds. The Worthington soils are developed much farther south than the Calais which terminate about White River near the southern end of the town of Randolph. The main body of these soils extends in broken areas from Lake Willoughby to the town of Reading. A detached area extends from the town of Marlboro south to the Massachusetts line where it joins a large area of the same soil in the eastern part of the Berkshire Hills section or western Massachusetts plateau section.

The part of the north-central plateau dominated by the Blandford and Woodbridge soils lies on both sides of the northern end of the Green Mountains. It does not support quite so prosperous a type of agriculture as the Calais-Worthington soils section, owing mainly to the fact that the soils are derived from noncalcareous material. The Blandford soils, which are invariably loams in texture, occupy the smooth parts of the plateau, and the Woodbridge soils lie along the lower slopes and at the bases of the hills. The intervening hillsides are more broken and are occupied by the Berkshire soils. Although the materials from which these soils are derived carry slightly more stone than the Calais or Worthington soils

they are not nearly so stony as the Berkshire and Becket soils of the southern part of the central plateau.

As Blandford loam is a young soil which has not been leached of plant nutrients, it is productive, especially for grass. The stony areas are comparatively small, and most of this soil can be plowed without difficulty.

Woodbridge loam is marked by an intense compaction in the substratum. Water moves along the top of this stratum, especially if there is higher ground to furnish seepage, as there is in most places. This soil also is comparatively free from stone and is well suited to mowing and pasture. It supports extensive sugar maple groves.

The Berkshire soils are variable in texture, with both loam and fine sandy loam occurring. They are more stony than the soils previously described and contain more shallow spots. The surface soil is brown in cultivated fields, and the yellowish-brown color of the subsoil extends to a depth of 20 or 24 inches. The substratum is variable, in few places being as compact as the substratum of the Woodbridge soils and in many places being only firm in place. The surface relief ranges from broken to hilly. This land, although a rather large acreage is in mowing and other crops, is used more extensively for pasture than for any cultivated crop, and large areas are in forest. The Berkshire soils extend south along the central plateau and include most of the soils in the southern part of the plateau.

The stony soils of this group are included mainly in the Becket series. These soils, unlike those in the northern part of the plateau, which are derived from schist, come from gneiss. As this rock is more resistant to glacial action, quantities of boulders are left on the soil. This section lies at a comparatively high altitude, ranging from about 1,500 to 1,800 feet above sea level. Most of the stony areas are forested. The smooth and less stony ground is in mowing and pasture, with a small acreage in other crops. Much of the pasture land that at one time was used for cattle and sheep has been abandoned and allowed to grow up to brush. This part of the State closely resembles the Berkshire highlands of western Massachusetts. It is in this section that most of the abandoned farms occur. The rugged relief, the prevalence of stone, and the isolated position of the land are all responsible for farm abandonment.

West of the southern extension of the Green Mountains lie the southwest valley and the Taconic Mountains and foothills. In the valley the soils of the Pittsfield series are dominant, and the Stockbridge and Madrid soils, though less extensive, are also important. The soils of this group comprise good farm land and, were they more extensive, would be the most important soils in Vermont. They are derived from limestone till, the various members differing mainly in the quantity of adulterants composed of noncalcareous materials. The soils have excellent structure and are very productive, especially of lime-loving crops. The agriculture consists of growing grass (timothy and clover) for hay, oats, buckwheat, and apples. As the soils contain little stone, cultivation is easy.

Of the soils in this group, Pittsfield loam has the highest content of lime and is highly calcareous at a depth ranging from 15 to 20

inches. The Madrid soils contain some quartzite and are less productive than the Pittsfield. Although there are few abandoned farms on these soils, they include much idle land. The stony areas of this belt are composed mainly of Farmington stony loam which is a shallow soil entirely unfit for cultivated crops. Being derived from limestone it is well suited to pasture. The Stockbridge soils contain much slate and schist. They are derived from deep till and are rather compact in the substratum. In places the surface soil is dark, and the substratum rather friable. These are good agricultural soils of about the same productive power as the Pittsfield soils, but they occupy a much smaller area.

West from the southwestern limestone valleys and south from the Champlain Valley lie the Taconic Mountains, on which the Dutchess, Cossayuna, and Nassau soils are developed. These soils are derived from noncalcareous shales that have been thinly glaciated. Most of the soils are shallow and filled with small slate fragments. The surface relief is broken and hilly. The steeper areas are used for pasture and the smoother slopes for mowing (timothy, redtop, and some clover), apple orchards, oats, and buckwheat. Yields of the general-farm crops are low, but apple production is good.

The eastern hill section is occupied mainly by soils of two series—the Colrain and Hollis. These are hilly and comparatively thin soils. The Colrain soils are derived from schist and impure limestone. They are brown fine sandy loams and carry a noticeable quantity of stone. They are used for pasture, for mowing (timothy and clover), to a limited extent for other crops, and for apple orchards. The limestone content enables them to maintain a better agriculture than the other soils of this section. These soils are the same as those in the apple-orchard belt of Franklin County, Mass. The Hollis soils are derived from schist, and a rather large proportion of them is very shallow and stony, but the loam is deeper and contains very little stone. These soils are used to a limited extent for crops and orcharding, and they are only fairly productive. Much of the land is in forest or is used for pasture.

The Shelburne soils occupy the rather small areas of deep till, or drumlins. Owing to the rather compact character of the substratum, they have an excellent moisture-holding capacity and are highly suited to grass and the staple farm crops. They are well suited to orcharding, as the position of most areas is low and protected.

The Charlton soils occur in small areas in the southeastern part of the State. These are dark-brown soils derived from schist and argillite. They are rather heavy and fairly deep and, although noncalcareous, are productive.

The soils of the Hermon series are developed in Essex County, in small scattered areas over the eastern part of the State, and in a well-defined belt along the western base of the Green Mountains. The soils, in general, are stony, as they are derived from granite. Forest covers most of the land, and the cleared areas are used mainly for pasture. Small areas of Gloucester soils lie southwest of Ascutney Mountain. They are browner soils than the Hermon and, as they occur at lower elevations, are somewhat better adapted to crop production, although they contain much stone.

The soils on the terraces scattered over the entire State along the larger streams are the leaven which raises the average productiveness of some sections that otherwise would have a very low agricultural rating. These soils are derived from many different materials, and all have gravelly or sandy substrata which furnish excellent drainage. They are free from stone and have level surface relief. The excellent texture provides a good medium in which to grow crops if fertilizers are used. Most of the potatoes produced in the State are grown on these soils.

The Merrimac soils are the outstanding soils of this group, and the fine sandy loam texture predominates. The true Merrimac soils are developed on the terraces in the southeastern part of the State and are derived from granite, gneiss, and schist. These soils are also the leading soils on the terraces in Massachusetts, and on them is grown a large proportion of the tobacco produced in the Connecticut Valley and the market crops grown in Massachusetts. In Vermont the soils of this group support a substantial agriculture. They are highly adapted to such crops as potatoes, tobacco, and vegetables but are not particularly well suited to grass.

The Colton soils are derived from the same materials as the Merrimac, but they occupy higher elevations, where the surface soil has developed a gray layer underneath the forest duff. They occur mainly in the northeastern part of the State and are adapted to the same crops as the Merrimac soils, with the exception of tobacco. The Agawam soils occur on the terraces of Connecticut River. They are highly productive when supplied with fertilizer, and their structure surpasses that of any other soil in this section. The Copake soils are in the southwestern part of the State. They are derived from a mixture of limestone and slate and have calcareous substrata below a depth of 2½ feet. These soils are adapted to the same crops as the Merrimac and, in addition, to clover and alfalfa. The Adams soils are derived from quartz and a small admixture of other materials but are underlain by clay materials at various depths below 5 feet. They reach their greatest development on the sand plains of Chittenden County. They are sandier and less productive than the other soils of this group.

The bottom land widely distributed over the State is predominantly composed of soils of the Ondawa group, which are mainly fine sandy loams. They are only fairly productive. The other bottom-land soils, the Hadley and Genesee, although not so extensive, are agriculturally more important. The soils subject to overflow along Connecticut River belong to the Hadley series. These are darker and decidedly more productive soils which are used for corn, hay, and vegetables. The Genesee soils are similar to the Ondawa, but they are derived mainly from limestone material and are alkaline in reaction. They are developed mainly in Otter Creek Valley. The imperfectly drained Ondawa soil and the undifferentiated alluvial soils occupy imperfectly or poorly drained overflow land and are used for mowing and pasture. Muck areas, which also include peat deposits, are of little importance under the prevailing agriculture.

Rough stony land occupies more than 20 percent of the area of the State. It is almost entirely in forest and has little or no agricultural value. Extensive areas, representing approximately an-

other 20 percent, are occupied by the stony phases of the Berkshire, Becket, Hermon, and Hollis soils and are largely in forest. The stony areas of such soils as the Worthington, Calais, Blandford, Woodbridge, and Colrain are successfully used for pasture. The stony areas of the Pittsfield, Madrid, and Addison soils are also highly adapted to pasture and are used for this purpose.

The Berkshire and Becket loams are used for mowing and pasture. Most areas of these soils occur in the sections where farming has practically been abandoned. Here the pastures have grown up to brush or forest, and the mowings have degenerated into pasture or are fast approaching that stage. Areas of such land, where advantageously situated, are used for mowing and for crops to a limited extent, as even the so-called "nonstony soils" contain a noticeable quantity of stone. Stone, rather than infertile soil, has been the limiting factor in the development of the upland or hill sections of the State, and the stonier areas have been abandoned, as they could not compete with land in the West, where improved farm machinery can be used.

Soils of several of the leading series are of about equal importance in the agriculture of the State. The Addison soils are the most important, and the loam of this series is probably the best soil, especially for cultivated crops, but it occupies a comparatively small acreage compared with that of the clay loam and therefore is not so important.

In the following pages, the soils are described in detail, and their agricultural adaptabilities are discussed. Their distribution is shown on the accompanying soil map, and their acreage and proportionate extent are given in table 13.

TABLE 13.—*Acreage and proportionate extent of the soils mapped in Vermont*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Addison clay loam	89,984	1.5	Lyons stony loam	1,600	0.1
Addison clay loam, shallow phase	8,000	.1	Copake fine sandy loam	31,936	.6
Addison clay loam, stony phase	13,504	.2	Schodack gravelly fine sandy loam	38,400	.6
Addison loam	17,792	.3	Schodack gravelly fine sandy loam, light-textured phase	384	.1
Addison loam, shallow phase	5,888	.1	Calais loam	201,984	3.4
Vergennes clay loam	103,552	1.8	Calais loam, stony phase	48,384	.8
Livingston clay loam	46,784	.8	Worthington loam	89,536	1.5
Suffield silt loam	55,872	.9	Worthington loam, shallow phase	42,304	.7
Suffield silt loam, heavy phase	4,288	.1	Worthington loam, stony phase	32,576	.6
Suffield silt loam, rolling phase	19,200	.3	Worthington fine sandy loam	27,264	.4
Sheldon fine sandy loam	20,352	.3	Worthington fine sandy loam, stony phase	960	.1
Sheldon fine sandy loam, deep phase	14,912	.2	Worthington fine sandy loam, shallow phase	1,984	.1
Sheldon fine sandy loam, rolling phase	52,224	.9	Blandford loam	197,952	3.4
St. Albans silt loam	23,040	.4	Blandford loam, stony phase	80,000	1.4
Adams loamy fine sand	51,200	.9	Blandford loam, shallow phase	18,560	.3
Pittsfield loam	38,528	.7	Greensboro loam	100,160	1.7
Pittsfield loam, stony phase	26,048	.4	Greensboro loam, shallow phase	13,248	.2
Pittsfield loam, imperfectly drained phase	12,224	.2	Greensboro loam, stony phase	212,544	3.6
Stockbridge loam	44,608	.7	Greensboro fine sandy loam	12,480	.2
Stockbridge loam, stony phase	22,080	.4	Greensboro fine sandy loam, stony phase	10,368	.2
Madrid loam	17,984	.3	Berkshire loam	140,352	2.4
Madrid loam, stony phase	21,568	.4	Berkshire loam, shallow phase	31,424	.6
Farmington stony loam	58,752	1.0	Berkshire stony loam	402,368	6.9
Dutchess loam	31,424	.6	Berkshire fine sandy loam	11,584	.2
Dutchess stony loam	65,408	1.1	Becket loam	54,080	.9
Nassau shale loam	17,536	.3	Becket loam, red-subsoil phase	2,048	.1
Nassau slate loam	3,968	.1	Becket fine sandy loam	192	.1
Nassau stony loam	31,296	.6	Becket stony loam	234,304	4.0
Cossayuna loam	14,336	.2	Hermon stony fine sandy loam	206,080	3.5
Cossayuna loam, stony phase	28,416	.5			

TABLE 13.—*Acreage and proportionate extent of the soils mapped in Vermont*—Continued

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Peru stony loam	36,352	0.6	Shelburne loam	42,624	0.7
Colton fine sandy loam	86,976	1.4	Shelburne loam, stony phase	18,816	.3
Colton fine sandy loam, heavy-subsoil phase	5,184	.1	Charlton loam	20,736	.3
Colton loamy coarse sand	4,544	.1	Charlton loam, stony phase	24,576	.4
Danby gravelly fine sandy loam	126,272	2.2	Hollis fine sandy loam	35,648	.6
Danby loamy sand	4,800	.1	Hollis stony fine sandy loam	129,024	2.2
Merrimac fine sandy loam	46,784	.8	Gloucester stony fine sandy loam	47,488	.8
Merrimac loamy sand	448	.1	Whitman stony loam	17,024	.3
Agawam fine sandy loam	21,312	.3	Hadley very fine sandy loam	6,720	.1
Agawam fine sandy loam, Podzol phase	5,056	.1	Hadley very fine sandy loam, low phase	7,296	.1
Agawam loamy fine sand, Podzol phase	320	.1	Genesee silt loam	11,456	.2
Hinckley gravelly sandy loam	38,912	.7	Ondawa fine sandy loam	52,032	.9
Hinckley gravelly sandy loam, light-textured phase	5,376	.1	Ondawa fine sandy loam, imperfectly drained phase	5,312	.1
Woodbridge loam	98,496	1.7	Ondawa silt loam, imperfectly drained phase	1,600	.1
Woodbridge loam, stony phase	70,208	1.2	Saco silt loam	18,368	.3
Woodbridge loam, imperfectly drained phase	36,288	.6	Alluvial soils, undifferentiated	86,656	1.4
Colrain fine sandy loam	48,704	.8	Rough stony land	967,808	16.6
Colrain fine sandy loam, stony phase	76,800	1.3	Rough stony land, mountain phase	321,792	5.5
Colrain loam	16,064	.2	Muck	26,368	.4
Colrain loam, stony phase	1,408	.1	Peat	37,824	.7
			Marsh	24,064	.4
			Total	5,839,360	

SOILS OF THE CHAMPLAIN VALLEY

Addison clay loam.—Addison clay loam occupies a fairly large area in the Champlain Valley, occurring mainly in a belt extending through the central part of Addison County into the southern part of Chittenden County. It is the most extensive soil derived from the clay deposits of the valley. It occurs on low, smooth ridges which have good drainage, considering the heavy character of the subsoil and substratum.

The surface soil is grayish-brown or brown granular clay loam or silty clay loam to a depth of 5 or 7 inches and is underlain by brown or reddish-brown clay loam or clay which gradually changes, at a depth ranging from 20 to 24 inches, to reddish-brown or yellowish-brown clay, in places faintly mottled with gray. This material changes abruptly, at an average depth of 3 feet, to dull yellowish-brown or dark-gray rather heavy calcareous clay which cracks badly on drying. In spots this soil may contain a small quantity of gravel, but the typical soil carries little or no stone. In some areas the surface soil has a definitely silt loam or silty clay loam texture.

Nearly all of this land is cleared and is used for mowing and cultivated crops, and only a comparatively small proportion is in plowable pasture. The acreage in mowing is large, and the percentage of clover and timothy, mixed, is rather high. Intertilled crops are not grown to so great an extent as on Addison loam or on the shallow phase of this soil, owing to the difficulty of cultivation attendant on heavy soils, even where drainage is well established. Small-grain crops are grown only as nurse crops for grass, and sod land is not broken any more than is absolutely necessary for reseeding the mowings.

Grass in mowing is the leading crop and occupies an acreage far greater than that in all other crops combined. Timothy and clover yields from 1½ to 2½ tons of hay an acre and alfalfa from 2 to 3

tons, although there has been some difficulty in maintaining stands of the latter crop. Corn for grain yields from 40 to 50 bushels, corn for silage from 8 to 10 tons, oats from about 30 to 40 bushels, and buckwheat from 25 to 30 bushels. The potato yield averages about 135 bushels an acre, which is not so high as on some of the lighter and less limy soils.

Although not so difficult to handle as the Vergennes soil, Addison clay loam presents problems of cultivation in the spring and in wet seasons, which are not experienced with the sandy soils of the terraces or the soils developed from the lighter glacial till. The necessity of plowing at the proper stage of moisture has stimulated the use of tractors on this land both for breaking and subsequent cultivations.

Where dairying is followed, this is one of the most valuable soils in the State, as it requires the use of the byproduct, manure, to make crop production successful. Only comparatively small quantities of commercial fertilizer are used, but lime is used by many farmers growing alfalfa on this land.

Addison clay loam, shallow phase.—The shallow phase differs from typical Addison clay loam in that it is underlain by beds of shale, most of which is calcareous, at depths ranging from 20 to 24 inches below the surface, and some scattered particles of shale occur throughout the soil profile above the shale strata. The surface relief is slightly more undulating than that of the typical soil, conforming more to the shape of the surface of the shale formation, on which it is deposited, than is usual for the typical soil deposited in rather thick lacustrine beds. Soil of the shallow phase is better drained than the typical areas, and it is all utilized for agriculture.

Most of this soil occurs on the islands of Lake Champlain and between the lake and St. Albans. It is used for growing alfalfa and beans, besides such crops as hay (timothy and clover), oats, and buckwheat. This soil has about the same use for crops as, and its production value is about equal to that of, the loam, although the surface soil is typically clay loam in texture. Yields of oats and buckwheat are lower on this soil because a fairly large acreage is seeded with little care or fertilization. Potato yields are lower, as there is not sufficient depth of soil for development of the crop and also because the shallow soil is more alkaline than the typical soil. Silage corn and corn for grain yield about the same as on the typical soil. Like the other Addison soils, this soil is neutral or only slightly acid in the surface soil.

Addison clay loam, stony phase.—The stony phase of Addison clay loam differs from the typical soil in being slightly more broken in surface relief, and in its stone content. The stones consist mainly of protrusions of the bedrock limestone through the clay deposits in places. The stones do not detract from the natural productiveness of the soil, but they interfere with cultivation. The land is utilized for pasture. The total area is not extensive, and for this reason the land is highly valued for pasture as it usually is associated with large areas of cultivable soils. Most of this stony soil occurs in small scattered areas in the southeastern part of the Champlain Valley from the vicinity of Middlebury to Brandon.

