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Soil Survey
of
Hampden and Hampshire Counties Massachusetts

By

W. J. LATIMER
United States Department of Agriculture, in Charge
and
L. R. SMITH
Massachusetts Department of Agriculture

Bureau of Chemistry and Soils
In cooperation with the Massachusetts Department of Agriculture

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SOIL SURVEY OF HAMPDEN AND HAMPSHIRE COUNTIES, MASSACHUSETTS

By W. J. LATIMER, United States Department of Agriculture, in Charge, and L. R. SMITH, Massachusetts Department of Agriculture

COUNTIES SURVEYED

Hampden and Hampshire Counties are situated in the southwestern part of Massachusetts, the center of the area being approximately 100 miles west of Boston. (Fig. 1.) The area is roughly rectangular in shape. The greatest north and south dimension is about 30 miles, and the greatest distance from east to west, about 50 miles. Hampshire County on the north includes an area of 577 square miles and Hampden County on the south has an area of 628 square miles, making a total area of 1,205 square miles, or 771,200 acres.

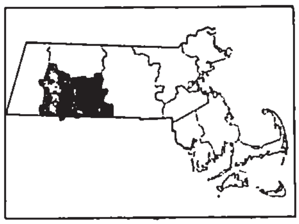

FIGURE 1.—Sketch map showing location of Hampden and Hampshire Counties, Mass.

Physiographically the area consists of a severely dissected somewhat uneven plateau crossed from north to south, about midway between the eastern and western boundaries, by a broad lowland belt, the Connecticut Valley lowland, in which lies the Connecticut River Valley. The plateau west of the lowland lies at an elevation, in its highest part, of about 1,800 feet above sea level[1] and slopes southeastward. The slope from the top of the plateau to the lowland is steep and the upland surface, although deeply dissected, still contains comparatively smooth areas, presumably remnants of an orginal surface.

East of the lowland the plateau has a maximum elevation of about 1,200 feet. It is more thoroughly dissected than that part lying west of the valley.

The lowland belt in which the Connecticut River Valley lies is the outstanding physiographic feature of the area. It is about 5 miles wide where it enters the area on the north but within a short distance expands to about 15 miles in width; the maximum width of 20 miles is reached near the center of the area and is maintained throughout the area southward. The floor of the lowland lies about 700 feet below the level of the adjacent plateau. A narrow serrated mountain range, the Holyoke Range, runs north and south, near the axis of the belt, rising to the level of the plateau on either side in places. The surface relief of the lowland is that of an uneven plain, though broad smooth terraces occupy a belt along the Connecticut River Valley, ranging up to several miles in width, and in extensive terraces in the " back valley " west of the Mount Tom Range, and in

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[1] Elevations taken from United States Geological Survey topographic sheets.

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the Wilbraham Valley on the eastern side of the lowland. These terraces lie from 100 to 200 feet above the Connecticut River which occupies a valley ranging up to somewhat more than a mile in width, all of which is subject to submergence during high water. Numerous small streams have cut narrow, shallow valleys back into the terrace plain, and where the larger streams traverse the terraces they have developed flood plains proportionate to their size; however, most of the terrace level is still intact. The otherwise rather level surface of the lowland is broken by numerous low smoothly rounded hills. A few level terraces include interior plains having imperfect drainage, owing to the level contour of the land and to the underlying clay beds.

The smoother parts of the western plateau, which represent the remaining level of the plateau, are in the northwestern part of the area in the towns of Plainfield, Goshen, Cummington, Worthington, and Chesterfield, and in the towns of Tolland and Blandford in the southwestern part. The surface relief ranges from rather smooth ridge tops to gently rolling hills, with a few hills rising to several hundred feet above the plateau. The broken area occurs mainly in the region contiguous to Westfield River and its tributaries. (Pl. 1, A.)

The eastern plateau is characterized by a system of alternating parallel ridges and valleys (pl. 1, B) with a north and south trend, along Chicopee and Swift Rivers and their trellislike branches. Near the central part of the plateau, in the town of Belchertown, a rather large area of subdued or smoother relief lies several hundred feet lower than the plateau level, and in the valley of Swift River a fairly broad terrace plain is developed.

The area lies in a region where the forest flora of the south, typified by oak, chestnut, and yellow poplar (tuliptree), merges with the spruce, canoe (white) birch, and hard maple forest of the north. The forest on the western highland consists mainly of spruce, beech, yellow birch, white birch, and rock maple; on the eastern highland, mainly of oak, chestnut, white pine, white birch, and gray birch; and in the valley the dominant growth is gray birch, white birch, pitch pine, oak, and cedar. Beech, white oak, red oak, maple, and white pine trees are fairly numerous in all parts of the area, and such trees as elm, aspen, ash, hickory, and walnut are not so plentiful, but grow in all but the higher places. Much of the forest below an altitude of 1,500 feet has developed from sprout land and has the typical characteristics of such forest, in that it is low and brushy and is accompanied by a thick undergrowth. In places the forest growth is entirely coniferous, and in others it is mixed. Where the forest is coniferous little or no underbrush occurs, but where it is hardwood the underbrush is thick, consisting mainly of sprouts, from the older trees, and of young trees such as linden, striped maple, and other shrubs common to the region. Much spruce grows in the higher situations, together with an underbrush of ground pine or trailing spruce in places, and much hemlock and laurel grows in the mountain gorges. The swamps contain tamarack, soft maple, and alder, and ferns, ground pine, and club moss form thick growths in damp places.

On cut-over land the second growth is in few places the same as the original forest, except where the original forest consisted of trees which sprout. In abandoned pastures a mixed growth, consisting of aspen, birch, and oak, forms the forest. Abandoned fields reforest with a volunteer growth of gray birch or white pine, and burned-over areas, with a single-growth forest of aspen, poplar, birch, or beech. The shrubs most commonly found are sumac, ground juniper, sweetfern, steeplechase, running cinquefoil, huckleberries, blueberries, and brier berries. The common grasses are broom sedge, poverty grass, Kentucky and Canadian bluegrass, Rhode Island bentgrass, small spear grass, wood spear grass, false redtop, and foxtail. Weeds, such as daisies, thistle, plantain, wild thyme, and sorrel, abound.

The first settlements within the area were made in 1636, at the present site of Springfield, by a party of English from the eastern colonies of Massachusetts. Settlements were made north of Holyoke Range in 1653 at Northampton and about five years later at Hadley. All the early settlers were English, coming either directly from England or adjacent English colonies to the east and south, and their descendants settled the entire region. It was not until about 200 years later that emigrants came from other countries. Irish emigrants began coming about 1850, and French Canadians soon after. Beginning with the opening of the twentieth century, large numbers of Italians, Poles, and other continental Europeans came. The Poles settled largely in the rural districts and the Italians in the industrial towns. The present population, according to the 1930 census,[2] in Hampden County is 335,496, and in Hampshire County is 72,801, making a total for the area of 408,297.

Hampshire County was formed in 1662 and included the three present valley counties. Franklin County was taken from the northern part in 1811 and Hampden County from the southern part in 1812. Springfield, the county seat of Hampden County, with 149,900 population in 1930, is the largest and most important city. It is a manufacturing and trucking center. Holyoke, located 7 miles north of Springfield, is the next town of importance. It numbers 56,537 people who, for the most part, are employed in manufacturing enterprises. Chicopee, with a population of 43,930 and Westfield, with 19,775, are other manufacturing towns of Hampden County. Northampton, the county seat of Hampshire County, with a population of 24,381, has numerous manufacturing plants, is a trading center for the central part of the valley, and is the seat of Smith College. Amherst, a small town, is the location of Amherst College and Massachusetts State College.