Addison loam.—Addison loam occurs as low smooth-topped ridges standing about 100 feet above drainageways or stream level. The

surface is on the level with the old or higher lake deposits which are about 500 feet above sea level. This soil is associated with Addison clay loam and occurs mainly on the ridges extending south from Burlington and south from Vergennes on both sides of Otter Creek.

The surface soil is brown or grayish-brown mellow loam which passes, at a depth of 6 or 8 inches, into a brown or yellowish-brown firm loam subsoil. The substratum is reached at a depth ranging from 20 to 30 inches. It consists of dark-gray, grayish-brown, or dull yellowish-brown heavy clay, more or less calcareous at a depth of 36 or 40 inches. Some gravelly areas are included with mapped areas of this soil, in which the gravel content does not exceed 15 percent of the soil mass and does not interfere with cultivation but does facilitate drainage. This soil contains no stone, which is a marked advantage over many Vermont soils. In places there is a noticeable quantity of gravel scattered on the surface and throughout the upper part of the soil profile. Most of the gravelly areas are on the ridges extending south from Vergennes.

Drainage is well established, although the heavy clay substratum has a tendency to retard the free movement of water. The surface soil, because of its loamy texture and good structure, is easily tilled, differing in this respect from the heavier members of this series and from the Vergennes and Suffield soils. Nearly all the land is cleared and in crops, the most important of which are hay (timothy, clover, and alfalfa), oats, silage corn, barley, buckwheat, and wheat. Yields are as high on this land as on any other soil in the State, as the farming practices combine the use of fertilizer with natural productiveness and good soil structure. Hay (timothy and clover) yields from 1 to 2½ tons an acre, alfalfa from 2 to 3½ tons, oats from 35 to 40 bushels, corn for silage from 10 to 12 tons, and buckwheat about 25 bushels. Some potatoes are grown, and the average production is about 150 bushels an acre. Only a comparatively small acreage of this soil is used for pasture, as it is so valuable for cultivated crops.

Addison loam, shallow phase.—The shallow phase of Addison loam occupies low smooth ridges throughout the Champlain Valley, mainly in the islands of Lake Champlain and in the section contiguous to the lake. The soil consists of a thin mantle of lake-laid silts over calcareous shale.

The surface soil ranges from silt loam to medium-heavy or heavy loam and contains some shale chips. This layer passes at a depth ranging from 5 to 8 inches into dark yellowish-brown loam or silt loam, containing a noticeable quantity of shale in places. In other places the shale influence is less marked, and the surface soil is wholly lake-laid material. This material grades, at a depth ranging from 15 to 20 inches, into partly weathered calcareous dark shale which becomes more or less solid rock at depths between 3 and 5 feet. Although this soil has smooth surface relief, the land is well drained. Here and there are small knolls which have little or no soil on them.

Practically all the land is cleared and in pasture, mowing, or such crops as corn (silage), oats, buckwheat, rye, and alfalfa. The percentage of the land in cultivated crops is probably higher than of any upland soil. The yields of oats, rye, and buckwheat are not so high as on some soils used for these crops. The acreage devoted to

these crops is rather large and, as a rule, the land is seeded with little preparation or fertilization, with the expectation of catching whatever can be made from land that otherwise might lie idle. Under such conditions, oat yields average about 30 bushels an acre and yields of buckwheat range from about 15 to 25 bushels. Corn for silage is highly fertilized and yields from 10 to 12 tons an acre in good seasons. Mowings cut from 1 to 1½ tons of timothy and clover hay, and potatoes yield from 100 to 125 bushels an acre. This is an important soil (1) because it belongs to the group of soils derived from calcareous material, which are more valuable for clover and alfalfa than the more highly acid soils; (2) because it is stone-free, thereby allowing easy cultivation and free use of mowing and other machines; and (3) because the surface relief is smooth enough to allow cultivation with tractors.

Vergennes clay loam.—Vergennes clay loam as developed in Vermont is far from being a homogeneous soil, and it includes several variations that have a marked effect on agriculture. Where typically developed under fair drainage, this soil has a gray surface soil containing a noticeable quantity of silt and a brown or grayish-brown clayey subsoil faintly mottled with yellowish brown and gray just above the gray calcareous clay substratum which occurs at an average depth of 20 inches. This kind of soil is well suited to mowing and is extensively used for that purpose.

On the flatter areas, such as the extensive flats in the section adjacent to Dead Creek in the towns of Addison and Panton, the surface soil is slightly darker and is underlain by light-gray silty material which passes into a reddish-brown clay layer at a depth ranging from 5 to 8 inches below the surface and extending to a depth of 10 or 12 inches before passing into highly mottled yellow and gray clay which rests on the calcareous clay commonly present at a depth ranging from 15 to 24 inches. This variety of soil is used extensively for pasture, and a small proportion is in mowing.

In the southern part of the belt of Vergennes soils, in the towns of Shoreham, Orwell, and Bridport, a variation occurs in the more broken areas, which is a much better soil than the rest of the areas. Here, the surface soil is gray, and the subsoil is yellowish-brown clay loam which passes, at a depth ranging from 15 to 20 inches, into gray or whitish-gray clay containing a noticeable quantity of white lime nodules. These areas are used more extensively for general-farm crops than the other areas, and rather successfully for alfalfa.

Included with Vergennes clay loam are fairly large areas having a silty clay loam texture. Such areas occupy low rather smooth terraces and are possibly an accumulation of stream deposits, together with material derived from the same source as the rest of the clay deposits of the Champlain Valley. Here, the surface soil is somewhat more grayish brown than the typical soil and consists of silt loam or silty clay loam to a decidedly greater depth than the rest of the areas. The calcareous material is reached at a depth ranging from about 24 to 36 inches. It is doubtful whether the clay substratum is quite so heavy or quite so calcareous as under the remainder of Vergennes clay loam. The mottled layer above the clay is very pronounced, however, owing to the prevailingly smooth level surface.

The crop use of the silty clay loam areas is intermediate between that of the two other variations of the clay loam described. This land is used more extensively for hay (timothy and clover) than the flat areas, but it is not used for alfalfa to the same extent as the rolling areas of the clay loam. Hay, the principal crop, cuts from 1 to 2½ tons an acre. The land is not used extensively for other crops.

Livingston clay loam.—Livingston clay loam is associated with the Vergennes, Addison, and Suffield soils, and it occurs in low poorly drained positions. It has a dark-gray or black surface soil that ranges from 1 to 12 inches in thickness, with an average of about 6 inches. This is a friable rather granular soil containing a high percentage of organic matter that does not entirely disintegrate when the land is cleared and drained. The surface soil is underlain by the characteristically mottled yellow, yellowish-brown, and drab gray clay of the flatter Vergennes soil. In most places the depth to calcareous material ranges from 24 to 36 inches. In some places the soil material is only very mildly alkaline or neutral.

A rather large area of this soil is not well drained and is therefore used only for pasture. It furnishes excellent grass where not too wet or soggy and not too thickly covered with brush.

On the islands of Lake Champlain much of the land has been drained and has been under cultivation for a long time. Here, it is used very successfully for alfalfa and such intertilled crops as beans and corn.

Many areas of this soil could be drained only with difficulty, and other areas probably could not be drained profitably. The land is most successfully used where the average annual rainfall is only 30 inches.

Suffield silt loam.—Suffield silt loam is developed from clays underlying the Champlain Valley section, and it occurs also in scattered and smaller areas in other parts of the State. The last-mentioned areas contain little or no calcareous material in the original deposit but in many places are alkaline below a depth ranging from 30 to 36 inches.

This soil occupies smooth level terraces having fairly good drainage. It has an 8- to 10-inch grayish-brown or brown surface soil containing a comparatively high proportion of silt. This layer is underlain by brown or yellowish-brown silt loam or silty clay loam, which gradually changes to grayish-yellow or greenish-gray clay at a depth ranging from 20 to 30 inches below the surface. In most places the underlying clays become bedded between depths of 3 and 4 feet. They contain silty and clay strata of bluish-gray and yellowish-gray colors, also. Small included areas of loam texture are in the vicinity of New Haven.

This soil is developed on the back terraces, or outer edge, of the ancient Champlain Sea, where the material was less calcareous. In places the outer, or stream edges, of the terraces are sharply broken, but as such areas are small they are included with the main soil. They are of little agricultural value. The largest areas are in the towns of Highgate, Sheldon, and St. Albans in Franklin County, in the town of South Burlington in Chittenden County, and in the towns of Monkton and New Haven in Addison County. The soil also occurs in widely scattered places, as in the vicinity of Fair Haven and along the Connecticut River near and north of White River Junction.

This soil differs from Addison loam mainly in that it is noncalcareous, although the substratum in many places is alkaline, and the material below a depth of 5 feet is usually calcareous, although in some places it is not. As the surface soil is more silty and of generally better structure than Addison clay loam or Vergennes clay loam, cultivation is easier.

Suffield silt loam is not so highly suited to grass as are the Addison soils, and it is not suited to alfalfa. It is successfully used for clover when small quantities of lime are added, and it is used to a small extent for cultivated crops. Grass, however, is the leading crop, both for mowing and pasture. Practically all of this land can be plowed, and the sod is changed more often than on Vergennes clay loam. If small grains are grown, they are usually sown as nurse crops for grass. Hay yields an average of about 1 or 1½ tons an acre.

Suffield silt loam, heavy phase.—The soil mapped as the heavy phase of Suffield silt loam represents areas of Suffield silt loam with a silty clay loam surface soil, occurring in the northwest corner of the town of Franklin and in the vicinities of Hinesboro and Monkton.

Although drainage is retarded slightly by the heavy clay substratum, this may be considered a fairly well drained soil. The areas of the heavy phase are slightly less well drained than typical Suffield silt loam or Addison clay loam.

Suffield silt loam, rolling phase.—The rolling phase of Suffield silt loam occurs mainly in the Champlain Valley north of Burlington. The areas present the appearance of kames, but they are really remnants of an eroded terrace. This soil has less brown in the surface soil and contains more greenish yellow or greenish gray throughout the profile than the Suffield soils mapped generally in Vermont. The material in general is not quite so heavy as is typical Suffield silt loam. The surface soil ranges from very fine sandy loam to silt loam, and drainage is thoroughly established. Nearly all the land is cleared and is used to a limited extent for pasture and for mowing. It supports an excellent bluegrass sod and is highly valued for grazing.

Sheldon fine sandy loam.—Sheldon fine sandy loam is developed from a thin sheet of sand over clay, although there are many variations and phases which differ in depth to the clay more than in any other respect. The depth to the calcareous material in the clay substratum also varies. This soil is naturally associated with the clay deposits of the Champlain Valley section, where it occurs mainly near the mouths of streams which entered the old embayment and deposited the sands on the clay.

The land is easy to work and, owing to its good moisture-holding capacity, is very productive where fertilized, but the natural fertility is rather low. The land may be considered fairly well drained, as the clay strata do not retard the movement of moisture to a great extent, and they also provide a means by which moisture can be held for the subsequent use of plants. On soil of this character in the lower Connecticut Valley in Massachusetts, heavy yields of tobacco and onions are produced.

The largest areas of Sheldon fine sandy loam are in Ferrisburg Town, Addison County, near the mouth of Otter Creek. Scattered areas are in Chittenden, Addison, and Rutland Counties.

The 6- to 8-inch surface soil consists of brown fine sandy loam. It is underlain by dark yellowish-brown mellow fine sandy loam which gradually changes to a pale-yellow color before passing into gray only slightly firm fine sandy loam. In most places the gray layer is about 4 or 6 inches thick, and it rests on gray or greenish-gray clay which in most places is neutral but in few places is strongly alkaline within a depth of 5 feet below the surface. The depth to clay ranges from 12 to 36 inches. The character of the sandy surface soil ranges from sandy loam to fine sandy loam, even approaching a loam in places. On some of the flatter areas, especially those in Ferrisburg Town and in places where the clay comes within 18 inches of the surface, the surface soil material is gray, and the characteristic brown layer in the subsoil is missing. Such areas, however, are small. Over most of the areas, the clay is calcareous below a depth of 3 feet, although there are many bodies in which the clay is not calcareous to the point of effervescing with hydrochloric acid. Much of it is neutral or mildly alkaline.

Nearly all the Sheldon fine sandy loam is cleared and used for crops. Although it is not especially adapted to grass, it is used for mowing, and fair yields of hay, averaging between 1 and 1½ tons an acre, are produced. The soil is used to a limited extent for small grains. It is also used successfully for silage corn which yields about 10 tons an acre. Potatoes yield from 125 to 150 bushels, and garden crops, including sweet corn, make good yields.

Sheldon fine sandy loam, deep phase.—The deep phase of Sheldon fine sandy loam has much the same profile as the typical soil, but the brown layer is deeper, and the clay begins below a depth of 36 inches, in most places between depths of 40 and 48 inches. This soil occurs in fairly large areas in Swanton, St. Albans, Sheldon, and Highgate Towns, and small areas are south of Rutland and northwest of Castleton.

Although this land is better drained than the typical soil, it still has good moisture-holding capacity. It is probably better suited to a number of crops which require better aeration and room for root development and yet require a good supply of moisture. It is well adapted to potatoes and garden vegetables. In Massachusetts this kind of land returns the heaviest yields of high-grade tobacco. This deep soil, like the rest of Sheldon fine sandy loam, is a dry-season or normal-season soil. In years of drought it produces better than the lighter or sandier soils and also better than the clay soils, and in normal seasons yields are excellent, comparing favorably with those on any soil in the section. Crops usually fail, however, in wet seasons.

Sheldon fine sandy loam, rolling phase.—The rolling phase of Sheldon fine sandy loam occurs in scattered areas along Lamoille, Missisquoi, Winooski, Connecticut, and White Rivers. The profile is similar to that of the typical soil, although the surface relief is bumpy in appearance, and the texture of the surface soil ranges from fine sandy loam to very fine sandy loam, and in some places even to

loamy fine sand. The depth of this sandy mantle over the clayey deposits varies considerably, ranging from 2½ to 4 feet.

The broken or rolling surface relief renders this soil less suitable for cultivation than the typical soil which is smooth. It is utilized mainly for pasture and furnishes fair grass. In places, on the steeper sided hills, the clay strata are exposed, but these spots are too small to consider separately.

St. Albans silt loam.—St. Albans silt loam has much the same topographic characteristics as the Addison soils. Drainage in most places is good, but in some places there is a decided tendency to imperfect drainage, which is shown by a slight mottling in the lower part of the subsoil.

This soil is characterized by a brown decidedly silty surface soil passing at normal plow depth into a brown or yellowish-brown subsoil which is only fairly firm. The subsoil grades at a depth of 20 or 24 inches into grayish-brown material, mottled or streaked with yellowish brown. Below a depth ranging from 30 to 36 inches, there is more gray and less brown. Some small slate chips of the parent noncalcareous slate are present throughout the profile.

On the islands in Lake Champlain and in the section near the northern end of the lake, a number of areas have loamy surface soils. These areas, besides the slate chips, contain a fair quantity of gravel well scattered throughout the surface soil, subsoil, and substratum. They also show slightly more mottling in the lower part of the subsoil and substratum. Some of them contain enough gravel to be designated as a gravel soil, although the quantity is not large enough to interfere with cultivation. The areas having a high gravel content are well drained and aerated in the surface soil, but little difference is noticeable in the mottled condition of the substratum, as there is little difference in the surface conformity of the two variations.

St. Albans silt loam occurs in the towns of St. Albans, Milton, and Swanton, and in scattered areas on the islands of Lake Champlain. This soil is acid and therefore not so well suited to legumes as the Addison soils. Yields of oats, buckwheat, and potatoes range slightly higher than on Addison loam, shallow phase. Hay yields range from about 1 to 1½ tons an acre, oats from 30 to 35 bushels, buckwheat from 25 to 30 bushels, and potatoes from 125 to 175 bushels. The land is stone-free and easy to cultivate, and tractors can be used equally as well as on the Addison soils. On account of its acidity, St. Albans silt loam is valuable for the production of a slightly different range of crops from those grown on the other soils of the Champlain Valley.

Adams loamy fine sand.[3]—Adams loamy fine sand reaches its best development on the extensive sand plains of Chittenden County. It has a dark-brown 7- or 8-inch surface soil underlain by yellowish-brown material which continues to a depth ranging from 20 to 24 inches, where it changes to pale yellow and finally to gray below a depth ranging from 36 to 40 inches. The entire profile is loamy fine sand to an average depth of about 8 feet, where it rests on a clay bed. The surface relief, in general, is level, but drainage is

[3] This soil was first recognized and mapped in Jefferson County, N. Y.

well established. Owing to the underlying clay, in the larger flats the moisture-holding capacity is fairly good. Small included areas really represent a fine sandy loam, and there are also small areas of coarse sandy texture. In places some gravel is in the substratum, but in general this layer is composed of "salt-and-pepper" sandy material that is everywhere underlain by the lacustrine clay beds, most of which are calcareous.

The principal areas of Adams loamy fine sand are in Chittenden County in the towns of Williston, Essex, Colchester, and Milton, and near Burlington and Highgate. This soil also occurs near Bristol, Addison County.

A large total area of this soil is covered with sprout forest consisting of gray birch, pitch pine, and scrub oak, together with some scattered white pine, soft maple, and elm. The ground cover is prevailingly sweetfern and huckleberry.

The cleared areas are used to only a slight extent for general farm crops, as this is not a strong soil, in fact, it is one of the poorest in the State. It has good structure, however, and responds readily to fertilization. In normal seasons, when neither too dry nor too wet, it produces good crops. As it is highly acid, it is not adapted to the production of clover. Although it is not considered a good grass soil, it is used for both mowing and pasture. The acreage devoted to market-garden crops is larger than that of any other soil in the State. This is partly owing to its location and partly to the fact that these crops do proportionately better than general-farm crops. No crop can be expected to succeed on this soil without intensive cultivation and high fertilization.

Hay yields about one-half ton to the acre, with yields as high as 1 ton under the most favorable conditions. Most of the crops grown for market on 911 acres in Chittenden County in 1929 were on this land. Sweet corn was the principal vegetable grown, and some tomatoes, melons, cucumbers, peas, cabbage, and asparagus were produced. All these vegetables make fairly good yields, as they receive heavy fertilization.

A fairly large area of this land lies fallow each season. The chief value of the soil is that it is near Burlington and is suitable for small farms. Such legumes as Canada field peas and soybeans, which are suited to sandy land, should succeed.

SOILS OF THE LIMESTONE VALLEY AND TACONIC MOUNTAINS

Pittsfield loam.—Pittsfield loam [4] is mapped in the limestone valleys west of the Green Mountains from Massachusetts to Canada but reaches its best development in the southwest (limestone) valley of Vermont, from Rutland to Bennington. It occurs as low smoothly rounded hills and ridges, contains little stone, and in most places is well drained. The Pittsfield soil in plowed fields is brown or dark yellowish-brown loamy soil to plow depth. It is underlain by a light-brown or yellowish-brown firm but mellow loam subsoil which extends to a depth ranging from 20 to 24 inches before passing into a mixed, not mottled, yellowish-brown and gray firm but not compact

[4] The Pittsfield soils were first mapped in the vicinity of Pittsfield Mass., and take their name from that city.

till. The till contains streaks of white material derived from partly decomposed pieces of marble and limestone, which effervesce strongly with hydrochloric acid.

In many places, especially in the scattered areas throughout the Champlain Valley, there is a noticeable quantity of gravel on the surface and throughout the soil. This, however, does not materially aid drainage, as the soil is already well drained, and it does not interfere with cultivation. The quantity of gravel is not sufficient to form a mulch and therefore seems to have little effect on the character of the soil.

This land, which was originally covered with a hardwood forest, has practically all been cleared and is utilized for crops. The type of farming is more nearly like that of New York State than any part of Vermont, as the topography is much the same as in central and southeastern New York. A large proportion of the land is in mowing, mainly timothy and clover, with a small proportion in alfalfa. Pasture does not occupy a large area, and it is not particularly good, as the land has grown up to hardhack, which is a pasture pest in the limestone valleys of this section. When this obnoxious shrub is kept down, the soil furnishes a good bluegrass sod. A comparatively large acreage is devoted to oats, buckwheat, and corn for silage. Under the present system of farming, yields are fairly good, corn for grain yielding about 50 bushels an acre, corn for silage about 9 tons, oats from 35 to 40 bushels, and buckwheat about 25 bushels.

The average production of potatoes falls as low on this land as on any other well-aerated soil in the State, averaging less than 100 bushels an acre. Apples are grown successfully, and the land is highly adapted to legumes. It is needless to state that this land is easy to cultivate. It is as productive as most land in the East and is desirable for farming.

Pittsfield loam, stony phase.—The stony phase of Pittsfield loam differs from the typical soil in that it carries a large quantity of stone and has a more broken surface relief. The stones are not so large or so plentiful as on most of Vermont's land, however, especially that east of the Green Mountains. As this soil is developed on low smooth ridges in the southwest valley and in scattered areas over the Champlain Valley, the surface relief is more subdued than over much of the eastern part of the State. The areas of this stony soil throughout the Champlain Valley contain more limestone than the areas in the southwestern valley, where much of the stone consists of quartzite.

This land is used mainly for pasture, to less extent for mowing, and a little of it is wooded.

Pittsfield loam, imperfectly drained phase.—Pittsfield loam, imperfectly drained phase, has a limestone influence which renders the entire profile more or less alkaline. The substratum, below a depth of 2 feet, is rather more compact than the typical Pittsfield substratum, and faint-gray and rust-brown splotches occur just above the compact material. This soil occupies the smoothly sloping hillsides in the belt of country immediately east of the Champlain Valley, extending from the vicinity of Milton Town to the vicinity of Starksboro Town.

This is one of the best soils for grass in the section and is used extensively for mowing. It is comparatively stone-free and can be

plowed readily, but the moisture held by the compact substratum prevents plowing in wet seasons or early in the spring. For this reason, the land is not used to a great extent for crops other than hay. In most parts of this section there is enough arable land on the stream terraces to supply the land needed for cultivated crops. Hay yields on this soil range from 1½ to 2 tons an acre. The land affords excellent pasture, as timothy and redtop do exceptionally well, and there is much Canada bluegrass.

Several stony areas occur here and there. Most of them are steeper than the rest of the soil, but they receive about the same amount of seepage water. The stones consist of limestone and erratic boulders of granite, gneiss, and schist. Such areas are not very important, except for pasture. A small acreage is devoted to sugar maple groves, and much of the land is in forest.

Stockbridge loam.[5]—Stockbridge loam has a dark-brown surface soil abruptly underlain by yellowish-brown slightly compact friable loam which changes, at a depth ranging from 12 to 15 inches, into greenish-yellow compact clay loam. Below a depth ranging from 24 to 36 inches, the substratum is tightly compact greenish-gray highly calcareous till. The entire profile contains a noticeable quantity of slate gravel and some scattered limestone boulders. The soil is developed from deep weathered till characteristic of drumlin forms.

Some variations from the typical soil occur. In the vicinity of Castleton, the material from which the soil is derived consists of more or less calcareous slate. In such places the till is rather heavy, and, although it contains free lime in only a few places above a depth of 3 feet, it is strongly calcareous below this depth. Areas of this soil in the limestone valley contain more limestone boulders and fragments of limestone, and they may be calcareous in places at depths of 20 or 24 inches, but in many places the substratum is less calcareous than in the areas in the slate section.

Typical areas of Stockbridge loam occur in the southwestern part of the State in the narrow limestone valleys and are surrounded by slate formations from which much of the material is derived. The soil occupies low smoothly rounded hills, or drumlins, closely associated with the Dutchess and Pittsfield soils.

Drainage is well established, although the heavy subsoil has a tendency to hold moisture. The land is not used for cultivated crops to so great an extent as the associated limestone-influenced soils. Its heaviness, together with its moisture-holding capacity, make it difficult to plow in early spring. Therefore it is not extensively used for tilled crops but is rather given to mowing. Like the other soils (already described) of this section, this soil is not used extensively for pasture, its desirability for mowing being paramount. It is well suited to clover, and timothy and clover comprise most of the mowing. Some buckwheat and oats are grown. Crop yields range rather high, where attention is given to cultivation, for this is one of the most productive soils in the State. Hay yields range from 1 to 2½ tons an acre, with an average of about 1½ tons; corn for silage, from 10 to 15 tons; oats, from 35 to 45 bushels; and buck-

[5] This soil was first recognized and mapped in the town of Stockbridge, Mass., in the soil survey of Berkshire County.

wheat, from 25 to 35 bushels. During dry seasons, grass remains green longer on this soil than on any other soil of the valley section.

Although the subsoil is alkaline, the surface soil is acid, and it is doubtful that clover or other legumes would succeed if the land were not limed. The substratum is considered rather too tight for complete success with alfalfa.

The dark areas of this soil are less extensive than typical Stockbridge loam. They occupy slightly higher ground, and the surface relief is gently sloping, a characteristic of the land occurring at the base of the mountains. The darker soil is derived from glacial till, weathered from a mixture of slate and limestone, and in places is influenced by graphites, which give most of the dark color to the soils. The dark areas have a dark-brown surface soil to plow depth, underlain by greenish-yellow mellow loam which grades downward into the greenish-gray substratum consisting of rather fluffy or somewhat firm material, at least not compact. The soil is well drained and aerated, and, owing to its good structure and moisture-holding capacity, it makes an excellent medium in which to grow crops.

The largest areas of the dark soil are on the ridge extending from the vicinity of Proctor to the base of Dorset Mountain, and small areas lie along the western edge of the valley from Dorset to Bennington. The land is utilized principally for mowing, silage corn, and oats, and only small areas are in pasture or other crops. Dairying is the leading farm industry, as it is on most of the better soils of this section, and this has its effect on the yields usually obtained. This soil is used more extensively for mowing (timothy and clover) and for silage corn than the Pittsfield soils or the lighter colored Stockbridge soils. Yields of these two crops are slightly higher, and other crops yield about the same. Orcharding has proved somewhat successful.

This is considered one of the best soils of the section. Although not so calcareous and not so well suited to legumes as Pittsfield loam, it is a better soil for grass.

Stockbridge loam, stony phase.—The stony phase of Stockbridge loam occurs in close association with the rest of the soil and is essentially the same, with the exception of the stones, which consist mostly of erratic boulders. The stone content, however, disqualifies the soil for crop production and where cleared the land is utilized mainly for pasture. Much of the land is in forest, not that the stone content is less than in some soils used for farming in the eastern part of the State, but because of the occurrence of other soils in the vicinity that can be more easily cultivated.

The dark areas of the stony phase are associated with the rest of the Stockbridge soils and, in general, they occupy steeper positions. In these areas the stone consists of slabs and more or less angular pieces of schist, limestone boulders, and small shaly or slaty fragments of the parent graphitic schist. The total area of the dark areas is comparatively small and the soil is of little importance. As it is good grassland where cleared, it is utilized for pasture.

Madrid loam.—The surface soil of Madrid loam in forested areas is gray, but in freshly plowed fields it is decidedly brown. The subsoil below plow depth is yellowish-brown friable loam grading downward into yellow firm but friable loam and changing at a depth ranging from 24 to 36 inches to firm, slightly compact mixed yellow, yellow-

ish-brown, and gray partly altered till which is platy in structure. This material will not effervesce with hydrochloric acid unless a piece of limestone is reached, but it is in most places neutral or mildly alkaline.

This soil occurs on smoothly rounded and smooth-sided hills with slightly flattened ridge tops, which afford good drainage and aeration. It lies on the east side of the limestone valley that extends less than two-thirds of the way down the State from the town of Monkton, Addison County, to Pownal, Bennington County, near the Massachusetts State line, where the limestone of the valley is influenced by the quartzite that formed the face of the mountain barrier to the east.

This soil is less extensive than Pittsfield loam, and, although it is not so productive, it may be considered of agricultural importance. Most of the Madrid loam is cleared, but a fair acreage is in second-growth forest of white pine, gray birch, white oak, sugar maple, and aspen. The land shows evidence of having been cultivated at one time. The cleared areas are in pasture, mowing, and the crops common to the limestone valley. The pastures contain much hardhack and birch, and only in the lower places do *Potentilla* and ferns grow. The acreage in recently abandoned mowings is very noticeable. Crop yields, although good, as compared with the mountain land, are not quite so good as those obtained on the Pittsfield or the other lime-influenced soils of the valley. Hay cuts from 1 to 1½ tons an acre, and other crops, such as corn for silage, oats, and buckwheat, yield slightly lower than on Pittsfield loam. This land is easy to till and can be handled by tractors with the same ease as the Pittsfield and associated soils. Crops, however, require more fertilizer and lime for successful production than on the other soils, and the labor income is probably lower on this land.

Madrid loam, stony phase.—In general the stony phase of Madrid loam occupies slightly steeper topographic positions than the typical soil, and it contains a larger quantity of stone which consists of quartz boulders, with some limestone and an occasional igneous erratic. Much more of this land is forested than of the typical soil. Most of the cleared areas are in pasture. The soil is not particularly adapted to grass, although it furnishes fair grazing. The stony areas are probably less influenced by lime than the typical soil, as they occur closer to the outcrops and contain more of the quartzite adulteration.

Farmington stony loam.—Farmington stony loam is characteristic of the low hills throughout the limestone valleys and the Champlain Valley, that include many limerock outcrops and ribs, on which there is a decidedly thin soil mantle. This soil ranges from a mere film to 3 feet in thickness, but in most places it is not more than 1 foot thick. Although the soil is decidedly brown to the depth that the subsoil occurs in most places, it is characteristic of the Pittsfield soils. In other places it becomes shaly and is like the Mohawk soils. The outstanding feature is the thinness of the soil over limestone.

Farmington stony loam is developed to only a small extent in the valleys south from Rutland, but northward to the Canadian border it is in evidence on most of the ridges that stand above the general level of the valley. It has a very low value for crops, but is good

grassland and can be utilized to advantage for pasture, as it is surrounded by a rather large area of tillable land. It is inclined to droughtiness in dry seasons.

Dutchess loam.—Dutchess loam occurs as low smoothly rounded hills and as gently sloping areas around the bases of the mountains scattered throughout the slate belt, or Taconic Mountain section. It has a brown loam surface soil that grades at plow depth into yellowish-brown or yellow friable loam which abruptly changes to yellow or greenish-yellow firm but friable loam containing some slate chips. Below a depth ranging from 20 to 24 inches the substratum is greenish-yellow or greenish-gray fairly compact till which contains quantities of bluish-gray slate fragments. The glacial deposit ranges in depth from 2 to more than 10 feet, and as it is derived largely from slate it contains little stone other than a few pieces of quartz. The soil is acid throughout the entire profile. Drainage is fairly well established. The presence of the shale rock increases the moisture-holding capacity of the soil to some extent and in places retards the free movement of water. Some banks of this soil are extremely seepy, and there is a strong tendency for them to slide when the complete moisture absorption point is reached. Scattered throughout areas of the typical soil are a number of small pebbly bodies on which the pebbles, composed of small angular quartz, occur in sufficient quantities to form a soil mulch, but they do not interfere with cultivation. Other small areas also contain stone.

The qualities mentioned make a fairly good soil for grass, and most of the land is used for the production of grass. It is nearly all cleared and is, or has been in recent years, used for mowing or pasture mainly and to a limited extent for such crops as corn silage, oats, and buckwheat. Mowings cut from 1 to 1½ tons of hay an acre. The land is fairly well suited to timothy and other grasses, but it is not so highly suited to clover and legumes as the Stockbridge and associated soils. Corn silage cuts from 6 to 8 tons, oats yield from 30 to 50 bushels, and buckwheat yields from 25 to 35 bushels an acre. Potatoes produce from about 100 to 150 bushels. Although crop yields are fairly good and this is considered one of the good soils of the State, it is not used for cultivated crops to the extent that the associated soils on the terraces are. It is used for apple orchards, and some of the best orchards of the State are located on this land. Although this soil is well scattered over the slate belt, the largest bodies are in the central part of the belt, from the town of Castleton to the town of Rupert.

Dutchess stony loam.—Dutchess stony loam differs widely from Dutchess loam, not only in the stone content, which consists of quartz, sandstone, and erratic igneous boulders, but in that it occupies steeper land. The stone occurs in sufficient quantity to interfere with cultivation and with the operation of mowing machines. The land is used mainly for pasture, and it furnishes good grass. Many of the pastures contain much sweetfern, sumac, and steeplechase (hardhack).

Nassau shale loam.—Associated with the Cossayuna and Dutchess soils and occurring on low smooth ridges scattered throughout the Champlain Valley are bodies of shallow shale loam which has devel-

oped from calcareous yellow and buff shale. The 5- to 7-inch surface soil is brown loam or silt loam, filled with shale fragments. This layer rests on yellowish-brown mellow shale loam which passes, at a depth ranging from 12 to 24 inches below the surface, into partly disintegrated yellow shale. This material changes, below a depth of 36 inches, to dark grayish-brown shale unaltered by weathering.

This soil is utilized extensively for pasture in the southeastern part of the valley, where it was formerly used to some extent for hay. It is successfully used in the northern part of the valley for the production of crops common to that section. Although shallow, the soil is cultivated with little trouble, as the rotten shale is easily plowed. It is used rather extensively for oats and buckwheat and to a limited extent for alfalfa and other crops. Like the other soils of this section, the land was probably first cleared and utilized for pasturing sheep. It furnishes excellent pasture and is a valuable soil in connection with dairying operations.

Nassau slate loam.—Nassau slate loam has a profile similar to that of the other Nassau soils, except that from the surface downward it contains a large quantity of small bluish-gray slate chips, and it merges with the bedrock of partly disintegrated slate at a depth ranging from about 24 to 38 inches. Small areas containing a noticeable quantity of quartz gravel are associated with this soil, and in such areas there is generally less slate. In some small bodies the quantity of slate on the surface is negligible, but numerous slate fragments are present at a depth ranging from 15 to 20 inches, and bedrock lies within 3 feet of the surface.

Nassau slate loam occupies low smooth hills and gently sloping hillsides, where drainage is usually good. This is not an extensive soil, although it is widely distributed over the slate belt and is closely associated with the other Nassau soils. About two-thirds of the land is cleared and is used mainly for pasture. A fairly large area is in mowing and such crops as oats and buckwheat. Yields are not high, and they range somewhat lower than on Nassau shale loam. Hay yields from one-half to 1 ton an acre, oats from 25 to 35 bushels, potatoes from 100 to 150 bushels, and buckwheat about 20 bushels. Many areas of this land have been abandoned within the last two decades, and the tendency is toward further abandonment, especially where the soil is surrounded by large areas of stony Dutchess and shallow Nassau soils.

Nassau stony loam.—Nassau stony loam occupies a larger area than any of the soils that occur over the more or less hilly and broken areas of the Taconic Mountains, except those occupied by rough stony land. Over much of this soil the profile differs little from that of Nassau slate loam, except that there are less small slate fragments and more large ones, also a noticeable quantity of quartz in the stony loam. Over nearly all areas of this soil slate bedrock lies within 3 feet of the surface. There are areas, however, in which much rib rock protrudes. In some other areas the stone is not so conspicuous, although in nearly all places the soil covering is thin.

About three-fourths of this land is covered with forest, and the rest is in pasture. The pasture areas have grown up with much *Spiraea* (hardhack), sweetfern, brambles, and birch sprouts. If pasture is needed, the land furnishes fair grazing where the brush is kept down;

otherwise it is best to let it revert to forest. The present forest growth consists of white oak, chestnut oak, beech, gray birch, and yellow birch.

Cossayuna loam.—Cossayuna loam resembles the Dutchess soils in that the surface soil is brown and grades downward through a yellowish-brown subsoil into a mass of shale fragments that merge with the parent rock material at a depth ranging from 3 to 5 feet below the surface. The surface soil of Cossayuna loam, however, contains more lime material in the form of embedded limestone boulders, and in places it is derived from calcareous shale. In many places the bedrock consists of sandstone, but the overlying glacial material is everywhere a mixture of sandstone, shale, and limestone. In some places there is a noticeable admixture of quartz gravel.

Cossayuna loam occurs in the northwestern part of the State on low ridges throughout the Champlain Valley. The largest areas are in the towns of Orwell, Benson, and Hubbardton.

The surface relief of Cossayuna loam is smooth. This soil occupies low sloping smoothly rounded hills that afford excellent drainage. Many areas occur in which the surface soil is thin, but even in such places the composition of the surface soil differs little from typical.

Nearly all the land is cleared and is used for pasture and mowing. It furnishes good bluegrass pasture. The ease with which the loose stone could be removed from this land (most of these were limestone and were burned for lime) rendered it suitable for cultivation at an early date. Later, mowing machines were used to advantage. Although most of the land is in pasture, it is capable of producing hay and many different cultivated crops.

Cossayuna loam, stony phase.—The stony phase of Cossayuna loam has a profile nearly identical with that of Cossayuna loam, but it contains more stone and many rib outcrops of the parent rock material. Small areas of dark soil occur on the ridges south from West Rutland. Nearly all this soil is in forest, and the small cleared areas are used for pasture. Like the typical soil, it furnishes fair or good grazing, but the stone content precludes its use for cultivated crops.

Lyons stony loam.—Lyons stony loam occupies small depressed areas scattered over the limestone valleys, which have uniformly poor drainage. This is the only poorly drained soil in the State developed from limestone till. The surface soil is dark brown and mucky to a depth of 8 or 10 inches. It is underlain by mottled yellowish-brown and gray heavy loam, which rests at a depth of 24 inches on gray more or less calcareous till. There is some stone in all areas of this soil, but in places there is a rather large content of stone. Most of the stone is quartzite, with some limestone and erratic igneous boulders. There are some unimportant small stone-free areas.