Four main-line railroads, together with a number of branch lines, serve the area. A number of electric interurban railway lines are still in operation, but bus lines have replaced those that have been discontinued, and practically every town is reached by rail or bus transportation. The public roads are good. A number of surfaced State roads cross the area in several directions, many of the county and town roads are surfaced or graveled, and the secondary roads

[2] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given when available.

are in fair shape for travel during the summer months. Every community and most residences have telephone service; every community has adequate schools and churches; and nearly every town has a public library.

The manufacturing industries give employment to a large number of people and create a ready market for local farm products. A wide variety of articles is manufactured.

CLIMATE

The climate of Hampden and Hampshire Counties is humid and is marked by long cold winters and comparatively short, but warm, summers. There is a difference of about 1.5° in the mean annual temperature of the region north of the Holyoke Range and that south of the range, as recorded by the Weather Bureau stations at Amherst and Springfield. Although no data are available, it is reasonable to assume that an even greater difference exists between the temperature of the valley [3] and that of the upland, especially the temperature on the plateau west of the valley where the elevations are much higher than in the rest of the region. There is every evidence that the valley in summer acts as an oven in retaining heat, consequently crops mature in a shorter time than on the upland.

The climatic conditions are well suited to the growing of general farm crops and market-garden crops, and to orcharding, dairying, livestock raising, and poultry raising.

The precipitation is well distributed so that there is an ample supply of ground water and sufficient moisture is available for growing crops.

The active growing season of five months is ample for the maturing of most crops grown in the valley, but on the plateau, particularly on the lower spots of the higher western plateau, frost damage to corn and garden crops is frequent in late spring and early fall. The average date of the last killing frost as recorded at both stations is May 4 and of the earliest is October 2. Frost has been recorded, however, as late as May 26 and as early as September 4. The winters are such that livestock must be well housed. Most of the farm buildings are arranged so as to effect a minimum of exposure to operatives.

Tables 1 and 2 give the more important climatic data as recorded at the United States Weather Bureau stations at Springfield and at Amherst. As these stations are located at elevations of 199 and 222 feet above sea level, respectively, they represent climatic conditions only in the valley region of the area.

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[3] In the following pages of this report the expression "the valley" will refer to the broad belt, described as the lowland in the preceding pages dealing with the physiography of the region. The modern valleys or flood plains of rivers will be described as such, e. g., the Connecticut River Valley.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Springfield, Hampden County, Mass.*

[Elevation, 199 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1864)	Total amount for the wettest year (1869)
	° *F.*	° *F.*	° *F*	*Inches*	*Inches*	*Inches*
December	28 6	62	−18	3 48	4 45	5 80
January	25 0	63	−11	3 29	2 51	3 31
February	26 0	56	−13	3 67	1 22	4 48
Winter	26 5	63	−18	10 44	8 18	13 59
March	33.1	71	−4	3 61	2 25	5.75
April	46 5	91	17	3 24	2 54	1.80
May	59.4	94	29	3 81	2 87	5 91
Spring	46 3	94	−4	10 66	7.66	13 46
June	70 2	101	37	3 57	56	5 88
July	73 2	100	48	4 27	1 22	2 67
August	70 7	102	40	4.08	2 54	1.40
Summer	71 4	102	37	11 02	4.32	9 95
September	63 0	95	28	3 50	2 61	4 17
October	50.8	86	26	3 90	2 97	13 50
November	38 8	73	5	3 53	5 16	3 30
Fall	50 9	95	5	10.93	10 74	20 97
Year	48.7	102	−18	43 05	30 90	57.97

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at Amherst, Hampshire County, Mass.*

[Elevation, 222 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1908)	Total amount for the wettest year (1888)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	27 8	65	−22	3 58	3 05	3 78	9.6
January	23 8	62	−22	3 38	2 25	3 87	12 0
February	22.3	58	−22	3.27	3 53	3 94	15 0
Winter	24.6	65	−22	10.23	8 83	11 59	36 6
March	34.5	76	−8	3.60	2 86	5.96	8.6
April	45.7	88	16	3 18	1.97	3 08	2 0
May	57.0	94	24	3.80	4 35	4 29	.0
Spring	45.7	94	−8	10.58	9 18	13 33	10 6
June	64.6	101	34	3 61	76	5 40	.0
July	71.0	100	40	4.40	3 28	3 63	.0
August	68.4	100	37	4.36	4 27	4 29	0
Summer	68.0	101	34	12.37	8 31	13 32	.0
September	61 4	97	25	3.66	1 73	10 70	.0
October	51 5	89	20	3 71	1.57	5 19	0
November	38.3	74	4	3.62	1.06	3 91	2 1
Fall	50 4	97	4	10.99	4 36	19 80	2.1
Year	47.2	101	−22	44.17	30.68	58 04	49 3

AGRICULTURE

In 1630 corn was supplied to the Massachusetts Bay Colony by the Indians of the Connecticut River Valley, and rumors of the rich meadows of the valley came to the settlers of the eastern part of the State and were directly responsible for the early movement of the colonists to this region. Settlements and clearings began in the lower part of the valley, and the meadow and terrace lands were the first to be farmed. Later, farming spread to the smaller stream bottoms and to the adjacent uplands and continued to advance until about 65 per cent of the area was cleared and used for crops or as pasture.

The early agriculture consisted of general farming in conjunction with livestock raising, and included the growing of hay, corn, wheat, rye, oats, hemp, and potatoes, as well as vegetables and fruits for home use. Cattle and sheep were the principal livestock, and milk cows supplied dairy products for home consumption. Agriculture reached its full development during the early part of the last century and probably reached its maximum of production about 1860. Since 1880 a marked decline in both acreage and production of crops has taken place, which is attributed to the migration of farmers to the then newly opened West and in later years to local industrial development. The decline in farming has been rapid during the last two decades.

Although an actual decrease in the acreage of land farmed and in the number of farms has occurred, there has been a tendency in some sections toward intensified farming and an actual increase in some lines of agriculture. Many farms in the rougher sections have been abandoned, with the consequent lessening of the area of the crops grown under the older type of farming. The increase in size of cities, particularly in the valley towns of Holyoke, Springfield, and Chicopee, has covered a large area formerly occupied by farms and is responsible, in a large measure, for the decrease in farm area recorded in Hampden County. Probably 20 per cent of the decrease in the farm area is attributed to the expansion of these cities. The introduction of tobacco and onions as field crops and the increased demand for market-garden crops, dairy products, and fruit, by the urban population, has revolutionized farming to such an extent that the older type of farming has practically disappeared. All these influences have had their part in centering agriculture in the valley.

According to the United States census, 78.15 per cent of the area was in farms in 1879, and 64.7 per cent of the land in farms was improved. By 1930 only 50.7 per cent of the area was in farms. The number of farms decreased 29.1 per cent during this period, notwithstanding the small holdings caused by the advance of town and city development over the valley and the large number of renters in the onion district. These last-mentioned influences have been pronounced during the last two decades and have had a slight tendency to check the downward trend in the number of farms.

The census figures show a decrease of 41.6 per cent in the acreage of hay during the period from 1879 to 1929. Pasture land has decreased to a marked extent. Much of it has grown up in brush, and the grass is of inferior quality. (Pl. 1, C.) A large acreage has reverted to woodland and has been abandoned for pasture altogether.

The acreage of corn for grain has decreased, but the acreage of silage corn has increased. The potato and small-grain acreages have decreased.