Most of this land is in pasture containing much hardhack and shrubby cinquefoil (*Potentilla fruticosa*). Some of the stonier areas are in forest. The land furnishes good pasture, even in dry seasons.

Copake fine sandy loam.—Copake fine sandy loam occurs on the terraces in the southwestern part of the State, in the limestone valleys and slate section, in small scattered areas on the islands of Lake Champlain, and in a few scattered areas throughout the limestone belt east of the Green Mountains. As mapped in Vermont, it has

many characteristics of the Palmyra and Hoosic soils mapped elsewhere. The areas developed in the limestone valleys of the southwestern part of the State are similar to the Palmyra soils of Berkshire County, Mass.

This soil has a brown fine sandy loam surface soil to plow depth, and in many forested areas there is a gray layer under the organic surface material. The subsoil is yellowish-brown friable fine sandy loam that grades, below an average depth of 24 inches, into mixed yellow and gray gravel and sand, which becomes stratified, loose, and open in structure below a depth ranging from 4 to 5 feet. The gravel consists of a mixture of materials—limestone, slate, and quartzite. Evidence of the soft rotted limerock exists within a depth of 3 feet, but little evidence of alkalinity is present above a depth of 24 inches. Although in most places there is enough calcareous material, below a depth ranging from 30 to 40 inches, to cause effervescence with hydrochloric acid, in places the calcareous material lies below a depth of 5 feet. In most places there is a noticeable quantity of gravel below a depth of 15 or 18 inches, and in other places much gravel is present above this depth and also scattered over the surface, but in few places in sufficient quantities to interfere with cultivation. The surface gravel is largely quartz.

Copake fine sandy loam, although acid in all soil layers, is not so strongly acid as the other soils on the terraces, and it is slightly better suited to crop production. In general, the soils on the terraces, owing to the open structure of the substratum, are not suited to grass. Good crops of hay, particularly clover and alfalfa, are produced on this land, however. It is used rather extensively for mowing. Only comparatively small areas, and these mostly old mowings, are in permanent pasture. There are, however, some abandoned fields. Hay (timothy and clover) yields from 1 to 1½ tons an acre, and alfalfa gives slightly higher yields, from 2 to 2½ tons. Oats produce from 40 to 60 bushels, potatoes average about 150 bushels, and silage corn yields from 8 to 12 tons an acre. These yields are obtained with good fertilization, as production of crops is rarely attempted on this land without lime, manure, and fertilizer.

This soil has developed from material washed from the slate in the southwestern part of the State and from slate and shale in the northwestern part. It has a profile much the same as the rest of the soils on the terraces, with the substitution of slate and calcareous shale for limestone and quartz. It has a small limestone influence. It is most prominently developed in the southwestern part of the State bordering the New York State line, where it is closely associated with the Dutchess soils.

The Copake soils are more acid than the soils derived from limestone. They are probably as well suited to grass as the limestone soils, but they are not naturally adapted to clover or alfalfa. Clover is grown, generally with the aid of lime. Potatoes yield from 150 to 200 bushels an acre, and other crops yield slightly less than on the terrace soils strongly influenced by limestone.

Schodack gravelly fine sandy loam.—This soil as mapped in Vermont is represented by two variations—(1) soil derived from limestone influenced by quartz and (2) soil derived from slate with some calcareous shale or limestone influence. The soil derived mainly

from limestone with a small admixture of slate and quartzite materials occurs in the limestone valleys of the southwestern part of the State from Brandon southward and to less extent in the valley of the limestone belt east of the Green Mountains. This soil is much the same as the soil mapped as Rodman gravelly loam in Berkshire County, Mass., except that the surface soil in forested places is well-defined gray soil material under the forest duff. In plowed fields the brown surface soil passes at a depth of 5 or 6 inches into a yellowish-brown subsoil. Both these layers are composed of mellow fine sandy loam containing a noticeable quantity of gravel. At a depth ranging from 15 to 20 inches the color becomes paler. The gravel increases with depth, and, below a depth ranging from 24 to 30 inches, the material is mixed gravel and sand, which contains enough limestone to effervesce with hydrochloric acid below a depth of about 3 feet. Owing to the broken surface relief and loose and open character of the substratum, drainage is inclined to be excessive. Most of the land is in pasture, mainly of bluegrass or colonial bentgrass. In most pastures, a growth of *Potentilla*, hardhack, juniper, and gray birch has sprung up. The grasses are used to a limited extent for mowing, and yields of hay are low, from one-half to 1 ton an acre or less.

The Schodack soils of the slate section differ from those of the limestone valleys in that they are developed from outwash, in which slate is the dominant material and the surface soil is brown. They occur scattered throughout the western part of Rutland and Bennington Counties, closely associated with the Dutchess soils. Like the other soils developed on kamelike surface relief, the land is well drained. Most of this soil is calcareous below a depth ranging from 6 to 8 feet. There are some areas, however, in which no free lime occurs.

Nearly all the Schodack gravelly fine sandy loam of the slate belt is cleared and is used for pasture. Mowing occupies a small area, and the land devoted to other crops is negligible. The soil furnishes fair grazing and is slightly more productive than the Hinckley or the Danby soils which will be described later. The stony areas, which are for the most part associated with the limestone-valley variation, contain many cobbles and boulders of quartz material, and such land is used exclusively for pasture, as it is not suited to cultivation.

Schodack gravelly fine sandy loam, light-textured phase.—The light-textured phase of Schodack gravelly fine sandy loam differs from the typical soil only in having a lighter texture and in containing little gravel in the substratum. This is a slightly poorer soil, and, with the exception of a small area in pasture, it is devoted to forest. This light-textured soil occurs in the limestone valleys and is derived mainly from limestone and quartzite.

SOILS OF THE CENTRAL PLATEAU

On the smoother areas of the northern part of the central plateau, the Calais, Blandford, and Worthington soils are developed. These soils have brown surface soils from 8 to 10 inches thick; yellowish-brown, quickly passing into greenish-yellow, subsoils; and greenish-gray compact substrata below a depth ranging from 20 to 24 inches.

They are prevailingly loams in texture and carry a comparatively small quantity of stone as compared with the other upland soils of the State, developed from glacial till. The surface relief is smooth or gently sloping, and drainage is well established. All these soils are adapted to grass and are used extensively for the production of hay (timothy and clover) and to less extent for small grains and intertilled crops than the soils of the Champlain Valley or soils of the limestone valleys of the southwest.

Most of the farms on these soils are of the dairy type, and this results in the use of large quantities of manure and comparatively small quantities of commercial fertilizer. In wet seasons yields of most crops are not good, but grass seems to thrive in either a wet or a dry season. The tendency for organic matter to accumulate on the soils is in part responsible for their dark color. The Calais are the most important of these soils, although the Worthington are more extensive and more widely distributed.

The Greensboro soils occur on the hillsides, associated with the Worthington and Calais soils, throughout the central plateau, where the soils are influenced by limestone. Owing to their position they are, in general, better drained than the other soils of this section.

On the broken and more rolling areas of the central plateau, outside the limestone section, the main two series of soils represented are the Berkshire and Becket. These soils have very similar profiles, but they differ in origin of material. They have brown mellow surface soils, yellowish-brown firm subsoils, and gray or greenish-gray compact substrata below a depth of 24 inches. They are well drained throughout, owing to their position and to the general steepness of the land. They contain a noticeable quantity of stone, even on the so-called " nonstony " soils. The stony soils are much more extensive than the nonstony ones and are for the most part in forest. It is the farms on these soils, especially those on the stony soils, that have been abandoned. Most of the pastures contain *Spiraea* (hardhack) and birch sprouts. These soils occur above an elevation of 1,400 feet in the southern part of the State and above 1,000 feet in the northern part. The crop acreage, other than the land in hay, is comparatively small.

The Hermon soils differ mainly from the Berkshire and Becket soils in that they have a loose substratum developed from shallow till derived from granite and associated with hard rocks. They have many boulders, both on the surface and embedded in the soil.

Calais loam.—Calais loam occupies extensive areas on the smooth upland in the area extending from Lake Memphremagog south to Randolph. It has an 8-inch dark-brown loam surface soil which grades into a greenish-yellow firm but friable subsoil becoming greenish gray and compact below a depth of 18 or 20 inches. This soil is derived mainly from a dark limestone with some phyllite schist, which is in part responsible for the dark color of the surface soil.

Only a small acreage is devoted to corn for grain, barley, wheat, and buckwheat, and a comparatively small acreage is in silage corn and oats. Crop yields are good; hay produces from 1½ to 2½ tons an acre, silage corn from 8 to 10 tons, and oats about 45 bushels. In general the soil lies too high and is too far north for best results

with corn and fruit. It is best suited to grass, and most of it is utilized for mowing. There are some good bluegrass pastures, but in general the soil is easily tilled, and mowings that have played out or are adjacent to stony hill land are used for pasture until such time as they can be conveniently reseeded.

Calais loam, stony phase.—The stony phase of Calais loam is not very extensive. Most of it occupies low hills, rising slightly above the general level of the typical soil, and gently sloping hillsides. Owing to the stone content, which interferes seriously with cultivation and the use of mowing machines, the soil is used for pasture. A large part of the forested area is covered with sugar maple groves.

Worthington loam.—Worthington loam lies within a belt east of the main belt of Calais soils, extending from Willoughby Lake to the vicinity of Cavendish, and in a small belt from Marlboro to the Massachusetts State line. This soil differs from Calais loam mainly in that it has slightly more rolling surface relief and is derived from material less influenced by limestone.

The surface soil is dark-brown loam 7 or 8 inches thick. It is underlain by yellowish-brown loam which extends to a depth ranging from 12 to 15 inches before grading into greenish-yellow firm but friable loam. Below a depth of 24 inches, greenish-gray rather compact till is reached. Like the Calais soil, the Worthington contains very little stone. It is well drained and slightly better aerated than Calais loam.

Grass is the main crop. Crop yields are about the same as, or a little lower than, on Calais loam, although potatoes yield from 150 to 250 bushels an acre. Orchard developments are small.

Worthington loam, shallow phase.—The shallow phase of Worthington loam differs from the typical soil in that bedrock lies within 3 feet of the surface. This shallow soil has a much lower value for crops and is used almost exclusively for mowing and pasture, for which purposes it seems to differ little from the typical soil. This is not an extensive soil but is well distributed throughout the typical areas of Worthington loam.

Worthington loam, stony phase.—The stony phase of Worthington loam is associated mainly with the typical soil in the eastern belt, but even there it is not so extensive as Worthington loam. It has the same general characteristics as the loam but has more stone on the surface and embedded in the formation from which it is derived. The stony areas occupy slightly more sloping ground or slightly elevated areas. The stone content in most places consists of dark impure limestone and schist. In some places the stones are granitic boulders, and in other places slabs of schist predominate. As it is good grassland and is otherwise unsuited for cultivation, this soil is used for pasture and for sugar maple groves.

Worthington fine sandy loam.—The profile of Worthington fine sandy loam is much like that of Worthington loam, except that the substratum is much lighter and consists mainly of partly rotted limestone and schist. This soil is developed on the smooth tops of ridges in the northeastern part of the State, mainly in the towns of Danville, St. Johnsbury, Lyndon, and Wheelock, in Caledonia County. It is used for the same crops as Worthington loam but returns slightly lower yields of most crops. It is, however, a good soil for

grass and is used mainly for this purpose. Mowings occupy by far the largest crop acreage. Records indicate that yields of potatoes are not very high. The land is fairly well suited to clover and other legumes.

Worthington fine sandy loam, stony phase.—The stony phase of Worthington fine sandy loam is used mainly for pasture for the same reasons that the other stony soils derived from limestone are used for that purpose. The included soils on the hillsides, associated with the Calais and Worthington soils, really belong to the Greensboro series. They have brown subsoils that extend to a depth of 20 or 24 inches and have more disintegrated or partly disintegrated limestone in the substratum than do the Calais or Worthington soils. Drainage is equally well established, although seepy spots appear on the hillsides in places.

Worthington fine sandy loam, shallow phase.—This soil differs from the typical soil in having a shallower profile to bedrock. The bedrock consists of dark micaceous schist and dark impure limestone, occurring in most places at a depth ranging from 24 to 30 inches beneath the surface. In many places it is partly disintegrated. Soil of this phase has nearly the same agricultural value as the typical soil and is used for the same crops.

Blandford loam.—Blandford loam has a profile similar to that of Worthington loam. In places there is little or no brown color in the subsoil, and the soil contains no partly rotted porous limestone fragments and boulders, so common to the Worthington soil. This soil, like the Worthington, is good grassland. It is used extensively for mowing and to a small extent for other crops. Yields are slightly lower than on the Worthington soil, although Blandford loam outranks the other soils derived from noncalcareous material in the production of grass. It contains little stone.

Blandford loam is rather extensively developed in the northwestern part of Orleans County and in the northeastern part of Franklin County. It occurs to some extent in the northeastern part of Orleans County, east of the Green Mountains in Lamoille County, and in the western part of Washington County. It also extends along the ridge tops in the southern part of the central plateau, in Halifax, Marlboro, and Newfane Towns in Windham County, and in scattered bodies in the western part of Windsor County. One of the most important areas is on the Mount Holly plateau in the southeastern part of Rutland County.

Blandford loam, stony phase.—The stony phase of Blandford loam is not very extensive, and, like the stony phases of the rest of the smoother plateau section, it is used mainly for pasture.

Blandford loam, shallow phase.—The shallow phase of Blandford loam represents areas of the loam in which bedrock is less than 3 feet below the surface, yet has a covering of soil thick enough to support a good grass sod. This shallow soil is used extensively for mowing. It occurs closely associated with the typical soil.

Greensboro loam.—Greensboro loam, as typically developed, has a 6- or 7-inch dark-brown surface soil. It is underlain by yellowish-brown firm but friable loam to a depth ranging from 15 to 20 inches, where it grades through a greenish-yellow layer into greenish-gray somewhat compact till. All this soil carries some stone, but not suffi-

cient to interfere with cultivation. The stones consist of impure limestone and schist, together with some erratic boulders.

Greensboro loam is equally well suited to grass as the other soils of this section, but, owing to the steeper surface relief, the use of mowing machines or other machinery is more difficult, and for this reason a larger area is in pasture. A rather large number of sugar maple groves are on this soil.

There are several variations of the Greensboro soils as mapped. Areas occur in the high valley west of the Green Mountains in the towns of Lincoln and Ripton, in Addison County; in somewhat larger areas in the southwestern part of the limestone belt, in the central part of Orange County; and in Pomfret, Sharon, Barnard, and Royalton Towns, in Windsor County, in which the limestone influence is not quite so noticeable as in the Greensboro soils in the northeastern part of the central plateau. The result is that crop yields are slightly lower. The land supports a good grass sod, but the bluegrass pasture is not quite so good as on the typical Greensboro areas. The included areas are browner in the surface soil, and the yellowish-brown color extends to greater depth, but this is caused mainly by the rust color of the schist rock and is of little agricultural significance.

Small areas included with Greensboro loam occupy low smoothly rounded hills or drumlins and have much the same profile as typical Greensboro loam, except that the deposits are much deeper and more compact than normal for this soil. This gives a moisture-holding capacity common to few soils. Although this is not a primal necessity in this section, it aids in the production of crops. As drainage is good, crops do not suffer in wet seasons, as they may do on the Calais and Worthington soils. This included soil is not extensive. It occurs in the northeastern part of the plateau in the town of Wheelock. Although grass is the main crop, other crops common to the section are successfully grown. The yields on this included soil compare favorably with those obtained on the Worthington soils. Very little of the land is in forest, and comparatively small areas are in pasture. Mowings of timothy and clover occupy the greater acreage.

Greensboro loam, shallow phase.—The shallow phase of Greensboro loam is closely associated with the brown Greensboro loam. It occurs in small scattered areas in the long, narrow valley west of the Green Mountains known as the Lincoln, or Ripton, Valley. This shallow soil resembles the brown Greensboro soil in color, but it is underlain at a depth ranging from 24 to 30 inches by brown, partly rotted schist or limestone. This soil is used successfully for potatoes and for cultivated crops in a greater proportionate area than the typical soil.

Greensboro loam, stony phase.—The stony phase of Greensboro loam occupies a greater total area than the nonstony part of the soil. Much of this land is in forest containing many sugar maple groves. The cleared area is almost entirely in pasture. The small areas cropped are used for the same crops and are attended with about the same success so far as yields are concerned.

Most of this stony land on the drumlins in Wheelock Town and vicinity is cleared and used for pasture, as the stones interfere with cultivation and also with the use of mowing machines.

Greensboro fine sandy loam.—Greensboro fine sandy loam is developed on both the gently and steeply sloping hillsides in the northeastern part of the central plateau in the towns west and southwest of St. Johnsbury Town.

The profile is similar to that of Greensboro loam, except that the structure of the lower subsoil layer is not so compact as the corresponding layer of the loam, and beds of rotted micaceous limestone are reached in most places at a depth ranging from 30 to 40 inches below the surface. In places the deeper part of the subsoil consists of greenish-gray firmer till which rests on bedrock at a depth ranging from 4 to 6 feet. In places where this soil occurs on drumlin forms the substratum below a depth of 24 inches is compact till which ranges from 20 to 25 feet in depth.

Most of this soil is cleared and under sod. Its excellent structure and thorough drainage render the land amenable to cultivation, but for some reason it is little used for intertilled crops. It is excellent grassland, supporting a good bluegrass sod. It is highly suited to clover, and this legume is present in practically all mowings.

Greensboro fine sandy loam, stony phase.—The stony phase of Greensboro fine sandy loam has the same physiographic and agricultural relations to the typical soil that the stony phase of Greensboro loam has to the loam.

Berkshire loam.—Berkshire loam is the most important soil of the central plateau and also the most widespread, extending in small detached areas from a point near the Canadian border on both sides of the Green Mountains to the Massachusetts line. This soil is derived mainly from schist and it is strongly acid. It is fair grassland, and where smooth enough and not abandoned is in mowing. Grass cuts an average of 1 ton of hay an acre. Timothy and redtop and other grass mixtures are more common in the mowings than clover, although some clover is grown.

Berkshire loam, shallow phase.—In the shallow phase of Berkshire loam the soil has a thickness ranging from about 24 to 30 inches over bedrock. It is used almost exclusively for hay and especially for pasture.

Berkshire stony loam.—Berkshire stony loam is far more extensive than Berkshire loam. Most of the land contains enough stone to interfere with cultivation, and no great area of this soil has ever been cultivated. A large area was at one time in pasture which has grown up in forest during recent years. The cleared area is used for pasture, but much of the pasture land has become overgrown with sprouts. Some of the soil is extremely shallow.

Small areas of Berkshire stony fine sandy loam are included with the stony loam. This included soil occupies rough hillsides and is mainly in forest.