The acreage in tobacco increased about 167 per cent between 1879 and 1929, and this is the only crop which shows an increase in acreage, according to the census reports. Although tobacco growing started about 1840, it was not an important crop until about 1900. Since that time it has become the principal money crop in the valley.

Shade-grown tobacco (grown under cloth) was introduced from Florida about 1900. The leaf is a high-grade cigar-wrapper type. Sumatra leaf was first introduced for shade growing, but it was soon discovered that this variety was not suitable. An improved variety of Havana Seed has proved satisfactory and is now used for shade production. By 1915 the shade-grown crop had reached 670 acres (*1*)[4] in this area, with an average yield of 1,000 pounds an acre. Much of the shade-grown tobacco was at that time and is at present grown in Hampden County, in the towns of Agawam, Southwick, Westfield,[5] and Chicopee. The crop showed a decided increase up to about 1920, then came a decrease, but during the last few years the production again shows evidence of an increase to about normal. This crop is grown almost exclusively by large companies, as the cost of equipment (posts, wire, and tents) is rather high for the individual grower. The acreage of shade-grown tobacco is much smaller than that of other tobacco as a result of the limited demand for the product and also on account of the expense of equipment necessary for growing it.

Although the methods in use in the tobacco districts have grown up with the industry, they receive the benefits of early experiments (*3*, *5*) on the tobacco soils of the valley. These early experiments showed that the sandy lands previously abandoned because of extremely low yields of general farm crops, where properly fertilized, were preferable for tobacco to land under a high state of cultivation to general farm crops. It is stated that the history of the successes and failures of the tobacco crop is largely one of weather conditions, both dry and wet seasons causing decreased yields (*11*).

The average yields of tobacco for the 10-year period from 1915 to 1924 were lower than for the period from 1905 to 1914. This created a serious situation which threatened the industry and brought the aid of the experiment stations of the two States concerned (Massachusetts and Connecticut). At first it was thought to be due to the decreased fertility of the land, following constant cropping to tobacco. Experiments by the Massachusetts station proved that this was not the case and that tobacco yields had a tendency to decrease when grown with cover crops or in rotations that gave good results with tobacco in other tobacco-growing regions. It was also shown by the results of these experiments that the use of lime in large quantities caused the development of black root rot, and that the adoption of a rotation system caused the development of brown root rot of the tobacco plant. These and other experiments have done much to explain the causes of, and remedy the damage done by, these diseases.

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[4] Italic numbers in parentheses refer to Literature Cited, p. 60.
[5] Westfield Town was incorporated as a city in 1920.

The growing of onions on a commercial scale, which began about 1900, has not caused a decrease in the acreage of tobacco. The onion crop is grown on land formerly used for corn, hay, and grass, or crops other than tobacco. The work is performed largely by immigrant labor which came into the valley as the onion industry was developing, and, in fact, made it possible to grow a crop requiring so much handwork. This industry has steadily increased. The land not suited to tobacco or onions is used for corn, hay, and pasture and represents the poorer land of the valley.

With the disappearance of so much open pasture, there has been a decline in the number of sheep and beef cattle kept, and with the rise of the industrial towns the number of dairy cattle has increased. Table 3 gives the number of livestock on farms as reported by the 1930 census.

TABLE 3.—*Number of livestock on farms on April 1, 1930*

Kind of livestock	Hampden County	Hampshire County	Kind of livestock	Hampden County	Hampshire County
Horses	1,639	3,047	Swine	5,990	3,268
Mules	31	32	Chickens	116,351	123,533
Cattle	12,781	19,401			

Holsteins predominate in the dairy herds, the other breeds represented being Ayrshire, Guernsey, and Jersey. The percentage of purebred dairy cattle is rather high. The horses consist of draft, semidraft, and standard-bred types. Duroc-Jersey, Chester White, Berkshire, and Poland China are the principal breeds of hogs; and Rhode Island Red, Plymouth Rock, and White Leghorn (in the order named) are the leading breeds of chickens.

The present agriculture consists of the production of corn for grain, fodder, and silage (pl. 2, A); small grains on a small acreage; hay, principally timothy and clover and some redtop; tobacco, grown under shade and in the open; potatoes; onions; market-garden crops, including sweet corn, tomatoes, cabbage, asparagus, spinach (pl. 2, B), cucumbers, lettuce, celery (pl. 3, A), squash and other vegetables; orcharding, mainly apples and some peaches; nursery products, consisting of ornamental trees and shrubs; pasture, consisting of bluegrass, bentgrass, poverty grass, and broom sedge; brush pasture; and woodland pasture. More than 50 per cent of the pasture is woodland and about 20 per cent of the remainder is brush pasture. The brush pasture contains ground juniper, gray birch, huckleberries, sumac, sassafras, and shadbush. Most of the pastures contain sweetfern, steeplechase, cinquefoil, blackberries, and blueberries.

Table 4 shows the value of all farm products by classes in the two counties in 1919.

TABLE 4.—*Value of agricultural products by classes in Hampden and Hampshire Counties, Mass., in 1919*

Crop	Value		Livestock and products	Value	
	Hampden County	Hampshire County		Hampden County	Hampshire County
Cereals	$385,078	$602,200	Domestic animals	$1,943,300	$2,550,250
Other grains and seeds	6,389	5,307	Dairy products, excluding home use	1,103,894	1,607,236
Hay and forage	1,370,191	2,123,632	Poultry and eggs	410,269	560,618
Vegetables	796,648	1,815,020	Wool	1,912	3,850
Fruits and nuts	399,587	507,995	Total	3,459,375	4,721,954
All other crops	1,279,616	2,384,516	Total agricultural products	7,696,884	12,160,624
Total	4,237,509	7,438,670			

Table 5 shows the acreage and yields of selected crops in 1924 in Hampden and Hampshire Counties as reported in the 1925 census.

TABLE 5.—*Acreage and yield of the principal crops in Hampden and Hampshire Counties, Mass., in 1924*

Crop	Hampden County		Hampshire County	
	Acres	*Bushels*	*Acres*	*Bushels*
Corn, total	3,611		5,665	
Harvested for grain	1,293	52,706	2,635	132,501
		Tons		*Tons*
Cut for silage	1,831	18,061	2,626	26,654
Cut for fodder	483		392	
Hogged off	4		12	
Hay, all kinds	32,652	35,327	50,830	53,549
		Bushels		*Bushels*
Wheat	6	64	1	10
Oats threshed for grain	49	1,490	80	2,815
Oats cut and fed unthreshed	253		436	
Rye	167	2,845	77	950
Buckwheat	27	468	22	427
Potatoes	1,331	172,559	1,608	216,697
Cabbage	220		139	
Cantaloupes	42		15	
Lettuce	32		17	
Onions	34		1,400	
Sweet corn	784		366	
Tomatoes	136		55	
		Pounds		*Pounds*
Tobacco	2,189	2,982,796	5,181	7,296,290
	Trees	*Bushels*	*Trees*	*Bushels*
Apples	85,905	190,073	111,835	310,780
Peaches	30,406	8,952	12,984	2,197

As reported by the 1930 census, hay is the most extensive crop, occupying 60,443 acres in 1929. The production of hay is widely spread over the area, hay being the leading crop in all parts except in the valley. About half the acreage is improved mowing, consisting principally of timothy and clover mixed. Clover alone and alfalfa occupy only a small acreage and are grown mainly in the valley. Redtop is used in the mowings of the smaller stream valleys.

Pasture land, which includes woodland and other pasture, occupied 147,993 acres in 1929, and most of this was outside the valley.

Most of the orchards are apple orchards. They are located in the foothills of the western highland, in the eastern upland, and on the hills throughout the valley.