Berkshire fine sandy loam.—Berkshire fine sandy loam covers a much less extensive area than Berkshire loam. It occurs well scattered over the section in which the Berkshire soils predominate. The profile is similar to that of the loam, but in many places the substratum is less compact. Agriculturally, this soil is used to about the same extent as the loam. Crops in general, and grass in particular, yield slightly less than on the loam.

Becket loam.—Becket loam occurs only in the southern part of the central plateau, where it occupies fairly smooth areas. The soil profile is similar to that of Berkshire loam, but the Becket soil is slightly more compact. Agriculturally, Becket loam is better than Berkshire loam, because it occupies larger and smoother areas which are better suited to farms. Crop yields are about the same on the two soils but slightly in favor of the Becket.

Much of this land has been abandoned and the pastures have grown up to birch sprouts. There are, however, probably more farmers continuing their operations on this soil than on any other in the southern, or rougher, part of the plateau.

In some large areas of Becket loam, bedrock lies within 3 feet of the surface but in few places is exposed. Here the moisture-storage capacity is not so great as in the typical soil. Land of this kind is free from stone, and mowing and cultivation are feasible. Crop yields are slightly lower than on the typical soil. The land is used mainly for mowing. It is not so well suited to deep-rooted crops, but grass seems to succeed.

Becket loam, red-subsoil phase.—This soil differs from the typical soil in that the subsoil is red or reddish brown, whereas the subsoil of the typical soil is brown. The subsoil is also heavier than the subsoil of Becket loam. This soil occupies only a small area in the towns of Dover and Newfane. All the soil contains much stone, and the rougher hillsides are very stony. The stonier land is used for pasture, and a small area is in mowing.

Becket fine sandy loam.—Becket fine sandy loam resembles Becket loam in all respects except the texture of the surface soil and the structure of the substratum. The substratum is not so compact as in the loam, or rather the compact layer lies at a greater depth. This soil is much less extensive than the loam, but it is used for the same crops. Potatoes probably do better than on the loam, but yields of other crops are lower.

Becket stony loam.—The surface soil of Becket stony loam consists of a 1- or 2-inch layer of gray fine sandy loam under the forest duff. It is underlain by a brown layer of the same thickness which passes into yellowish-brown fairly firm loam that becomes mottled just above the substratum. The substratum consists of very compact gray till lying at a depth ranging from 18 to 24 inches. This tight substratum serves to hold the surface water which, owing to the smoothly sloping surface relief of much of this section, is removed with difficulty. Many large depressions of Whitman stony loam and peat are associated with this soil, and many depressed areas, too small to map separately, are scattered throughout bodies of this soil. The stone content is too great for profitable cultivation.

This soil is extensively developed in Essex County. Nearly all the land is covered with forest, and it has little agricultural value. Small areas around the edges of the forests are used for pasture. A large number of contiguous low swampy areas of peat and Whitman stony loam make access to this section difficult.

Extensive areas of Becket stony loam are associated with Becket loam. As the stony soil occupies the steeper and rougher hillsides and narrow ridges, it is for the most part in forest. The small cleared areas are used for pasture and furnish fair grazing where the brush is not too thick.

Hermon stony fine sandy loam.—Hermon stony fine sandy loam is extensively developed in the northeastern part of the State. This soil is the same as Becket stony loam, except that it has a comparatively loose gray substratum in place of the compact substratum of the Becket soil. The larger number of boulders consist of granite, gneiss, and quartzite. In general this soil occupies rough land, large areas of which are in forest. Only a fair proportion of the land is used for pasture, and little is used for cultivated crops. For grass, this soil is inferior to most of the upland soils, and the stone content precludes its use for other crops.

This soil includes small areas of Hermon fine sandy loam, mainly in the northeastern corner of the State, small bodies in the Lincoln-Ripton Valley, scattered areas extending from that valley south along the west base of the Green Mountains, and small scattered areas in other parts of the central plateau. The included soil has a lower crop value than either the Berkshire or Becket soil of the same texture, owing primarily to the looseness of the substratum, which gives to the soil a lower moisture-holding capacity. The land is not so well suited to grass as the Becket and Berkshire soils but is used more extensively for this crop, both for pasture and mowing, than for other crops.

Hermon stony fine sandy loam, like the other soils derived from noncalcareous material, is strongly acid. Clovers and legumes do not succeed so well as on the soils derived from limestone material.

Shallow areas of this soil bear the same relation to the typical soil as the shallow phases of other soils already described. They represent a soil, ranging from 20 to 30 inches in thickness, resting on hard bedrock. Owing to its freedom from stone, this land can be used for the same crops as the nonstony areas of the typical soil, but it is generally used for mowings and pasture.

Peru stony loam.—The imperfectly drained areas scattered over the central plateau are occupied by the Peru soils which occur only in small bodies.

Peru stony loam has a dark-brown surface soil and a brown subsoil which becomes yellowish brown and mottled with rusty brown and gray before reaching the substratum of compact gray and greenish-gray till. The surface relief ranges from level to gently sloping and drainage is imperfectly established. The stone content is normal for the stony soils of this section. The stones are granite, gneiss, schist, and impure limestone, according to the locality in which the soil occurs.

The land is used almost exclusively for pasture which contains much arborvitae and alder. Some areas are heavily wooded with spruce and balsam fir.

Small areas of nonstony soils are included with this soil. Nearly all the nonstony areas are cleared or have been cleared at some time in the past and used mainly for pasture. They support much arborvitae and hardhack. Small areas are used for mowing, but no cultivated crops are grown, as in wet seasons crops would drown out. The land furnishes good grass in dry seasons, but it is difficult to harvest hay in wet seasons, as the ground becomes very spongy. This included soil is closely associated with the Becket and Berkshire soils and occurs to some extent in association with the Worthington and Blandford soils.

Colton fine sandy loam.—Colton fine sandy loam has a profile similar to that of Merrimac fine sandy loam, which is described later. It is developed on the terraces over the northeastern part of the State, and to a limited extent west of the Green Mountains in a narrow, intermittent belt along the east side of the limestone valley. It is used for the same crops and yields are about the same as those obtained on Merrimac fine sandy loam. In general, yields are lighter than on the Copake soils, except of potatoes, which yield equally as well on Colton fine sandy loam as on any soil in the State. This soil probably is not quite as well suited to corn as the Merrimac soils, as it occurs farther north and much of it at higher elevations, where corn does not mature so well.

The gravelly and stony areas are more prominently developed along the base of the western foothills of the Green Mountains. These areas contain much gravel, cobbles, and boulders of quartz material. They are not highly suited for farming. About one-half of the land is cleared and used for pasture, and a small amount is used for mowing and crops. Yields are not very high, as the soils are not very productive. They are not good soils for grass and afford but poor grazing.

Colton fine sandy loam, heavy-subsoil phase.—The heavy-subsoil phase of Colton fine sandy loam resembles the typical soil, with the exception that it has a slightly heavier and more compact substratum below a depth of 24 inches. This soil occupies rather high positions and for this reason is mainly in mowing. It is used to a small extent, however, for potatoes which produce good crops. It has a better moisture-holding capacity than the soils with light substrata. The total area of this soil is small, but it has a wide distribution. There are several small bodies in southeastern Essex County and in northeastern Caledonia County in the northeastern part of the State. Other areas are scattered throughout the northern part of the State.

Colton loamy coarse sand.—Colton loamy coarse sand is developed mainly on the terraces in the northwestern part of the State, where granitic material predominates. With the exception of the gray layer under the forest duff, the profile corresponds to that of Merrimac loamy sand. This soil is used to such a small extent for crops that it may be classed as forest land. It is covered with spruce, larch, white (canoe) birch, and aspen, with a ground cover of blueberries, ferns, and sand willows.

Danby gravelly fine sandy loam.—Danby gravelly fine sandy loam differs from Hinckley gravelly sandy loam in that it has a gray surface soil developed under the forest duff. As in the other soils of this section, this indicates a different climatic condition, however slight. This soil is developed throughout the northeastern part of the State and extends along the eastern base of the Green Mountain foothills to the Massachusetts line. Although not extensive, the areas are widely distributed. The areas west of the Green Mountains are derived largely from quartzite, and they have a slightly lower value than the rest of the land.

Danby gravelly fine sandy loam has about the same crop value as the Hinckley soil, which is not very high. It is probably slightly better suited to grass, as it occurs farther north and is higher. Therefore, moisture conditions should be slightly better. The stony areas of

Danby gravelly fine sandy loam bear the same relation to the Danby soil that the stony areas in the Hinckley soils bear to Hinckley gravelly sandy loam. They occur in about the same proportion and are not important, even in the sections in which they are mainly developed.

Danby loamy sand.—Danby loamy sand is distinguished from Hinckley loamy sand by the gray layer under the forest duff. Most of this soil is derived from quartzite and contains little gravel or stone. The largest areas lie along the western base of the Green Mountains, where the soil is associated with the gravelly Danby soils and the Hermon soils.

Most of the land is covered with forest, and where cleared there is danger of soil drifting. The land has a very low agricultural value.

SOILS OF THE EASTERN HILL SECTION

The Merrimac, Colrain, and Shelburne soils are the leading soils of the eastern hill section. The Colrain and Shelburne soils are all influenced by limestone, although they differ somewhat in the depth of the deposits from which the soil is developed. The glacial drift from which the Colrain soils are developed is shallow, ranging from 2 to 4 feet in thickness, whereas the Shelburne soils are derived from deep till, which ranges from 10 to 25 feet in thickness. The Colrain and Shelburne soils occupy smoothly rolling or hill country which affords good drainage. They all have brown surface soils, yellowish-brown mellow subsurface soils, and greenish-yellow or greenish-gray subsoils, although they differ in depth to the substratum and also in the structure of the substratum. The Colrain soils have firm but not compact substrata, whereas the substrata of the Shelburne soils are compact. These soils are characterized by rust-brown, partly disintegrated limestone scattered over the surface and throughout the deposit from which the soils are derived. The Merrimac soils occupy smooth terraces having gravelly substrata. They are acid and well drained.

Merrimac fine sandy loam.—Merrimac fine sandy loam is the most important member of the Merrimac series. It has a brown mellow surface soil 5 or 6 inches thick and a yellowish-brown friable subsurface soil which grades into pale-yellow gravelly fine sandy loam at a depth ranging from 15 to 20 inches. This material grades, between depths of 24 and 30 inches, into loose gravelly sandy loam that becomes a bed of stratified sand and gravel below a depth ranging from 40 to 48 inches. A fairly large area, which has a sandy loam texture, is included with this soil in mapping. The sandy loam areas are slightly less productive than the typical soil, as crops suffer in dry periods more readily than on the fine sandy loam.

The largest areas of Merrimac fine sandy loam are on the terraces along the lower reaches of Connecticut River and tributary streams, particularly near the mouths of the streams, and on the terraces in the stream valleys in the central part of the State from Montpelier south.

Nearly all the land is cleared and is used rather extensively for mowing or for cultivated crops. Yields are only moderate, except where the crop is highly fertilized. Mowings of timothy and clover

cut from 1 to 1½ tons an acre, oats yield from 40 to 60 bushels, and potatoes from 125 to 250 bushels, depending on the season and fertilization. The higher yields are obtained with the use of both manure and fertilizer. A large acreage is devoted to potatoes. Such vegetables as sweet corn, cabbage, squash, and asparagus are grown to some extent.

This is one of the easiest soils in the State to cultivate, as it is mellow and free from stone. Cultivations can be made within a comparatively short time after rains without serious injury to the soil. Owing to the favorable texture and structure of the soil, root penetration is easy. Although the moisture-absorbing and moisture-holding capacity are not so good as in some of the heavier soils. the land retains enough moisture for growing crops in normal seasons.

Gravelly areas of Merrimac fine sandy loam contain from 30 to 40 percent of gravel in the material above the subsoil, but otherwise they are like the typical fine sandy loam. This gravelly soil is slightly more porous and slightly less productive than the fine sandy loam. It is, however, better suited to orcharding than the typical soil, as the gravel acts as a mulch when the land is lying fallow. It is used for the same crops as the typical fine sandy loam.

Most of the stony areas contain about the same quantity of gravel and in addition contain some stones consisting of small rounded granitic and quartzitic boulders. Most of the gravelly and stony areas are covered with forest consisting of white pine, scrub oak, and soft maple, accompanied by a ground cover of sweetfern and huckleberry. Many of the stony areas, where cleared, are in pasture, although they furnish but scant grazing.

Merrimac loamy sand.—Merrimac loamy sand occurs in scattered areas associated with other Merrimac soils. Besides differing in texture, this soil contains little gravel in the subsoil which is composed of coarse sand consisting of granite and quartz grains. This land is commonly termed "sand plains", and it is little valued for farming. Much of it is covered with forest typical of the Merrimac soils, with the addition of pitch pine. The cleared areas which have been abandoned are in broomsedge and running, or common, cinquefoil. The cultivated areas produce extremely low yields, and in dry seasons crop failures are general.

Agawam fine sandy loam.—Agawam fine sandy loam is developed on the terraces of Connecticut River and to a small extent on tributaries of this river. The surface soil is fine sandy loam or very fine sandy loam. This soil surpasses the Merrimac in structure and moisture-holding capacity, and it is therefore one of the best soils occurring on the terraces.

Besides being used in the production of the common crops of the State, this soil is used for sweet corn, potatoes, other vegetables, and tobacco. Yields are excellent, potatoes producing from 150 to 250 bushels an acre and tobacco from about 1,200 to 1,500 pounds of good grade cigar wrapper and filler tobacco. It is on this same soil that much of the tobacco and onions of Hampshire and Franklin Counties, Mass., are grown.

Agawam fine sandy loam, Podzol phase.—The Podzol phase of Agawam fine sandy loam occurs on the terraces along the northern reaches of Connecticut River. The surface soil is grayer than that

of the typical soil. This soil is too far north to mature many of the crops grown in the southern part of the State. It is, however, highly suited to potatoes, the main crop grown on this land, which yield 150 to 250 bushels an acre. Fertilization practices are the same as on the typical soil.

Agawam loamy fine sand, Podzol phase.—The Podzol phase of Agawam loamy fine sand occurs in close association with the Podzol phase of the fine sandy loam and differs from that soil only in texture of the surface soil. It does not have such good moisture-holding capacity as the Podzol phase of Agawam fine sandy loam, and therefore is not so productive. It is used for practically the same crops as those grown on the fine sandy loam, but with lower returns. Fertilizer is more apt to leach away and be lost, and crops are not so certain in dry seasons. An excellent grade of tobacco is grown on this soil in Massachusetts.

Hinckley gravelly sandy loam.—Hinckley gravelly sandy loam has much the same profile as the Merrimac gravelly soils. This soil differs from the Merrimac soils only in that it has rougher surface relief.

Most of the land is cleared and used for pasture, with a comparatively small area in mowing. It is not valued very highly for agriculture. The pastures furnish only fair or poor grazing, as the land is too droughty to be well suited to grass. Hay normally yields from one-half to three-fourths ton an acre, and in dry seasons the crop is a failure. The land can be used for orcharding, but it is not highly recommended for this purpose if other and better land is available. It is fairly well suited to small fruits and brier berries. The forest growth is scrub oak, pitch pine, gray birch, and white birch, accompanied by much sweetfern and huckleberry.

The substratum furnishes good road material. A rather large proportion of the soil is gravelly fine sandy loam. The stony areas contain, besides gravel, a quantity of rounded cobbles and boulders of granite and quartz. The stones interfere with cultivation to such an extent that the land is left in forest or, if cleared, furnishes a low-grade pasture.

Hinckley gravelly sandy loam, light-textured phase.—This phase of the Hinckley soil has much the same profile as the other Hinckley soils, except that it contains no stone and very little gravel. It has a low agricultural value, and most of the land is wooded. A wind-blown variation of this soil occurs in small scattered areas in the Connecticut Valley and also in the sand plains of Chittenden County. It has the same surface relief and in general the same soil profile. It contains no gravel, and all the material is loamy fine sand or fine sand. This land has a low agricultural value and is rarely used for crops. In places, where the surface soil has been disturbed by cultivation, the soil material has a tendency to shift.

Woodbridge loam.—Woodbridge loam occurs in the belt between the Pittsfield soils and the higher areas that skirt the base of the Green Mountains. This soil also occupies scattered areas over the eastern hill section. Some bodies that have a fine sandy loam surface soil are included in mapping. The outstanding feature of

this soil is the compact substratum which retards the movement of water and root penetration. The 2-foot layer above the substratum is fairly well drained.

Woodbridge loam occupies gently sloping hillsides which in most places receive a certain amount of seepage water from higher ground. This land is excellent for grass but not particularly suited to other crops. It is highly acid, and clovers do not succeed so well as on the Pittsfield soils.

Woodbridge loam, stony phase.—The stony phase of Woodbridge loam is rather extensive and occurs in association with the typical soil. The land is divided about equally between forest and pasture. It furnishes about the same quality of pasture as the typical soil, which may be considered good. It also includes a large acreage devoted to sugar maples.

Woodbridge loam, imperfectly drained phase.—The imperfectly drained phase of Woodbridge loam occupies the lower slopes that receive drainage water from the higher adjacent soil areas. It is associated with Woodbridge loam, west of the Green Mountains in the central part of Franklin County and extends in irregular spots as far south as the town of Richmond.

The profile is similar to that of the loam, except that there is a more pronounced mottling above the hard compact substratum, and in this respect it resembles the Canfield soils of central New York. Some stony spots occur, but these are not large and do not detract from the value of this soil as a grass soil. It is inferior, however, to the typical soil as farming land. For this reason it is mainly in pasture, and, as it furnishes good grass, most of the land is cleared. Some of the land is in mowing, but cultivated crops are grown only to small extent.

Colrain fine sandy loam.—Colrain fine sandy loam is extensive and is probably the most important soil of this section. It occurs in scattered areas in a belt extending through the towns of Guilford and Brattleboro northward to the town of Weathersfield and in scattered areas north from Ascutney Mountain to the vicinity of St. Johnsbury. It is derived from schist and impure limestone, similar to the material from which the Worthington soil is derived, but the Colrain soil is much browner and also occurs at a much lower general level.

Although the moisture-holding capacity is fairly good, like on most shallow soils of this section crops may suffer to some extent during excessively dry seasons. From 60 to 70 percent of the land is cleared and farmed. Grass (for hay and pasture) and apples are the leading crops. Hay yields from 1 to 1½ tons an acre, silage corn from 8 to 10 tons, and potatoes from 100 to 150 bushels. The pastures are good, as they contain much bluegrass besides colonial bentgrass. The shallowness of this soil and the presence of rib rock are responsible for the small area in intertilled crops.

In the vicinity of Woodstock and Reading post office, Colrain fine sandy loam is browner to a greater depth than in other areas of this soil; in many places it is decidedly brown to a depth of more than 3 feet. The subsoil and substrata are mealy or fluffy and not compact, as in the Shelburne soils, nor composed of partly disintegrated rock, as in the typical Colrain soils. This included soil occupies rather

steep hillsides which in general are too steep for successful cultivation. As this is excellent bluegrass land it is nearly all cleared and in pasture. Some areas are in mowing. Little else than hay is grown, although this mellow soil should produce excellent crops of vegetables where the relief allows cultivation.