Corn for grain, silage, and fodder occupied 9,035 acres in 1929. Corn is grown more extensively in the valley than elsewhere, but it occupies a fair acreage in all parts of the area.

Tobacco, which occupied 5,566 acres in 1929, is grown only in the valley. Shade tobacco occupies about one-seventh of the total tobacco acreage and is grown mainly in the southern part of the valley.

Potatoes are grown in all parts of the area, occupying 2,051 acres in 1929. Onions are grown only in the northern part of the valley, and occupied 1,298 acres in the same year. Other vegetables, occupying more than 2,500 acres, are grown mainly for market in the vicinity of Springfield and in gardens throughout the area. Sweet corn and asparagus occupy large areas devoted to market-garden crops. Oats occupy the largest small-grain acreage.

In point of value, the tobacco crop, which is grown for cigar wrappers is the most important in the area, not only in total value but in acre value. The hay crop comes next in total value but has a relatively low acre value. Corn, fruit, potatoes, onions, and other vegetables are all about the same in total value, but there is a wide range in the acre value of these crops, market-garden vegetables and fruit probably having the highest acre value, with onions and potatoes next. All these market-garden crops have a higher acre value than corn, small grains, and hay.

Grass (hay and pasture), corn, potatoes, vegetables, and fruit, which have been grown since the earliest settlement, are suited to both the climate and the various soils of the area. However, these crops are grown more or less indiscriminately, and often on soils not best suited to their production.

Tobacco was introduced because a large area of the soil of the valley was well suited to the crop and because the economic return from this crop was greater than from the staple crops previously grown. The production of tobacco has since spread to lands well suited to the staple crops, but even here better acre returns are obtained from tobacco.

Onion culture was stimulated because certain restricted lands of the valley were highly adapted to the growing of onions, and Poles, who are employed to do the necessary handwork, were coming into the valley in large numbers. Market-garden vegetables are grown mainly to meet the demand in the industrial towns and because a comparatively large acreage of land suited to vegetables is favorably situated. Commercial orcharding, principally apples, has been developed because the climatic, soil, and economic factors are favorable.

Commercial fertilizers are extensively used on the valley farms, especially for tobacco, onions, and market-garden crops. According to the 1925 census, 3,116 farms reported the use of commercial fertilizers (including lime) at a total expenditure of $1,228,341 in 1924. Practically twice as much ready-mixed fertilizer is bought as unmixed chemicals, and much of the unmixed chemicals is applied separately. The commercial mixed fertilizer consists of standard brands of high quality, mainly of grades ranging from 3–10–6 [6] to

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

4–8–4 for corn and general use; 8–6–6 for top-dressing; 7–4–7, 6–8–12, and 6–6–14 for tobacco; from 3–8–7 to 6–8–7 for onions; and 5–8–7 for all-around purposes. Cottonseed meal is the main source of nitrogen; bone, the main source of phosphorus; and sulphate of potash, the main source of potash. The largest tonnage of mixed concentrated fertilizers are of 5–3–5, 5–4–5, 5–8–7, and 4–8–5 grades, and of the separates, superphosphate (acid phosphate) and nitrate of soda lead in tonnage. The use of high-grade or concentrated fertilizer is on the increase.

All the available manure is used on silage corn, tobacco, and market-garden crops, and tobacco stalks and stems are used on tobacco land. Lime is not in general use except in the tobacco, onion, and market-garden districts where it is used rather freely in preparing land for these crops, especially for onions. Lime is usually applied at a rate ranging from 1 to 2 tons an acre at such times as needed, smaller amounts being used for tobacco. It is occasionally used outside the valley when sod land is turned.

Farm labor in the onion and tobacco districts in the northern part of the valley, where many of the inhabitants are Poles, is plentiful, but it is scarce in other sections and farm wages are high in all parts of the area. Much of the labor is performed by members of the farm family. According to the 1925 census, 2,853 farms reported the hire of labor at a total cost of $2,076,715. Extra labor on tobacco, onion, and market-garden crops, and in orchards, is employed during the rush season and at harvest, and on the dairy farms employment is permanent. Laborers employed by the year are usually furnished with quarters and the cash expenditure is not so high, but the short-season laborers are paid by the day at a much higher rate. Monthly wages range from $45 to $75; day wages range from $2.50 to $5; and a man with a plow team in the rush season receives $7 a day.

According to the 1930 census, the average size of farms in the area is 90.5 acres. Some increase in the size of farms in the upland has taken place in recent years, owing to the consolidation of abandoned farms, but this increase has been offset by the small holdings resulting from suburban developments in Hampden County and by the increase of rented farms in the onion and tobacco districts of Hampshire County. A very large number of the smaller farms are in the valley, and only a few farms in the area contain more than 1,000 acres.

Little change in farm tenure has taken place during the 50-year period from 1880 to 1930. In 1930, 89 per cent of the farms in Hampden County and 82.8 per cent of those in Hampshire County were operated by owners. A few are operated by managers and the rest by tenants. Indications point to an increase of tenants in the tobacco and onion districts of Hampshire County. Few farms outside the valley are operated by tenants. A large proportion of the tenant farms are rented for cash, the rental amounting to about 5 per cent of the property value. The remainder of the tenants are largely share renters and for the most part grow onions on a share basis, in which the owner furnishes the land, fertilizer, team work, and half the seed; the tenant does all the handwork and harvesting; and each receives one-half of the crop. The cash rent for tobacco and onion land ranges from $30 to $50 an acre, and on tobacco farms this rent includes the use of barns or curing sheds, one shed

30 by 75 feet to every 2½ acres of tobacco land. Land rented for growing onions must be first-grade level well-drained land containing no stone or gravel. The high rents are based on the value of these lands for the production of high-grade cigar wrapper tobacco, but even at these rents, the land is successfully used for intensive crops of onions, potatoes, asparagus, sweet corn, and other market-garden crops. Other classes of land rent for much less. In many places mowings are sold at a comparatively low figure, the buyer cutting the hay. Pasture land commands the lowest rent, depending on the location of the land and condition of the grass.

The equipment of the farms ranges between wide limits, from that of the well-appointed valley farm to that of the small hill farm. Most farms have adequate buildings for the type of farming followed. The dairy farms have silos and most of them have good barns and milk houses, and all orchard farms have packing houses and are equipped with spraying apparatus. The tobacco growers have curing sheds, the shade-tobacco growers have the necessary tents, and all have horse-drawn planters and stringer horses or gather baskets where the crop is primed. The onion growers have wheel cultivators and graders. Many of the better farms are equipped with trucks and tractors with a full complement of plows, harrows, and cultivators. On farms using horse-drawn implements the equipment includes wagons, 2-horse plows, cultivators, harrows, fertilizer and grain drills, manure spreaders, mowing machines, hayrakes, tedders, and loaders, potato diggers, drags, and rollers. The smaller farms and hill farms as a rule do not possess such elaborate equipment, but nearly all have mowing machines, hayrakes, 2-horse plows, and an assortment of plows, harrows, cultivators, and hand tools.

In 1930, the value of land and buildings was $8,753 a farm in Hampden County and $8,302 in Hampshire County. The average acre value of land and buildings in Hampden County in 1930 was $94.13 and in Hampshire County was $93.53. The valley land is exceptionally high priced, whether it be in the typical farming sections of such towns as Hadley and Hatfield or in towns surrounding the city of Springfield. The two classes of land demanding the higher prices are land which is available for subdivision and land equipped for growing shade tobacco. The open-grown tobacco and onion land of the upper valley ranks next.[7]

The most extensive and by far the most important farm industry is dairying. This consists of converting grass, hay, and corn silage, supplemented by bought grain, through the medium of the dairy cow, into whole milk which is disposed of to milk companies in near-by cities and industrial towns. Dairying is well scattered over the area but reaches its best development in the towns of Granby, Belchertown, Amherst, Hatfield, South Hadley, and Hadley.