Colrain fine sandy loam, stony phase.—The stony phase of Colrain fine sandy loam is associated with the typical soil and is slightly more extensive. It contains much more rib rock and also more loose stone. Much of this soil occurs on steep hillsides. About one-half of this stony land is covered with forest. The cleared area is used for pasture. The stony areas of the browner soil are mainly in forest, and a small area is used for pasture.

Colrain loam.—Colrain loam occupies a much smaller area than Colrain fine sandy loam. It is, however, a slightly better soil, as the substratum is heavier and is thicker overlying the bedrock. For this reason the land is used more for cultivated crops and gives uniformly better yields.

Colrain loam, stony phase.—The stony phase of Colrain loam is essentially the same as the typical soil, except in its stone content, which gives the land a lower agricultural value.

Shelburne loam.—Shelburne loam has a compact substratum, in this respect resembling Woodbridge loam. The Shelburne soil, however, has a number of partly disintegrated limestone boulders embedded in the substratum, which render it more porous than the Woodbridge soil. Water is not held above the substratum, but the soil has good moisture-holding capacity and, therefore, is better suited to cultivated crops than the Woodbridge soil and is about equal to Colrain loam for crop production. The land is used for mowing (timothy and clover), silage corn, and apple orchards.

The total area of Shelburne loam is not large, but this soil is well distributed over the eastern hill section and the lower parts of the central plateau.

Shelburne loam, stony phase.—The stony phase of Shelburne loam is less extensive than the typical soil. Most of the stone consists of granitic boulders. The land is used for pasture.

Charlton loam.—Charlton loam is not extensive, but with its dark-colored phase is the best farming soil in the group of noncalcareous soils of the eastern hill section. It occurs in small areas scattered over the soil belt in the southeastern part of the State just back from the Connecticut Valley terraces. The surface relief in general is smooth, as the soil occupies the flattened ridge tops where the glacial deposits are a little thicker than on the hillsides. This land is used more extensively for farming than Hollis fine sandy loam and gives generally better yields. Where well farmed, the yields compare favorably with those on the Colrain soils and of many crops range slightly higher. This land is used more extensively for cultivated crops, as the structure renders it better suited for cultivation.

The dark-colored areas of Charlton loam are the best soils in this group. They have a dark yellowish-brown mellow loam surface soil passing at a depth of 6 or 7 inches into a greenish-yellow firm but friable loam subsoil which grades downward, at a depth of 18 or 20 inches, into greenish-gray firm but not compact loam. Below a depth ranging from 24 to 30 inches is the substratum of greenish-gray till

The dark color is inherited from the argillite in the parent material.

This dark-colored soil occupies smooth-topped ridges and smooth valley walls, where drainage is good. It occurs in the southeastern part of the State and in intermittent narrow strips northward to the vicinity of Lunenburg Town.

Nearly all the land is cleared and is used for the crops common to the upland soils of this section. Hay yields an average of 1 ton an acre and corn silage an average of about 10 tons. Mowing, which is mostly from wild grasses, receives little attention.

Charlton loam, stony phase.—The stony phase of Charlton loam occupies the steeper hillsides and broken ridges and is associated with Charlton loam. This land is mainly in forest of white oak, chestnut oak, and gray birch. The cleared areas are used almost exclusively for pasture. Some areas having dark surface soils are included with this soil. They are associated with the areas derived from graphitic schist.

Hollis fine sandy loam.—Hollis fine sandy loam is predominantly a shallow brown fine sandy loam soil, with the schist bedrock at an average depth of 2½ feet below the surface. Although this so-called "thin land" is not particularly strong, it is used for mowing and for apple orchards.

Hollis stony fine sandy loam.—In the northwestern part of the State in Franklin County and extending south into Chittenden County, mainly on the ridges throughout areas of the Woodbridge soils, is a shallow brown fine sandy loam soil which ranges in thickness from 12 to 24 inches over bedrock. This soil is not particularly stony, but in numerous places bedrock is exposed. The relief in general is steep. The land has a low value for farming, and most of it is in forest or is used for pasture. Most of the pastures are filled with brush, and the grass is not of very high quality. As the moisture reserve in the soil is not great, grass has a tendency to fail in dry seasons. The stony fine sandy loam in the southeastern part of the State contains many shallower areas, in which bedrock is exposed in spots. This included variation of soil has a very low agricultural value and is mainly in forest.

Gloucester stony fine sandy loam.—An inextensive soil in the eastern hill section is Gloucester stony fine sandy loam. It is developed along the lower reaches of the West River section in Jamaica, Townshend, Newfane, Springfield, Chester, Cavendish, and Weathersfield Towns. This soil has a brown mellow surface soil to normal plow depth, passing into mellow yellowish-brown fine sandy loam which grades downward into gray loose till composed mainly of granitic material. It contains numerous boulders of the parent material. Most of this land is in forest, and a few cleared areas are in pasture. It contains sufficient boulders to prevent or seriously interfere with cultivation and the use of mowing machines. In many places the surface relief would allow both were it not for the stone. The nonstony areas have a slight advantage over the stony areas in that they are less stony and smoother and therefore slightly more productive. This land is used for the same crops as Charlton loam, but yields are lower.

Whitman stony loam.—Whitman stony loam occupies depressed areas that have poor natural drainage. It occurs in small bodies well scattered over the State, except in the limestone areas. This

soil has a dark-brown or almost black mucky surface soil from 8 to 12 inches thick. It is underlain by mottled yellowish-brown, rust-brown, and gray loam which passes at a depth of 24 inches into gray till presenting a wide variation in the degree of compaction, from more or less loose to tightly compact, but in general firm in place. The land is covered with a growth of red maple, gray birch, arbor-vitae, and spruce, according to elevation, and there is a heavy undergrowth of alder and other water-loving shrubs. This soil is not used for agriculture.

SOILS OF THE BOTTOM LANDS

The soils on the flood plains of the streams may be divided into three groups as follows: Well-drained soils, imperfectly drained soils, and poorly drained soils. In the group of well-drained soils are included the Genesee and Hadley; in the group of imperfectly drained soils, the Ondawa and Saco; and in the group of poorly drained soils, alluvial soils, undifferentiated.

The Genesee soils are widespread over the bottom land, and the Hadley soils are the most productive soils of the bottom lands if not of the entire State.

Hadley very fine sandy loam.—Hadley very fine sandy loam is the most important soil on the bottom lands in the State. It is developed on the high bottom land of Connecticut River. This soil lies above normal overflow and is covered only by extremely high flood waters. It has a dark yellowish-brown surface soil to plow depth, which is underlain by greenish-yellow or olive-colored mellow very fine sandy loam. Both the subsoil and substratum are mellow and friable throughout.

As this soil has excellent structure and good moisture-holding capacity, it may be considered very productive. Crop yields on this soil in Vermont do not compare with yields obtained on the same soil in the tobacco and onion districts of Massachusetts, because it is not so intensively farmed. In Vermont the common farm crops for this section—hay (timothy and clover), corn (for silage and grain), wheat, and some small grains—are grown with only a normal quantity of manure or fertilizer.

Hadley very fine sandy loam, low phase.—Hadley very fine sandy loam, low phase, occupies the normal overflow land along Connecticut River and to some extent along the streams which receive drainage water from the dark-colored rocks of the central plateau, mainly along Winooski River from Bolton to Winooski. It is similar to the typical soil in color and structure of the profile. It includes small areas of silt loam texture.

Farming is carried on largely without the use of fertilizer. The land is utilized for pasture, mowing, and to a small extent for corn and a very few other crops. Hay yields about 1½ or 2 tons an acre, corn for grain from 45 to 65 bushels, and silage corn from 10 to 15 tons.

Genesee silt loam.—Genesee silt loam occupies slightly lower and wider bottoms than does Ondawa fine sandy loam. It is developed mainly in the bottom lands of Otter Creek. It is used more extensively for mowing than for any other crop, although some corn is grown. Like most well-drained silt loam bottom lands, it is productive, and yields compare favorably with those obtained on the Hadley soils. The material from which this soil is derived receives most of

its deposits from limestone regions, and it has an alkaline subsoil. It is similar to the Genesee soils of New York. In places the lower part of the subsoil is imperfectly drained.

Ondawa fine sandy loam.—Ondawa fine sandy loam is a much browner soil than Hadley very fine sandy loam. The subsoil is yellowish brown, and the substratum is pale yellow and gray. The structure is much the same as in the Hadley soil, but the Ondawa does not contain quite so much fine material. This soil includes some areas of very fine sandy loam texture and some of sandy loam.

Ondawa fine sandy loam is widely distributed over the State, occurring along nearly all the large streams. Crop yields are slightly lower than on Hadley very fine sandy loam. Hay yields from 1 to 1½ tons an acre and corn from 40 to 60 bushels.

Where this soil occurs along streams near the base of the mountains, there is apt to be much gravel and some stone. These areas are the results of floods, and some were caused by the 1927 flood. Good bottom land is often rendered useless or of low value for farming following such disastrous floods.

Ondawa fine sandy loam, imperfectly drained phase.—The imperfectly drained phase of Ondawa fine sandy loam has a profile similar to that of the typical soil in texture and in structure, but it has a darker brown surface soil, a darker yellowish brown subsoil, and a mottled rust-brown and gray substratum. The mottled condition of the substratum is caused by imperfect drainage. In places even the subsoil is mottled.

This imperfectly drained soil is not extensive. It is used for mowing and pasture. Grass can be produced and the land used for mowing without artificial drainage.

Ondawa silt loam, imperfectly drained phase.—The imperfectly drained phase of Ondawa silt loam is similar to Ondawa fine sandy loam in all respects except texture. The imperfect drainage results in mottling occurring a few inches closer to the surface. The imperfectly drained phase occurs on Black Creek in Franklin County, where it is used for mowing. Good yields of timothy and redtop are obtained.

Saco silt loam.—Saco silt loam has a 7- or 8-inch mellow brown silt loam surface soil which is underlain by mottled rust-brown and gray material passing at a depth of 20 inches into greenish-brown or bluish-brown silty clay loam which, although heavy, is not intensely plastic. Like the other bottom lands this soil is used for mowing and pasture. Hay yields are good, but little attention is given to farming. Most of this soil is alkaline in the subsoil. The land needs drainage for best results, but owing to the heavy subsoil thorough drainage is difficult to secure.

Alluvial soils, undifferentiated.—These undifferentiated soils occupy overflow land along the smaller streams, that is invariably poorly drained. They vary considerably in texture but most of them are fine sandy loam. The surface soil is prevailingly dark brown and mucky to a depth of 8 or 10 inches, and the mottled rust-brown and drab subsoil changes below a depth ranging from 20 to 30 inches to dark-gray very fine sand or rather heavy clay. The land is used for mowing and especially for pasture.

In many places, owing to floods, quantities of gravel, sand, and even cobbles are deposited on this land. In places the deposits are

thin, but in other places they are several feet thick. Many such areas have been rendered practically useless for agriculture.

MISCELLANEOUS LAND TYPES

Rough stony land occurs mainly in the Green Mountains and in Essex County, but it also occupies numerous smaller areas in nearly all parts of the State. Muck, peat, and marsh occupy low bottom lands and filled-in lake beds where water stands on the surface throughout most of the year. The muck is used to a limited extent for wild hay, otherwise these soils are of little agricultural value. It would be impractical to drain large areas as frost damage to growing crops would be great in late spring and early fall.

Rough stony land.—Rough stony land consists of land too rough and broken or too stony for profitable farming. Some of the land could be used for pasture were the demand acute enough, but under existing economic conditions it is better utilized for forest, and probably 95 percent is covered with forest.

The areas of rough stony land in the northeastern part of the State, particularly in Essex County, are composed of Hermon stony fine sandy loam containing an excessive quantity of granitic boulders; the areas in most of the Green Mountains north from the Mount Holly plateau are Berkshire stony loam containing a large quantity of schist rocks; and those in the southern reaches of the Green Mountains are Becket stony loam, containing predominantly large granite gneiss boulders. In other sections the character of the land reflects the character of the native rock, as most of the rough stony land is thinly glaciated.

Rough stony land, mountain phase.—The mountain phase of rough stony land includes the stony mountain land that furnishes only fair or poor forest and may be considered as having no value other than scenic.

Muck.—Muck is composed of a mixture of brown organic material and mineral soil material, and it is shallow, in few places more than 3 feet thick. Much of this land is covered with wild grasses, but in most places there is a thick growth of alder and red maple.

Peat.—Peat is a deeper deposit than muck, consisting of brown fibrous partly digested organic matter. It is invariably covered with a growth of red maple, tamarack, and spruce.

Marsh.—The marsh areas are covered with marsh grasses. This land occupies the low intermittently water-covered areas along Lake Champlain and the lower courses of contributory streams. It has little or no agricultural value.

AGRICULTURAL METHODS AND MANAGEMENT

As already pointed out, farming practices in Vermont differ to some extent in different sections. Dairying, the leading type of farming, is followed in all sections but in various degrees of development. The dairy farms are concerned mainly with crops necessary to the production of milk, and the acreages of these crops vary widely in the different sections. The adjuncts to dairy farming and the other phases of the farm unit also differ according to the section.

In the Champlain Valley, in the limestone valleys of the southwestern part of the State, and on the soils developed on the terraces, a larger proportionate acreage is devoted to mowing than to pasture,

and the proportion of the land in cultivated crops compared with that in mowing is greater than in other sections. In some parts of these sections the cultivated crops vary in their proportions to mowing and pasture to even a greater extent. On the islands of Lake Champlain and the territory just east of the lake farming is more intensified. Silage corn, oats, barley, beans, and alfalfa are grown on a larger scale than in other parts, thereby reducing to a minimum the cost of feed purchased. The farmers in the rest of the valley follow more or less this type of agriculture, but hay (timothy and clover) predominates over other crops.

Over the central plateau mowing occupies the larger proportionate acreage of the total farm land. In the limestone section of the plateau clover and timothy predominate, whereas over the noncalcareous areas timothy and redtop are the leading grass crops.

In the Champlain Valley, when sod is turned in preparation for seeding grass, a rotation is practiced that includes corn the first year and oats or barley with timothy and clover the second year. The grass is used for mowing until such time as convenient to change, which is ordinarily from 3 to 6 years or even longer. Under the best farming conditions the shorter period of mowing is prevalent. Mowings may run for an indefinite period and be used eventually for pasture. When a sod is turned the land is usually limed, and if a cultivated crop is grown it is fertilized.

Over the rest of the State sod land is not changed so often as on the better valley land, because in general it is not easily tilled. The indefinite period is observed by many farmers. The same practice is followed in many places on the low clayey soils of the Champlain Valley. Often oats, buckwheat, or barley are planted as a catch crop, and no fertilizer is used, especially where the preceding crop was fertilized. Under these conditions, where a sod is turned, a nurse crop of some small grain may be used with the grass, and sometimes the grass is seeded without a grain crop. If pasture is desired, which may be the case on a stony piece of land where it is difficult to use a mowing machine, bluegrass is added to the mixture. In the higher sections many sugar maple groves grow, from which most of the underbrush has been cleared, and the land is used for pasture.

In the southern part of the central plateau and in the Taconic Mountains and the eastern hill sections the acreage in pasture predominates over that in mowing, and intertilled crops are largely confined to small patches on the terraces, where silage corn, potatoes, vegetables, and small grains are grown. On these terrace lands sod is turned frequently, because the land is adapted to and is used for cultivated crops to greater extent than the hill land.

In the areas where commercial orcharding is followed, which is only in the lower parts of the State, in the Champlain Valley, low hills bordering the Taconic Mountains, and eastern hill section, farming methods are essentially different from those followed on the dairy farms. Most of the orchards are cultivated, fertilized, and sprayed. Cultural methods in the orchards require extensive and frequent cultivations in spring and early summer, and in most of the orchards it is common practice to sow cover crops about midsummer rather than to keep the land in sod or under clean cultivation throughout the season.

Fertilizer and manure are used in different quantities, according to the amount available, farming conditions, and the crop desired. Although the total quantity of commercial fertilizer used is not large, many crops are not attempted without some fertilizer. On the dairy farms the tendency sometimes is to make too liberal applications of manure and to depend entirely on this soil amendment, whereas some fertilizer is needed with certain crops.

Modifications of the "New England standard nine" (*6*, pp. 25–28) fertilizer are used, with a large proportion of superphosphate and some nitrate of soda. This is not surprising when it is considered that the soils of Vermont and also farming practices differ from those of most of New England. Under Vermont conditions the New England standard nine becomes the "Vermont standard seven", as 0–12–6 [6] and 5–4–5 are not used. Three-fourths of the fertilizer sold in Vermont, however, conforms, in a general way, to the New England standard nine. Grades sometimes employed for general use are 5–8–7 and 4–8–4. From 250 to 500 pounds of 3–10–4, from 250 to 300 pounds of superphosphate, or from 100 to 150 pounds of nitrate of soda, in addition to manure, are used on silage corn and for top-dressing sod. From 500 to 1,000 pounds of 3–10–4 or 5–8–7 are used for vegetables. Potatoes are not grown on a commercial scale without applications of high-grade fertilizer, usually from 500 to 1,500 pounds an acre of a 4–8–4, 5–8–7, or 10–16–14 grade, in which the potash ingredient is usually muriate. From 2,000 to 2,500 pounds of 5–3–5 or 7–4–7 grades, in which the potash is in the form of a sulphate, are used in the Westminster tobacco district. From 300 to 500 pounds of superphosphate are used for oats and beans. Heavier applications are often made where hay is to follow these crops. Nitrogenous fertilizers are used for the trees in orchards, and fertilizers suited to the cover crop are also used.

The Vermont Agricultural Experiment Station has carried on a number of field trials that are pertinent to or have a direct bearing on many of the soils of the State. Thirty-six percent of the alfalfa trials in 1905, described in Bulletin 114 (*7*), were successful. It is significant that 10 out of 12 of the permanently successful alfalfa plots were located in the Champlain Valley. So far as can be determined, these plots were on Addison clay loam, Addison loam, Addison loam, shallow phase, and the better drained areas of Vergennes clay loam. The two areas outside the valley were on bottom land which, owing to its position, received much wash from limestone material. Livingston clay loam on South Hero Island is used successfully for alfalfa, and it is reasonable to assume that the rest of this soil, if properly drained, would be equally well adapted to this crop. About one-half of the alfalfa crop of the State is grown in Addison and Grand Isle Counties on the five soils just described as being adapted to alfalfa.

On the imperfectly drained heavy clay soils, alfalfa has a tendency to heave out during winter (*5*). For this reason the flat areas of Addison clay loam, the level stretches of Vergennes clay loam, Livingston clay loam in its natural state, and the heavy phase of Suffield silt loam are not recommended for alfalfa, but practically all the soils derived from limestone are suited to this crop. Such well-drained soils as Pittsfield loam, Stockbridge loam, and Copake fine

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

sandy loam are fairly well suited to alfalfa and are used in Berkshire County, Mass., and Columbia and Rensselaer Counties, N. Y., to a limited extent for this crop.