Livestock raising includes the breeding and raising of the necessary dairy cattle, the raising and fattening of pigs for market on a somewhat smaller scale, the keeping of a few sheep for wool and lambs, and the raising of a few draft and purebred horses. A large number of chickens are kept for the sale of eggs and poultry.

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[7] Information obtained from assessors' books in a selected number of towns.

All these branches of the livestock industry are well scattered over the area.

The curing and handling of the tobacco crop is an important industry in the valley. Two methods of harvesting are in use, one consists of cutting the whole stalk near the base and spearing it on a lath and the other of priming, or picking the leaves as they mature, and stringing them on a string passed through the stem near its base. The priming method gives a better grade of leaf and is the only method used with shade-grown tobacco. The crop is air cured, ventilated sheds or barns being used for this purpose. Charcoal fires are used to prevent sweating during damp or muggy weather. Hail and wind insurance is usually carried on the tobacco crop.

Onions require no special equipment, as they are dried, sorted, and packed in the open and stored in cooperatively or privately owned warehouses or sold to dealers who store them for winter sale.

Apples are usually picked by itinerant labor, packed in baskets and barrels for market, and stored in warehouses. A large quantity of eating apples is disposed of in small baskets on the farms and at roadside stands.

Potatoes are usually harvested with diggers and packed in barrels by the larger growers. Where dug by hand the crop is sold in bulk.

A number of small mills saw lumber in the rougher sections of the eastern upland and the western highland, and a rather large quantity of cordwood is cut from the forests of these regions.

The methods in use on the farms vary widely with the different sections and vary within each section according to the type of agriculture. Over the highlands and even in the valley, where dairying is followed, the standard crop rotation of the Northeastern States is used, which consists of sod land followed by corn and grass. On some farms small grain, such as rye or wheat, is used as a nurse crop for the grass. Timothy and clover is used for hay. Redtop may be substituted for timothy entirely or a mixture of the two may be used. If permanent pasture is desired, bluegrass is added to the seed mixture. Sod is allowed to stand for an indefinite period before reseeding and is used for pasture after the mowing fails. On the more valuable land it is reseeded every three or four years, and experience seems to indicate that reseeding at least every fourth year gives best results. Millet is sown as a substitute for hay in dry seasons.

Results obtained at the Massachusetts Agricultural Experiment Station with corn indicate that manure applied at the rate of 15 tons an acre, gave the highest yield, with an increase in stover and a slight decrease in grain yield over a 10-year period (*4*). Complete fertilizer containing 160 pounds of nitrate of soda, 320 pounds of dissolved bone, and 160 pounds of muriate of potash gave a slightly lower yield, with a drop in the grain yield during the second 5-year period. On land on which no fertilizer was used, the yields were less than half the yield on the manured land, with a decided drop during the last 5-year period. The yields reported in this series of experiments are summarized in Table 6.

TABLE 6.—*Results of fertilizer experiments on corn over a 10-year period*

Kind of fertilizer and period	Yield of stover	Yield of grain
	Pounds	*Pounds*
Manure, first 5-year period	22,000	18,000
Manure, last 5-year period	24,000	16,000
Complete fertilizer, both periods	(1)	(1)
No treatment, first 5-year period	9,000	6,000
No treatment, last 5-year period	5,000	2,000

[1] Slightly less.

The yields of grass and clover in the same series of experiments, under different fertilizer treatments, are given in Table 7. In these experiments clover failed where no potash was applied.

TABLE 7.—*Fertilizer used and average acre yields of grass and clover covering a 6-year period*

Kind of fertilizer	Amount	Amount of fertilizer constituents			Average acre yield for a 6-year period
		Nitrate of soda	Dissolved bone	Muriate of potash	
	Tons	*Pounds*	*Pounds*	*Pounds*	*Tons*
Manure	15				2½
Nitrogen, phosphorus, and potash		160	320	160	1⅔
Phosphorus and potash			320	160	1½
Nitrogen and potash		160		160	1⅓
Nitrogen and phosphorus		160	320		1¼
Nitrogen		160			1
No treatment					½

The Massachusetts Agricultural Experiment Station [8] recommends seeding of timothy and clover for hay on well-drained upland, and on wetter lands to add redtop and alsike clover, increasing the amount with the increasing wetness of the land.

Sod land is sometimes rejuvenated by applications of manure and a top-dressing of phosphate and nitrate fertilizers. Potatoes, vegetables, and other crops are grown in small fields. Manure is used for corn and on the special crops to the extent of the supply. Fertilizers are used in amounts ranging from 250 to 500 pounds an acre of 3–10–6 for corn, and from 250 to 300 pounds of phosphate with from 100 to 150 pounds of nitrate of soda for small grains or grass. Potatoes receive from 500 to 1,500 pounds of 4–10–6 to 5–8–7 fertilizer an acre. Complete fertilizers containing muriate of potash are used outside the valley. This kind of fertilizer is used by Aroostook County, Me., potato growers and has been found to give the best results (*2*).

Irish Cobbler and Green Mountain are the leading varieties of potatoes. The Rural Russett is giving satisfactory results in the valley where sulphate of potash fertilizer is used.

The commercial orchards, mainly apple, are cultivated until the middle of the season, then are planted to a cover crop of rye, buckwheat, or clover. Most of the small orchards are in sod. Nitroge-

[8] The station is located on Merrimac fine sandy loam, Agawam very fine sandy loam, and Melrose fine sandy loam; on Suffield silt loam on the Connecticut Valley terraces; and on Cheshire fine sandy loam and Cheshire gravelly fine sandy loam on the glacial till.

nous fertilizers, such as nitrate of soda or sulphate of ammonia, are used for the trees, and different small amounts of 3–10–6 fertilizer are used for the cover crops. McIntosh, Baldwin, Wealthy, Gravenstein, Delicious, Williams, Rhode Island Greening, Hubbardston, Northern Spy, Tompkins King, and Fall Pippin are the leading varieties in commercial orchards. Of these, the first five are considered by the experiment station[9] as giving entire satisfaction (*10*). These and a number of other varieties are grown in home orchards.

In orchard experiments conducted by the experiment station an application of 10 tons of manure an acre, together with intertilled crops gave best results, and 600 pounds of ground bone and 200 pounds of muriate of potash gave fair results. Where no fertilizer was used strip cultivation was better than sod. Experiments on Merrimac sandy loam show that the manured plots were only slightly better than the unfertilized plots, but where bone and potash were used the yields were better. The fertilizer used contained 600 pounds of ground bone, 320 pounds of sulphate of potash or 160 pounds of muriate of potash, and 225 pounds of sulphate potash-magnesia.

Champion, Elberta, Belle, Carman, Mountain Rose, Lola, Early Crawford, and Greensboro are the leading varieties of peaches grown.

In the valley most of the land is under clean cultivation, and rotations of corn and grass, which are practiced in other parts of the area, are almost unknown. Manure is not produced on many of the valley farms and is scarce, so that commercial fertilizers are the main dependence in keeping up the fertility of the land. Tobacco is grown by many farmers year after year on the same land, and the same is true of onions. This system is conceded by growers and experiment station authorities to be the best plan, although it is contrary to the usually accepted systems of soil improvement (*6*, *7*, *11*).

Most of the tobacco growers plow the land in the fall and allow it to remain fallow until spring. This has been proved by the experiment station to be less satisfactory than when the land is not disturbed, but is considered better practice, according to the same authorities, than cover crops. Tobacco does better following onions, potatoes, or tomatoes than following other crops, but if the onion crop has been properly limed or the potato crop has received muriate fertilizer, the tobacco crop that follows may not be satisfactory. A cover crop of timothy, which was found to be less injurious than other cover crops, injured the tobacco crop to the extent that its use was proved to be inadvisable even where the organic content of the land was very low, and where a cover crop was needed to protect the land from shifting. Injury to tobacco following cover crops is due probably to brown root rot.[10]

When a tobacco crop does not succeed following tobacco and lime has not been heavily used, it is probably due to the accumulation or formation of manganese and aluminum sulphate, from the continued use of sulphate fertilizer (*4*, *9*). This toxic condition was found to be relieved by the use of lime which is commonly applied when the land is fallow, the amount depending largely on former treatment.

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[9] The station orchard is located on a gravelly area of Cheshire fine sandy loam.

[10] JONES, J. P. HAVANA SEED TOBACCO AS INFLUENCED BY TIMOTHY COVER CROP. Mass. Agr. Expt. Sta. Circ. 73, 3 p. [Mimeographed.]

In past years too much lime was used, so that the present tendency is a conservative use of lime. The Connecticut station has found that tobacco is damaged by black root rot on land which is slightly acid, neutral, or alkaline; that lime is not needed unless the soil is strongly acid; and that the best results are obtained on medium-acid land.

It is common practice to apply the available manure at the rate of 3 or 4 cords[11] an acre, although some growers do not use manure but depend entirely on commercial fertilizer. Tobacco stems and stalks are returned to the land. Commercial fertilizers are used at a rate ranging from 2,000 to 3,000 pounds an acre, and on some farms from 500 to 1,000 pounds extra are added when manure is not available, or is added later as a top-dressing. The fertilizers in common use range from 5-4-5 to 7-4-7 mixtures, the latter when manure is not used. Cottonseed meal, castor pomace, and fish scrap are the chief sources of nitrogen, although some sodium nitrate and ammonia sulphate are used; phosphate or ground bone is the source of phosphorus; and sulphate of potash is the principal source of potash, and in addition some carbonate of potassium. The experiment station used 3,000 pounds of 5-4-5 fertilizer on tobacco experimental plots. This seems to be accepted as a satisfactory tobacco fertilizer. Tobacco is a very sensitive crop, and as the soil is only the medium in which to grow the crop, all the factors, except rain, must be supplied and carefully controlled. It would be better, if even the moisture supply could be controlled by overhead irrigation. Therefore it is important that the soil should be well aerated and yet have structure sufficient to give it a good moisture-holding capacity. As the object in growing the crop is to produce as large a number of high-grade cigar-wrapper leaves as possible, every effort should be made by the growers to avail themselves of the methods worked out by the Massachusetts and Connecticut Agricultural Experiment Stations, which are located on the same soils and on similar soils to those on which tobacco is grown.

The Massachusetts Agricultural Experiment Station at Amherst is located on Merrimac fine sandy loam, Agawam very fine sandy loam, Melrose fine sandy loam, Suffield silt loam, Cheshire fine sandy loam, and Cheshire gravelly fine sandy loam. The first two are tobacco soils and are used for experimental plots. The Connecticut Tobacco Experiment Station at Windsor is located on Merrimac loamy sand, Merrimac sandy loam, Chicopee fine sandy loam, and Enfield fine sandy loam. All these soils occur in the Connecticut Valley and are used for tobacco culture.

In experiments with tobacco it is assumed, from the experience of growers and the results of former experiments, that a certain amount of fertilizer composed of certain elements is necessary to produce a satisfactory crop. Many of the experiments were conducted with different percentages of the different element carriers, to determine the effect on the quality and burning properties of the leaf. The Connecticut station experiments showed that old tobacco land gave no response to applications of phosphatic fertilizer. Results seem to

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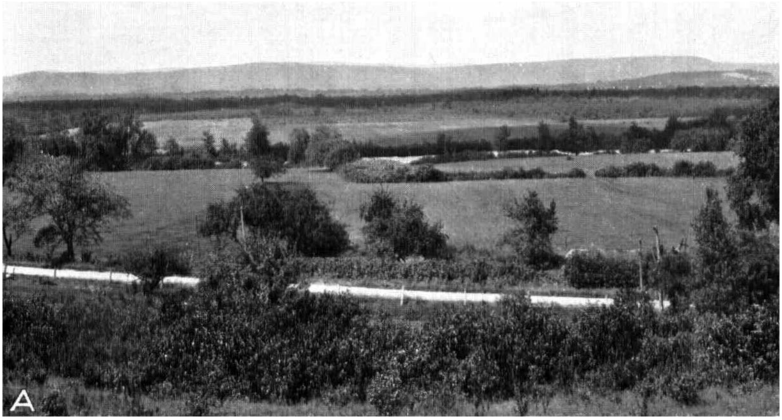
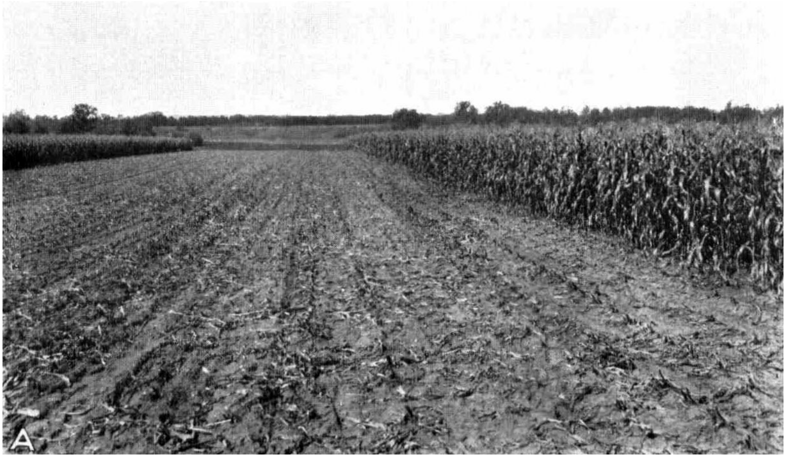
[11] A cord of manure averages about 4 tons. A cord of cattle manure ranges in weight from 3½ to 5 tons and of horse manure from 2½ to 4 tons.



A, The Westfield Plain including areas of Merrimac loamy sand, Merrimac sandy loam, Chicopee loamy coarse sand, and Chicopee fine sandy loam B, a view of the eastern highland near Ludlow The soils are rough stony land, meadow, and Merrimac fine sandy loam, C, a stony pasture on Gloucester and Whitman stony loams, containing much fern and spirea



A, Silage corn on Agawam fine sandy loam, B, spinach on Agawam fine sandy loam indicate that a medium-acid soil and fertilizer of the right quantity and quality are the most important factors, aside from weather, in the growing of tobacco. In the system of farming prevailing on many farms in the valley, manure is not available, cover crops are not used, and rotations are not feasible, therefore commercial fertilizer must be depended on to keep up fertility.

Much attention is given to the selection and preparation of the bed for growing tobacco plants. Clean plots are selected, which are reasonably free from infection and sterilized with steam as a precaution against fungous diseases. Cottonseed meal, alone or mixed with an equal amount of 6–8–12 fertilizer, is used as a starter. Havana Seed and Connecticut Broadleaf are the two leading varieties grown in the open. Havana Seed is used more extensively than Connecticut Broadleaf, and a cross between the two is used to some extent. An improved strain of Havana is used almost entirely for shade growing.