The heavy calcareous soils and particularly the darker soils of the Champlain Valley are highly adapted to the culture of dry beans, and it is on this class of soils that they succeed best. The well-drained areas of Livingston clay loam and the shallow phase of Addison loam are included in this class and are well suited to this crop.

Apple orchards succeed in Massachusetts and also in Vermont on Colrain fine sandy loam, Colrain loam, Shelburne loam, Shelburne loam, stony phase, and Dutchess loam, and on Charlton loam and Hollis fine sandy loam, where not too shallow. Commercial orchards are also developed on the Dutchess, Pittsfield, and Addison soils in Massachusetts, New York, and Vermont. Such soils as Ondawa fine sandy loam, imperfectly drained phase, Saco silt loam, alluvial soils, undifferentiated, Whitman stony loam, and Peru stony loam come under the class of soils mentioned in the fourteenth report of the Vermont Agricultural Experiment Station (*11*, p. 237), on which bluegrass and red clover will not succeed. The station recommends the growing of redtop and alsike clover after the wetter or imperfectly drained areas, where sedges, rushes, blueflag, and grasses—bluejoint, false redtop, cut grass, reed canary grass, and fowl meadow grass—grow, are drained. Fowl meadow grass, the most valuable of these wild grasses, and tame grasses should replace the rushes.

From present indications dairying, that is, the production of market milk and cream, will continue to be the leading type of farming. Dairying will in all probability expand, and the production of crops which successfully maintain dairy cattle may occupy most of the farmers' time. This at least may be expected in the more favorable locations. Such enterprises as apple orcharding and the production of smaller fruits, of maple sugar and sirup, and of poultry should not be neglected, however, as these may prove successful where dairying may not. The back areas, which have been abandoned, are a problem. They can of course be allowed to revert to forest, for which purpose alone a large area is undoubtedly suited. An extensive area of cleared land is in abandoned pastures, grown up mainly to brush, and the roots of the brush serve to keep the soil from slipping down the hillsides. If the land is not utilized for sheep grazing, for which purpose it is admirably suited, it will in a short time revert to forest. Such areas lie mainly on the central plateau in the southern part of the State. Further information on land utilization in Vermont may be obtained from Bulletin 357 of the Vermont Agricultural Experiment Station (*2*).

SOILS AND THEIR INTERPRETATION

The soils of Vermont belong to the general group of podzolic soils. They are divided into three soil provinces as follows: (1) The true Podzols of the north country, (2) the brown, or incipient, Podzols of New England, and (3) the Gray-Brown Podzolic soils of the North Atlantic States.

The part of the State lying above an elevation ranging from 1,200 to 1,500 feet at the Massachusetts line and from 750 to 1,000 feet at the Canadian border belongs to the true Podzol province. There

are exceptions to this rule, however, as many of the sandier soils are true Podzols developed at lower elevations, and there are heavy loams which are not strongly podzolized at the higher elevations.

The soils of the rest of the State, with the exception of certain soils of the Champlain Valley and the limestone valleys of the southwestern part, which belong to the Gray-Brown Podzolic soil province, are included with the incipient Podzols.

The true Podzol soils cover the greater part of the State, but the group of Gray-Brown Podzolic soils is comparatively small. The soils in these regions are the results of biological and climatic forces acting on the parent material. The resultant soils vary according to stage of development and difference in parent material. In a glacial region, where most of the material was accumulated by glacial action, the development differs radically from that of soils in a residual region, in the comparative youth of the formations from which the soils are derived and their lack of development. Soil development in Vermont has taken place in most places only to a depth ranging from 15 inches to 2 feet; in few places deeper. Where erosion has played such a small part, the hillsides are developed to equal or greater extent than the plateau levels, because eluviation and particularly oxidation have been more active than on the more level terrain, although in the nonglacial region, a residual soil on a hillside, owing to erosion, is invariably younger and less developed than the soils on the plateau.

The mode of deposition or method of accumulation of the parent material has had as great an influence on the resultant soil as the character of the rock material from which it was derived. The lithological character of the parent-rock material has had a marked bearing on the distribution of the soils. In Vermont there are six formations resulting from the methods of accumulation of the parent material, besides some spots where the raw rock has been left exposed by the removal of the weathered material by glacial action. They are (1) glacial till, including sheet till or ground moraine, drumlins, and drumloid forms of deep till and morainic material, (2) outwash material in the form of kames and eskers, more or less hummocky and composed of gravel and sand, (3) outwash material in terrace forms with level or smooth surfaces, (4) lacustrine deposits, most of which are heavy and calcareous, (5) stream deposits or recent alluvial material, and (6) organic accumulations.

Imperfect or poor drainage has had little influence in the development of the soils, as there is a comparatively small part of the total area of the State that is poorly drained or even imperfectly drained, or that shows development under a high water table.

On the smoother parts of the central plateau, the Worthington, Calais, and Blandford soils are developed. Worthington loam may be taken as the most representative of these soils. A description of a complete profile of a sample taken 8 miles west of Lyndon, Vt., is as follows:

0 to 3 inches, dark-brown organic matter, leaf mold, and moss.
3 to 4½ inches, light-gray fine sandy loam.
4½ to 5 inches, brown fluffy loam.
5 to 12 inches, yellowish-brown fine but friable loam.
12 to 24 inches, greenish-yellow firm but friable loam.
24 to 48 inches, greenish-gray partly altered till which is only fairly compact and contains schist and limestone boulders in all stages of decomposition.

Below a depth of 48 inches, dark greenish-gray raw till which is compact in place.

In places the brown B horizon extends to a depth of 18 inches.

The pH values of samples of Worthington loam taken at different depths are as follows: From 0 to 3 inches, 4.4; from 3 to 4 inches, 4.4; from 4 to 12 inches, 5.2; from 12 to 24 inches, 6.0; from 24 to 48 inches, 5.9; and from 48 inches +, 6.2.

On the more broken areas of the central plateau, occurring on gently sloping or steeply sloping hillsides and in places on smooth ridge tops, the Berkshire, Becket, Hermon, and Greensboro soils are found. Berkshire loam is typical of the soils of this group.

Samples of Berkshire loam, taken 5 miles north of the town of Weston, on a hillside 1,800 feet above sea level, show the following layers:

0 to 2 inches, dark-brown or black organic matter or leaf mold.
2 to 3 inches, gray fine sandy loam.
3 to 4 inches, very dark brown or coffee-colored mellow fine sandy loam and loam.
4 to 12 inches, brown mellow loam.
12 to 20 inches, pale yellowish-brown firm but friable loam.
20 to 38 inches, pale greenish-yellow compact partly weathered till.
38 to 48 inches +, gray very compact gritty raw till.

The stony areas of this soil are apt to contain much rib rock and blocks of schist. The soil throughout the entire profile is acid, as shown by the pH determinations of samples of Berkshire loam, taken in Hampden County, Mass.: From 0 to 2 inches, 3.6; from 2 to 4 inches, 4; from 4 to 12 inches, 4.8; from 12 to 24 inches, 5.1; and from 24 to 48 inches, 5.2.

The Woodbridge soils occur on the hillsides and lower slopes of the central plateau, in the foothills west of the Green Mountains, and in the eastern hill section. These soils occur below the level on which Podzol profiles develop in soils with loam textures in this latitude and under the rainfall of this region. The forest is predominantly sugar maple, together with some beech, yellow birch, and white birch.

Samples of Woodbridge loam, collected near Underhill, Vt., show the following profile:

0 to 3 inches, dark-brown mellow loam.
3 to 12 inches, brown or yellowish-brown firm but not compact loam.
12 to 30 inches, yellowish-gray firm loam.
30 to 48 inches +, tightly compact till.

The soil throughout the entire profile is acid. The pH values of the soil material in different layers of Woodbridge loam 2 miles east of Granville, Hampden County, Mass., are as follows: From 0 to 2 inches, 4.0; from 2 to 6 inches, 4.6; from 6 to 12 inches, 4.7; from 12 to 20 inches, 4.8; from 20 to 30 inches, 5.1; and from 30 to 48 inches, 5.3.

In most places the substratum is so compact that moisture passes along the top of the compact till, particularly if there is higher ground from which to drain, as there is in most places.

An imperfectly drained phase of this soil occurs on the low smoothly sloping hills in the foothills northwest from the Green Mountains.

Shelburne loam has much the same profile as Woodbridge loam, but the Shelburne soil is influenced by limestone, and much of it occurs as low smooth hills or drumlins. The limestone rock embedded in the till is in many places partly rotted, and moisture passes readily

through these porous spaces. The pH values of different layers of Shelburne loam from Franklin County, Mass., which will serve to show the differences between these two soils, are as follows: From 0 to 2 inches, 5.1; from 2 to 10 inches, 5.4; from 10 to 18 inches, 5.9; from 18 to 24 inches, 6.1; and from 24 to 48 inches, 6.3.

Besides the Woodbridge and Shelburne soils, the Colrain, Charlton, Hollis, and Gloucester soils are well-drained upland soils of the eastern hill region. All these soils are derived from comparatively shallow till, and they differ mainly in the character of the parent material.

Colrain fine sandy loam is the most typical and probably the most extensive of these soils. It is derived from schist and limestone, and much rib rock is present in the stony phase. A description of a profile of this soil 2 miles west of Guilford Center is as follows:

0 to 5 inches, dark-brown mellow fine sandy loam.
5 to 20 inches, yellowish-brown mellow fine sandy loam.
20 to 26 inches, greenish-yellow mellow fine sandy loam.
26 to 36 inches, greenish-gray fine sandy loam.

The entire profile contains a quantity of brown schist and rust-brown partly disintegrated limestone. In places bedrock is reached within a depth of 3 feet, and in few places is it deeper than 5 feet. The pH values of different layers of Colrain fine sandy loam at Colrain, Mass., a few miles south of this section, are as follows: From 0 to 5 inches, 5.2; from 5 to 10 inches, 5.6; from 10 to 20 inches, 5.2; and from 20 to 30 inches, 6.5.

Colrain loam, which occupies a small total area, has developed from a slightly deeper and heavier formation. This soil is characterized by fewer protrusions of rib rock and more loose boulders. It invariably occurs on ridge tops.

The variation of Colrain fine sandy loam in the vicinity of Woodstock is much browner than the typical Colrain soils. The brown color extends to bedrock, which in most places is about 3 feet below the surface. The soil is derived from limestone, with only a slight schist influence. Brown soils develop from the material produced by weathering of either of these rocks. The difference between the browner soil and typical Colrain fine sandy loam is clearly shown by a comparison of pH values. The pH values of different layers of the included soil are as follows: From 0 to 1½ inches, 6.5; from 1½ to 3 inches, 6.3; from 3 to 8 inches, 6.3; from 8 to 20 inches, 6.2; from 20 to 36 inches, 6.4; and from 36 to 48 inches, 6.5.

The Charlton soils are derived from schistose, argillite, and granite rock material, and they reflect the character of the parent material. The surface soils are heavier and decidedly darker than the corresponding layers of the Colrain or Hollis soils. These soils have rich-brown firm B horizons, which pass at a depth of 18 or 20 inches into greenish-yellow or greenish-gray medium heavy fairly compact C horizons. The deposits from which the Charlton soils are derived are considerably thicker than the deposits from which the Hollis or Gloucester soils are derived. In places they contain many bluish-gray slate fragments, which intensify the dark color, but they contain little stone.

The Gloucester soils, although they have a similar profile, as regards depth and arrangement of horizons, as the Hollis soils, are somewhat thicker over bedrock. The Gloucester soils are derived

from granitic material, which gives rise to numerous boulders and a loose or firm but not compact C horizon or substratum.

The poorly drained soils of the upland are represented by the Whitman and Lyons soils. These soils occupy depressions between hills and gentle slopes on low ground around ponds or stream bottoms. They are, in general, stony. They have dark-brown mucky surface soils, yellowish-brown, mottled with drab gray, B horizons, and gray C horizons which range from loose to highly compact, but are invariably waterlogged. Lyons stony loam is associated with the limestone soils, and Whitman stony loam occurs over the rest of the upland. The Lyons soil has an alkaline substratum, whereas the Whitman soil is acid throughout.

The Pittsfield, Madrid, Stockbridge, and Farmington soils are developed on the well-drained upland of the limestone valleys in the southwestern part of the State and on the low ridges adjacent to the Taconic Mountains. These soils have smooth gently rolling or sloping surface relief. They all are influenced by limestone, but the extent of this influence varies. The depth of the deposits differs in the different soils. These soils, with the exception of the Madrid soil, which is podzolized, belong to the soils having brown surface soils.

The Pittsfield soils are the most typical soils of this group. Following is a profile description of Pittsfield loam 5 miles south of Bennington:

0 to 6 inches, dark-brown granular loam.
6 to 15 inches, yellowish-brown firm loam.
15 to 24 inches, pale-yellow or gray, streaked with brown, firm loam.
24 to 48 inches, dark greenish-gray till mixed or streaked with brown or reddish-brown and white or gray fairly firm gritty till. The brown, gray, and white streaks and patches are caused by disintegrated and partly disintegrated pieces of calcite limestone and dolomitic limestone.

The pH determinations of samples of Pittsfield loam, taken 2½ miles south of Shoreham, will serve to show the comparatively small quantity of calcareous material that has been removed by leaching. All of this soil is not quite so alkaline as this sample, as there is an intergrade between the Pittsfield and the Madrid soils. The pH values are as follows: From 0 to 6 inches, 6.5; from 6 to 14 inches, 7.4; from 14 to 18 inches, 7.6; and from 18 to 36 inches, 8.1.

The Dutchess, Cossayuna, and Nassau soils are developed from shallow deposits of materials derived from slate and shale. They occur in the Taconic Mountains and foothills and on the low ridges scattered throughout the Champlain Valley. They are in general well drained.

The Dutchess soils are derived almost entirely from slate and are acid throughout the entire profile. The loam and stony loam are developed from deposits that are in few places deeper than 3 feet, and in most places many large and small slate fragments are on the surface. The stony areas also contain quartz rock and a small quantity of "grit" rock, or conglomerate.

A profile of Dutchess loam shows the following layers:

0 to 5 inches, dark-brown loam containing some organic matter.
5 to 12 inches, dark yellowish-brown loam mixed with slate fragments.
12 to 24 inches, yellow or pale-yellow slate loam.
24 to 36 inches, bluish-gray till composed largely of small slate fragments.

On the clay deposits of the Champlain Valley and in smaller scattered areas in other parts of the State, the Addison, Vergennes,

Suffield, Sheldon, and Livingston soils are developed. All these soils, except the Livingston, have fair drainage, but only the Addison and Sheldon can be termed well drained, and even the substratum of the Sheldon is to some extent impervious to the downward movement of moisture. These soils occupy smooth or level topographic positions.

The Addison soils are the only soils of this group which occupy a position sufficiently undulating to afford good drainage and a measure of aeration necessary for oxidation. The following description is of a profile of Addison clay loam 1 mile southeast of Vergennes.

0 to 6 inches, grayish-brown or brown clay loam.
6 to 12 inches, reddish-brown clay loam.
12 to 20 inches, pale reddish-brown clay loam or clay.
20 to 36 inches, yellowish-brown clay which has a blocky structure. The material in this layer is alkaline but does not effervesce with hydrochloric acid.
36 to 48 inches, gray or grayish-brown clay streaked with white calcareous material. The lower part of the layer contains small odd-shaped pieces of claystone which is highly calcareous.

Addison loam is browner in the surface horizon, but the clay present at a depth ranging from 18 to 36 inches is dark gray in color and blocky in structure. The shallow phase of this soil rests on fairly disintegrated calcareous shale at a depth ranging from 18 to 24 inches. The pH values of different layers of Addison loam, shallow phase, 1½ miles north of Grand Isle, are as follows: From 0 to 5 inches, 7.1; from 5 to 12 inches, 7.5; from 12 to 20 inches, 7.6; and from 20 to 30 inches, 8.0.

The Vergennes soils occur on the extensive level areas where drainage is at least imperfect. Although the Addison and Vergennes clay loams are derived from the same material, the contrast between the two soils is so great that a description of a profile of the Vergennes soil, 3½ miles west of Addison, is given for comparison.

0 to 3 inches, dark-brown clay loam or loam, containing some organic matter from grass roots.
3 to 8 inches, whitish-gray silty clay loam.
8 to 9 inches, reddish-brown clay or clay loam.
9 to 15 inches, brown clay loam containing some yellow mottles.
15 to 24 inches, gray clay strongly mottled with yellow and yellowish brown.
24 to 48 inches, dark-gray clay of decidedly blocky structure. Some lime nodules are present at a depth ranging from 4 to 6 feet below the surface.

The pH values for the same samples of Vergennes clay loam are as follows: From 0 to 3 inches, 6.6; from 3 to 8 inches, 6.1; from 8 to 15 inches, 7.1; from 15 to 24 inches, 8.2; and from 24 to 48 inches, 8.3.

In places, the surface soil of Vergennes clay loam is grayish brown and the reddish-brown clay layer is entirely lacking. In other places the reddish-brown clay layer extends to a depth of 10 or 12 inches below the surface, but in few places is closer than 4 inches. Soil of this kind occurs on the gentle swells throughout the flat areas. In many places the C horizon, below a depth of 20 inches, is strongly impregnated with lime nodules and white streaks of lime material.

Livingston clay loam occupies low depressed areas which have poor drainage. The 1- to 12-inch surface soil is dark brown or almost black, and the soil in the rest of the profile is similar to that in the Vergennes soil, except that it contains more mottles above the gray clay. The clay also is highly mottled and effervesces faintly with hydrochloric acid below a depth of 24 inches, and strongly below a

depth of 30 inches. The pH values of different layers of Livingston clay loam, one-half mile west of Addison, are as follows: From 0 to 7 inches, 7.0; from 7 to 17 inches, 6.6; and from 17 to 24 inches, 6.7.

The Adams soils are prevailingly loamy fine sands, and their profiles differ so radically from those of the other soils formed on the terraces that a description is given for comparison. The location of the profile described is 1 mile south of Fletcher.

0 to 2 inches, dark-brown organic matter and leaf mold.
2 to 6 inches, gray fine sand.
6 to 7 inches, dark-brown mellow loamy fine sand.
7 to 15 inches, yellowish-brown loamy fine sand.
15 to 30 inches, pale yellowish-brown or yellow loamy fine sand.
30 to 48 inches, gray fine sand composed almost entirely of quartz and containing some dark mineral particles.
48 to 120 inches, bedded fine sand, very fine sand, and sand of the same character as that in the horizon above.
Below a depth of 10 feet, calcareous clay.

These soils are developed mainly on the sand plains of Chittenden County.