Tobacco growing determines many of the farm practices in the valley. In rotation with tobacco, potatoes are grown with tobacco fertilizer, owing to injury to the burning quality of the tobacco leaf caused by the muriate of potash in the typical potato fertilizer. From 1,500 to 2,000 pounds an acre are used. In fact, the tobacco growers use tobacco fertilizer in varying amounts on nearly all other crops in order to prevent injury to the tobacco which might follow the use of other fertilizer.

Onions, the next crop of importance in the valley, are grown largely with commercial fertilizer. From 1,000 to 2,000 pounds of lime an acre are used, the amount depending on previous lime treatment. (*12*.) Much of the tobacco growers' troubles originated from the use of land on which onions had been grown and to which large amounts of lime had been applied. Manure is rarely used on onion land as it carries weed seed and interferes with the use of the wheel-hoe cultivator. Rye is sown as a cover crop between crops of onions to prevent drifting of the surface soil. From 2,000 to 3,000 pounds of 5–8–7 or 6–8–7 fertilizer, with an acid-phosphate or bone base, are usually applied at one time, but, if needed, an additional 1,000 pounds of an 8–6–6 mixture are applied as a top-dressing in the middle of the season. Southport Globe is the principal variety of onions, and some Yellow Danvers are grown. Much of the work connected with growing onions is done by hand.

Market-garden crops, with the exception of asparagus, are grown to slight extent in the tobacco and onion districts, but they are grown in the valley near the large industrial centers and usually on land that would be suitable for onions but not for tobacco. From 1 to 2 tons of lime an acre, according to the crop grown; from 10 to 12 tons of manure; and in addition from 1,000 to 2,500 pounds of 5–8–7 fertilizer with a top-dressing of 500 pounds of 8–6–6 fertilizer or nitrate of soda to force the crop, are used with most market-garden crops. The valley farmer as a rule specializes, although on some farms the farming systems overlap; but, in general, the dairy, orchard, tobacco, onion, or market-garden farms are separated, owing to the wide difference in cultural methods and management required.

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SOILS AND CROPS[12]

The soils of the hill or glacial till region of Hampden and Hampshire Counties do not differ essentially from the soils of New England in similar physiographic positions except those derived from calcareous till. These soils are comparatively young and unleached when compared with the soils of the Southern States and are not so poor as traditionally supposed. Although they are not so inherently fertile as the soils of the prairie or Great Plains areas of the Middle West, they compare favorably with soils in the eastern part of the United States. The determining factor which has limited or adversely affected the development of the New England soils is their stone content. The quantity of stones in these soils, with the exception of small areas of comparatively stone-free soil, is sufficient to limit, or prohibit in most places, the use of modern labor-saving machinery which has been such an important factor in the agricultural development of other sections of the country. The texture and structure of these stony New England soils allow ready root penetration, adequate drainage, and good moisture-holding capacity, all three factors necessary to crop production.

The combination of the soil and the humid climate make New England a forest region. Where the land is cleared these same conditions favor the production of grass. The stony areas, too rough and broken for profitable grass culture or for grazing, can be utilized for forestry.

These soils are not so well suited to corn as the soils of the prairie region or to wheat as the soils of the Great Plains area, but they could be used to fair advantage for these crops, if it were not for the stone content, and, in many places, adverse topography.

The soils developed on the terraces are similar to the soils of southern New England in the same situations, and they approach in development and character the soils of the Atlantic coastal plain of Long Island and New Jersey. These terrace soils are well drained, smooth, stone free, and well suited to the use of improved cultural machinery. However, they are less fertile than the hill or bottom-land soils, as they are weathered from lighter-textured material than the hill soils and are leached to a greater extent than the upland or bottom-land soils. These conditions have favored more thorough leaching. Both surface soil and subsoil are of excellent structure which forms a good medium in which to grow crops where the fertility is supplied through manure or commercial fertilizers. These lighter soils are not so well suited to grass as the soils derived from glacial till, but they are adapted to such crops as tobacco and a wide variety of vegetables, including onions and asparagus, that is, to intertilled crops which require heavy fertilization.

The bottom-land or alluvial soils occupy a comparatively small area but are important in that they, like other alluvial soils, are unleached and therefore fertile. They are similar to other bottom-land soils of the northeastern part of this country in that they have

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[12] There is an apparent discrepancy in the correlation of the soils along the Berkshire-Hampshire County line. Becket stony loam in Hampshire County is mapped against Becket stony fine sandy loam in Berkshire County, as there is only a very small area of the stony fine sandy loam in Hampden and Hampshire Counties. Owing to their small extent in Hampshire County, the soils mapped as Hermon in Berkshire County are included in the Gloucester soils in Hampshire County.

not received in the past and do not receive at present the amount of deposits that the bottom lands receive in regions where erosion is more active. However, these small deposits are received from soils which still retain much of their mineral properties. The bottom-land soils, though not adapted to so wide a range of crops as the upland or the terrace soils, are better suited to corn than any soils in this region and are equally well suited to grass as the upland soils and much better suited to this crop than the terrace soils. Although crops on these bottom-land soils are not subject to damage from overflow as in other sections, especially in the Southeastern States, there is some danger from floods, and the tendency is not to plant valuable crops on the lower parts of this land.

The soils of the area covered are divided into six groups as follows: (1) Soils consisting of dark yellowish-brown or greenish-yellow very fine sandy loam or loamy fine sand. These soils carry no gravel or stone, and the soil material is much deeper to the sandy substratum than is common with the soils of this region. They occupy the northern part of the valley, the Hadley and Agawam soils predominating. (2) Soils having light-colored surface soils, with gravelly and sandy substrata lying below a depth of 2 feet. These are brown soils ranging from fine sandy loam to loamy sand and in places are very gravelly. They are dominant in the southern part of the Connecticut Valley. The Merrimac and Chicopee soils are the most important in this group. (3) Heavy-textured soils, ranging from fine sandy loam to silt loam, in general, with heavy silty clay or clay subsoils and substrata. They lie in all parts of the valley, most of them in comparatively small areas. (4) Brown or reddish-brown soils with a small content of stone or gravel, which range from fine sandy loam to loam in texture. These soils have compact or merely firm subsoils. They occur on the rolling lands of the valley, mainly on the foothills of the valley borders. (5) Brown soils of the eastern uplands, most of which are stony fine sandy loam or loams, with light or loose gray substrata below a depth of 2 feet. The stone-free soils, or those containing only a small quantity of stone, are not extensive. The Gloucester soils predominate in this region. Nearly all the rust-brown or ocherous-yellow soils in the southeastern part are loams and include both stony and stone-free soils. The substratum of the soils in this corner of the area ranges from firm to compact. (6) Brown soils of the western uplands, which are stony soils with compact subsoils. The stone-free soils occupy a very small area of the total highland, occurring mainly on the ridge tops. The Becket, Berkshire, Woodbridge, and Worthington soils predominate in this region.

The area of poorly drained land is very small, consisting of scattered small areas in the upland and small stream bottoms and filled-in lake beds.

Rough stony land is extensive and widely distributed over the area outside the valley and, where it is extensively developed, affects the region adversely.

The distribution of the soils of these two counties and the type of agriculture developed on them correspond closely to the three physiographic divisions, the valley, the eastern-hill region, and the western highland. Each of the three divisions contains a group of soils which, as soils, regardless of the relief of the surface on which they lie or their geographical location, strongly influence the crop distribution.