The pH determinations of samples of this soil from the same locality are as follows: From 0 to 2 inches, 3.8; from 2 to 6 inches, 4.2; from 6 to 15 inches, 4.8; from 15 to 30 inches, 5.4; and from 30 to 48 inches, 6.1.

Developed on the outwash materials, or terraces, are the Merrimac, Colton, Adams, Agawam, and Copake soils. The Colton and Adams soils have Podzol surface soils. The Merrimac, Agawam, and Copake soils are not so extensive as the Colton and Adams soils. All the soils of this group, except the Agawam and Adams, have gravelly or coarse sandy substrata.

Colton fine sandy loam is the most extensive soil of the group. A description of a profile of this soil follows:

0 to 3 inches, dark-brown organic matter.
3 to 4 inches, gray or purplish-gray fine sand.
4 to 5 inches, very dark brown fluffy fine sandy loam.
5 to 15 inches, yellowish-brown friable fine sandy loam.
15 to 20 inches, pale yellowish-brown fine sandy loam containing some gravel.
20 to 36 inches, fairly loose and open gravelly sand passing below into layers of stratified sand and gravel, largely of quartzitic and granitic material, which are loose and open in structure.

Some of the Colton soils contain much gravel, even in the upper horizons. The loamy coarse sand member of the series contains very little gravel, even in the C horizon. The parent material consists of granite gneiss, schist, and quartzite, and the soil is highly acid throughout the entire profile.

The heavy-subsoil phase of Colton fine sandy loam occurs at high elevations and is derived from the dark-colored materials found mainly in the central plateau. This soil has a podzolized surface soil similar to that of the typical Colton soil. It passes, at a depth ranging from 15 to 20 inches, into rather compact greenish-gray loam, the C horizon, that has a somewhat platy and vesicular structure, therein differing, not only from the typical Colton soil but from the other soils on the terraces.

The Merrimac soils are derived from the same material as the Colton, but they occur at lower elevations, mainly in the southeastern part of the State. The surface soil is dark brown, but does not develop into a Podzol. These soils have the same textural variations as the Colton.

Throughout Vermont, the outwash material which has a hummocky surface relief is known geologically as kames. The Danby, Hinckley, and Schodack soils are developed on such material. The Danby are the most extensive of these soils, and the following description of a profile of Danby gravelly fine sandy loam, 2 miles north of Salisbury, is fairly representative of the arrangement of the soil horizons in soils of this group.

0 to 1 inch, dark-brown organic matter.
1 to 3 inches, gray or purplish-gray sand.
3 to 15 inches, brown or yellowish-brown sandy loam.
15 to 24 inches, pale-yellow or pale yellowish-brown sandy loam containing some gravel.
24 to 36 inches, a layer of sand and gravel, which is fairly loose and open in structure.

The parent material consists of quartzite, granite, and other crystalline rocks of this region. Small areas containing well-rounded boulders occur here and there but are not common. Areas of loamy sand are associated with this soil. The material throughout the entire profile is strongly acid. The Danby soils are developed in small scattered areas over the northern part of the State. The areas west of the Green Mountains are strongly influenced by quartzite.

The soils of the first bottoms are represented by the Ondawa, Genesee, Hadley, and Saco soils, in addition to alluvial soils, undifferentiated. All these soils are young and have no definite profile development, except areas on the higher and better drained bottoms, where a rudimentary profile is developed. The fine sandy loam and silt loam textures are dominant in the bottom lands. There are, however, small areas of loamy fine sands and others in which gravel and even stones have been washed onto the surface by excessive floods. This latter condition is more prevalent in the meadow pastures near the base of the mountains, and it is this class of land which suffered most during the 1927 flood.

The soils of the Ondawa series are the most widespread, and they occur on the well-drained bottoms of streams in nearly all parts of the State. Ondawa fine sandy loam is the most extensive and most typical Ondawa soil. Following is a description of a profile of this soil 2½ miles northwest of Bennington.

0 to 6 inches, brown mellow fine sandy loam.
6 to 20 inches, yellowish-brown mellow fine sandy loam which becomes paler with depth.
20 to 24 inches, pale-yellow fine sand.
24 to 36 inches, gray fine sand.

The pH values of the alluvial soils differ considerably, according to the section in which they occur. Where much of the drainage is received from, or influenced by, limestone, the soil is mildly acid, neutral, or slightly alkaline in places, and where the soil is derived from noncalcareous rock material it is acid or strongly acid.

The alkaline soils belong to the Genesee series, and they occur mainly along Otter Creek.

Alluvial soils, undifferentiated, is a classification applied to low poorly drained bottom lands having no well-defined texture or profile.

Muck occupies the bottom lands in which the soil consists of fairly well decomposed organic matter mixed with mineral soil material. Most of the muck deposits are shallow and are underlain by sand

at a depth ranging from 20 to 36 inches. In a few places the deposits are 5 feet thick. Drainage is even poorer than in the undifferentiated alluvial soils. Peat represents filled-in lakes consisting of raw and partly decomposed fibrous brown peat. The deposits range in thickness from 3 to more than 20 feet.

SUMMARY

Vermont is in the northwestern corner of the New England States, adjoining the Canadian border. Its north-and-south length is 160 miles, and the total area is 9,124 square miles. The Green Mountains, which extend north and south through the center of the State, are the outstanding physiographic feature. The average elevation of this mountain range is between 2,000 and 3,000 feet above sea level, and a few peaks rise to a height of 4,000 or more feet. East of the mountains is the central plateau which lies at an elevation of 1,800 feet in the southern part and 1,000 feet in the northern part. This plateau is characterized by broad, smooth, somewhat flattened ridge tops and narrow deeply incised valleys. Northwest of the foothills of the Green Mountains lies the Champlain Valley, a broad smooth section ranging from 100 to 500 feet above sea level. South of this is the Taconic Mountain range and hill section, with the interspersed limestone valleys which culminate in the fairly broad southwestern valley lying at an elevation ranging from 500 to 1,000 feet. Southeast from the central plateau there is a broken hill section, known as the "eastern hill section", which ranges from 750 to 1,200 feet above sea level.

Fully 90 percent of the land in the State is well drained and supports, or originally supported, a heavy tree growth extending to the tops of the higher mountain ranges. At present, according to the 1930 census, 40 percent of the State is cleared, and the land is used for crops and pasture. The cleared land is about equally divided between crop land and pasture, and in addition to this there is an equivalent area of woodland used for pasture. The rest of the State is forested, with the exception of that part occupied by cities or towns and a few rocky and marshy areas.

Vermont has always been a livestock country, owing to the abundance of grass. Dairying has replaced the raising of cattle and sheep because of market demands, and on account of competition from the Western States in the production of meat animals. The combination of the physical qualities of the land and the location in respect to large centers of population has made this section especially suited to dairying.

The relation of the soils to the crops grown on them depends on a wide range of factors that are expressed in the individual soil types.

Grass is the leading crop, and this grows more or less luxuriantly in nearly all parts of the State, but Kentucky bluegrass, timothy, and clover reach their best development on soils that are derived from limestone and still contain some calcareous material. Soils of this class are more extensive in the Champlain Valley than elsewhere in the State. All the soils of the major groups of the Champlain Valley are highly calcareous at depths ranging from 15 to 36 inches. They have the highest lime content of the soils of the State and compare favorably with the other soils of the Eastern States derived from limestone. Besides grass (timothy and clover), silage corn, oats, barley, buckwheat, beans, and alfalfa are

grown extensively and successfully on the soils of the Champlain Valley. Owing to the smooth surface relief and freedom from stone, which allows easy cultivation and the use of machinery, a comparatively high percentage of the cultivated crops is grown in this section.

The soils have been developed under a heavy forest growth in a humid climate. The cold winters have prevented leaching through a long period of the year. At higher elevations, above 1,000 and 1,200 feet, which prevail over a large part of the State, conditions are favorable to the accumulation, under forest cover, of a fairly thick (1 or 2 inches and in some places thicker) layer of organic matter on the surface and for the development of Podzol soils. Beneath the surface organic layer is a gray layer, from which the iron and soluble salts have been removed with the organic acids, and below the gray layer is the brown zone of accumulation. This zone is brown or yellowish brown, but is in few places indurated. At lower elevations, under the normal rainfall for this region, the soils are brown, fading below to yellowish brown, and they have a well-defined organic layer on the surface. These areas are covered mainly with deciduous trees, whereas conifers predominate at the higher elevations. At low elevations, below 400 or 500 feet, and where the rainfall is 30 inches or less, represented by a small area in the northwestern corner of the State, Gray-Brown Podzolic soils are developed, which have a thin organic surface layer mixed with mineral soil. The conditions under which all the soils have developed precludes the accumulation of carbonates in the surface soil.

A large area of the State was cleared during the early settlement of the United States, and since that time much of the cleared land has been in grass. As grass has a tendency to combat the influence of leaching the fertility from the surface soil and to build up a condition under which it thrives, the soil in this layer has been considerably altered and improved under the grass influence. The development of the surface soil differs considerably with the texture of the soil material, as the lighter textured soils are more easily leached than the heavy ones.

The parent material from which the soils have been derived has been accumulated, at least in the upland, by glacial action and on the terraces by outwash as water-deposited material of glacial origin. The soils of the stream bottoms are derived from alluvial material. All these soils are comparatively young, as contrasted with the soils of the unglaciated region. Soil development has taken place to a depth ranging from only 15 to 30 inches, depending on the character of the parent material. Even within the soil disintegration is far from being complete, as there is much raw material in the surface soil. This mineral matter becomes available slowly as weathering and soil development progress. Under these conditions the lithological character of the parent rock material has exerted a strong influence on the soils. In most places the subsoils are yellowish brown, yellow, or greenish yellow, fading below to the color of the unaltered deposit, which is some shade of gray, ranging from greenish gray to gray.

The soils and general agricultural development of the Champlain Valley are similar to those of the Mohawk Valley and lake section of New York; those of the southwestern part of the State are like, in most respects, those of the Berkshire Valley of Massachusetts and Connecticut and the area between this valley and Hudson River; and

those of the southern part of the central plateau and the eastern hill section are similar to those of a part of central New England. The northern part of the central plateau is essentially Canadian, and the mountain sections are like northern New Hampshire and northern Maine.

The best developed agriculture is carried on in the Champlain Valley on soils of three major series, the Addison, Vergennes, and Suffield. The section ranking next in agricultural importance is the northern part of the central plateau, where the Worthington, Calais, Greensboro, and Blandford soils are the leading soils. About 60 percent of the crop land and 65 percent of the pasture land of the State are in these two belts, which occupy about 40 percent of the total area of the State.

Outside this section, the agriculture is spread thinly over the rest of the State. There are scattered areas in which farming is as well advanced as on the soils of the Champlain Valley, but they are small compared with the large surrounding poorly developed areas. Areas of good farming land are on the Pittsfield soils in the southwestern part of the State; on the Colrain soils in the eastern hill section; and on the Merrimac, Agawam, and Hadley soils of the terraces and bottom lands along Connecticut River.

On the south-central plateau, the Berkshire are the dominant soils; in the Taconic Mountains, the Dutchess; and in the Essex Mountain section, in the northeast corner of the State, the Hermon. All these sections have mediocre or poor farm developments.

The soils developed on the terraces, represented by the Merrimac, Copake, Agawam, Colton, and Adams soils, are scattered along the larger streams in nearly all parts of the State. These soils are the leaven which raises the average crop acreage in many sections.

The Ondawa, Genesee, and Hadley soils represent the well-drained soils of the present flood plains of the streams, and the Saco, alluvial soils, undifferentiated, muck, peat, and marsh are the poorly drained soils. These soils are well distributed over the State. Rough stony land is extensive and occurs mainly on the Green Mountains, Taconic Mountains, and Essex Mountains.

The soils of Vermont are best suited to grass, although they are not inherently so fertile as the soils of the prairie region, or Great Plains, of the West. The humid climate prevents serious hindrances to grass growth from droughts and fosters a luxuriant grass cover throughout the season. The soils, as grasslands, are better than most of the soils of New England and compare favorably with those of any section in eastern United States. The soils are not suited to wheat or corn as grain crops. Corn silage, however, can be grown profitably, although yields are somewhat lower than in the Corn Belt. Oats and barley succeed on certain soils and are grown extensively. The climatic and soil conditions on all areas except the higher plateaus are well suited to apples, and extensive orchards are developed in certain localities in the belt of lower lying country in both the east and west sides of the State.

The Addison, Sheldon, St. Albans, and Suffield soils are already utilized, not to their full extent but more nearly to capacity than the other soils. Such crops as hay (timothy and clover), silage corn, oats, barley, beans, buckwheat, and alfalfa are the leading crops. These are the most valued farming soils. They occupy,

roughly, about 7 percent of the State. The success of alfalfa on the Addison soils was noted on the loamy gravelly areas and on the shallow phases but not on the clay loam, and more alfalfa might be grown, as these soils are well suited to the crop. The other soils are less calcareous than the Addison and not so valuable for alfalfa.

The Vergennes soil covers about 2 percent of the State, but is not used to nearly its full capacity. The difficulty of handling this soil, because of its heavy texture and imperfect drainage, is probably the principal drawback to its use. In some of the extensive flats occupied by Vergennes clay loam a brown or reddish-brown compact horizon has developed near the surface. On such land little success seems to be attained with alfalfa, but where the land is better drained this crop succeeds to a marked degree. The Vergennes soil is admirably suited to grass, and only the better grasses should be seeded. In this section the roads are almost impassable in wet seasons, and it is at a disadvantage as a milk-producing section. Most of the land is comparatively cheap.

The Worthington, Calais, and Blandford soils are primarily adapted to grass, and their complete utilization for dairying should be fostered. They are not so well adapted to the production of some of the other crops needed in conjunction with dairying as are the soils of the Champlain Valley. As grass soils they are without equal in eastern United States. In a few towns the Worthington soil is used successfully for growing potatoes.

The Greensboro, Shelburne, Colrain, and Woodbridge soils, although slightly less productive, are almost as valuable for dairy farms as the Worthington, Calais, and Blandford soils.

Most of the soils associated with the Pittsfield are used to fair advantage. Considerable areas of pasture land have grown up to cinquefoil (*Potentilla fruticosa*), and they furnish only fair grass under present conditions. Much of the cultivated land is used for timothy and clover hay, oats, and buckwheat with good results. Most of the recently abandoned land is on Madrid loam, which is somewhat poorer than Pittsfield loam. Soils of the Stockbridge series, though not extensive, are highly valued for farming.

The Farmington soil, composed of shallow stony soil, occurs in small areas surrounded by cultivable land, and its use as pasture is unquestioned, although its value for other crops is negligible.

The Dutchess, Cossayuna, and Nassau soils are not highly productive for general farm crops, but are suited to apple growing, and it is on this land and in the eastern hill section that orcharding should be extended. Other soils of the lower lying belts are highly suited to orchards, but these soils are comparatively low in price compared with some other soils.

The soils on the terraces associated with the Merrimac are all-round soils and highly desirable for crops which require intensive cultivation. Although plant nutrients must be supplied, the structure is such that crops respond readily to good cultivation. These are the best potato and vegetable soils of this section. They are widely distributed and are held at the highest acreage price of the soils in the State.

The soils of the bottom lands are not so valuable as they were at one time. Disastrous floods in recent years have damaged them in many places by overwash and cutting, and there is always the

possibility of the recurrence of floods. In the larger stream bottoms these soils represent the best cornland in the State, and along the smaller streams there is much good meadowland.

About 60 percent of the soils are stony. The value of areas of stony soils adapted to grass, occurring in conjunction with smooth cultivable land, is enhanced for pasture. Where the stony areas are too extensive the land can be utilized only for forest. Extensive areas, approximately 20 percent of the State, are occupied by stony types of the Berkshire, Becket, Hermon, Gloucester, and Hollis soils that should remain in forest unless the demand for pasture is far greater than at present. Where located advantageously the stony areas of such soils as the Worthington, Calais, Blandford, Woodbridge, and Colrain can be successfully used for pasture under present conditions. The stony areas of the Pittsfield, Madrid, and Addison soils are highly adapted to grass and are used for pasture.

Rough stony land occupies about 20 percent of the area of the State. It is almost entirely in forest and should remain so, as it has little or no agricultural value.

LITERATURE CITED

(1) BENNETT, H. H., and CHAPLINE, W. R.
1928. SOIL EROSION A NATIONAL MENACE. U. S. Dept. Agr. Circ. 33, 36 pp., illus.
(2) CLAYTON, C. F., and PEET, L. J.
1933. LAND UTILIZATION AS A BASIS OF RURAL ECONOMIC ORGANIZATION. Vt. Agr. Expt. Sta. Bull. 357, 144 pp., illus.
(3) HAWES, A. F., and CHANDLER, B. A.
1914. THE MANAGEMENT OF SECOND GROWTH HARDWOODS IN VERMONT. Vt. Agr. Expt. Sta. Bull. 176, pp. [31]–86, illus.
(4) ———
1930. A THIRD OF A CENTURY OF FEEDING-STUFF INSPECTION. Vt. Agr. Expt. Sta. Bull. 324, 48 pp., illus.
(5) ———
1916. CONCERNING ALFALFA AND SOYBEANS. Vt. Agr. Expt. Sta. Bull. 204: 40–72.
(6) ——— JONES, C. H., and ANDERSON, G. F.
1925. COMMERCIAL FERTILIZERS. Vt. Agr. Expt. Sta. Bull. 248, 40 pp.
(7) ——— and JONES, L. R.
1905. ALFALFA IN VERMONT. Vt. Agr. Expt. Sta. Bull. 114, pp. [111]–132, illus.
(8) HITCHCOCK, J. A.
1925. A STUDY IN VERMONT DAIRY FARMING. Vt. Agr. Expt. Sta. Bull. 250, 48 pp., illus.
(9) ———
1928. ECONOMICS OF THE FARM MANUFACTURE OF MAPLE SYRUP AND SUGAR. Vt. Agr. Expt. Sta. Bull. 285, 96 pp., illus.
(10) HOOKER, P. K.
1926. STUDIES IN VERMONT DAIRY FARMING. II. ENOSBURG, FRANKLIN CO., AREA. Vt. Agr. Expt. Sta. Bull. 256, 45 pp., illus.
(11) JONES, L. R., and EDSON, A. W.
1901. FOWL MEADOW GRASS. Vt. Agr. Expt. Sta. Ann. Rept. (1900–1) 14: 237–247.
(12) REED, W. G.
1918. FROST AND THE GROWING SEASON. Atlas of American Agriculture, pt. 2, sec. 1, Advance Sheets no. 2, pp. 29–40, illus.
(13) WALKER, L. S., and BOYCE, E. F.
1929. COMMERCIAL FERTILIZERS. Vt. Agr. Expt. Sta. Bull. 301, 24 pp.
(14) YOUNG, H. P.
1927. STUDIES IN VERMONT DAIRY FARMING. III. RANDOLPH-ROYALTON AREA. Vt. Agr. Expt. Sta. Bull. 268, 64 pp.

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Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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