In the following pages of this report the different soils of the area are described in detail and their agricultural uses and relationships are discussed; their distribution is shown on the accompanying soil map, and their actual and proportionate extent are given in Table 8.

TABLE 8.—*Acreage and proportionate extent of the soils mapped in Hampden and Hampshire Counties, Mass.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Hadley very fine sandy loam	6,720	0.9	Cheshire sandy loam, stony phase	14,208	1.9
Hadley very fine sandy loam, overflow phase	1,856	.2	Wethersfield loam	2,240	.3
Hadley loamy very fine sand	576	.1	Wethersfield loam, brown phase	5,312	.7
Hadley loamy fine sand, overflow phase	960	.1	Wethersfield fine sandy loam, brown phase	4,736	.6
Hadley silt loam	1,536	.2	Holyoke stony fine sandy loam	4,800	.6
Hadley silt loam, overflow phase	3,904	.5	Gloucester loam	15,424	2.0
Agawam fine sandy loam	11,200	1.4	Gloucester stony loam	11,264	1.5
Agawam loamy fine sand	1,472	.2	Gloucester fine sandy loam	13,696	1.8
Chicopee fine sandy loam	22,016	2.8	Gloucester stony fine sandy loam	62,272	8.1
Chicopee loamy coarse sand	7,680	1.0	Essex loam	4,736	.6
Merrimac fine sandy loam	11,328	1.5	Essex loam, stony phase	2,240	.3
Merrimac sandy loam	32,896	4.3	Brookfield loam	4,928	.6
Merrimac sandy loam, deep phase	192	.1	Brookfield loam, heavy phase	2,688	.4
Merrimac sandy loam, brown phase	2,112	.3	Brookfield stony loam	12,928	1.7
Merrimac coarse sandy loam	8,000	1.0	Brookfield stony loam, heavy phase	1,216	.1
Merrimac loamy sand	29,504	3.8	Whitman stony loam	12,288	1.6
Manchester gravelly fine sandy loam	10,944	1.4	Worthington loam	8,448	1.1
Hinckley gravelly sandy loam	29,568	3.8	Worthington loam, stony phase	5,376	.7
Hinckley gravelly sandy loam, brown phase	1,472	.2	Woodbridge loam	13,312	1.7
Hinckley loamy sand	13,568	1.8	Woodbridge stony loam	29,760	3.9
Windsor fine sand	2,624	.3	Shelburne loam	320	.1
Windsor loamy fine sand	832	.1	Shelburne loam, stony phase	1,344	.1
Enfield fine sandy loam	4,416	.6	Becket loam	9,408	1.2
Melrose fine sandy loam	6,400	.8	Becket loam, shallow phase	768	.1
Suffield fine sandy loam	3,712	.5	Becket stony loam	15,936	2.1
Suffield fine sandy loam, steep phase	1,920	.2	Berkshire loam	4,992	.7
Suffield silt loam	6,656	.8	Berkshire stony loam	11,520	1.5
Suffield silt loam, steep phase	384	.1	Berkshire fine sandy loam	1,152	.1
Suffield silt loam, heavy phase	256	.1	Blandford loam	8,192	1.1
Scarboro loam	2,880	.4	Blandford loam, stony phase	1,984	.2
Cheshire fine sandy loam	12,416	1.7	Peru loam	3,520	.5
Cheshire fine sandy loam, gravelly phase	768	.1	Hollis fine sandy loam	3,200	.4
Cheshire fine sandy loam, shallow phase	1,344	.1	Hollis stony fine sandy loam	12,224	1.6
Cheshire sandy loam	6,208	.8	Ondawa fine sandy loam	8,128	1.0
			Meadow	35,136	4.5
			Muck	20,224	2.6
			Peat	2,432	.3
			Rough stony land	150,528	19.5
			Total	771,200	

THE VALLEY SOILS

CONNECTICUT RIVER VALLEY SOILS

The dominant soils of the Connecticut River Valley, which includes only the terrace and bottom land of the present river, belong to the Hadley and Agawam series.

Hadley very fine sandy loam.—Hadley very fine sandy loam, the principal agricultural soil of the valley and also the most important in the area, is an alluvial soil. It has been deposited in fairly recent times and represents the lowest terrace of Connecticut River. It lies above normal overflow, but not beyond the possibility of inundation. In fact, much of this terrace was covered to a slight depth during the 1927 flood. The surface relief ranges from fairly level to gently sloping and is characterized by a series of gentle swells that paralleled the current at the time the deposit was laid down, and the general trend conforms to the present course of the stream.

This soil is characterized by a dark greenish-yellow or olive color that becomes slightly paler with depth. The texture is very fine sandy loam to a depth ranging from 3 to 4 feet where it becomes loamy sand. The mealy or mellow condition of the surface soil extends to a depth ranging from 5 to 10 feet below the surface, deeper in places. The sandy texture of the substratum insures excellent drainage. The productive power of this soil may be attributed to several factors in addition to its long usage and excellent handling. It is a newly formed unleached soil and therefore contains a relatively high proportion of mineral elements needed in plant growth, its excellent structure allows plant-root penetration and development, and the lower part of the subsoil has a large moisture-retaining or storage capacity. These factors make it the most desirable farming soil in the area, and its acre value is high. It is rather low in organic matter.

Hadley very fine sandy loam occurs mainly in the towns of Hatfield, Hadley, and Northampton, in Hampshire County; and to less extent in Holyoke and the towns of Chicopee, West Springfield, and Agawam, in Hampden County. It covers a total area of 10.5 square miles.

About 75 per cent of the land is farmed. Approximately one-fourth of the total acreage is in Hampden County and is covered largely by city developments.

In the northern part of the valley (Hampshire County) this soil is used extensively for farming, tobacco (grown in the open) and onions being the most important crops. A large part of the total acreage of both crops is grown on this soil, possibly 40 per cent of the tobacco and 50 per cent of the onions. Other crops may occupy a larger acreage, but all crops are subordinated to these two, that is, all rotation, fertilization, and other farm practices conform to the production of tobacco and onions. Corn, both for grain and silage, and hay are the other leading field crops which are grown on a fair acreage. Rye is used as a cover crop and for this reason may be considered an important supplementary crop. Potatoes and asparagus are grown for market and occupy a much larger acreage than other vegetables which are grown mainly in home gardens.

Crop yields on this soil average higher than on any other soil in the area and compare favorably with the yields on any soil in the East. Tobacco yields from 1,200 to 2,000 pounds an acre, depending on the previous management of the field, the variety, and the season. Tobacco is fertilized with 3 or 4 cords of manure an acre, if available, and from 1 to 1½ tons of 5–4–5 fertilizer. The crop is not attempted without heavy fertilization and other practices which are brought out in the section on Agriculture. Onion (dry) yields range from 500 to 1,000 bushels an acre in a normal season. Usually 1 ton of lime and from 1 ton to 1½ tons of 6–8–7 fertilizer are used an acre. In wet seasons there is danger of loss of fertilizer and non-development of the crop, as in the 1927 season when the average acre yield fell as low as 100 bushels. Corn yields better than on most soils of the East, and yields on farms where dairying is followed compare favorably with those of the Corn Belt. The yields range from 50 to 75 bushels an acre under good conditions, with reported yields as high as 100 bushels. These heavy yields are obtained through the use of one-half to 1 ton of 3–10–6 fertilizer supplemented with manure. Corn silage yields from 10 to 15 tons an acre, according to the previous condition of the land and amount of fertilizer used. Only one soil in the area, the overflow phase of Hadley very fine sandy loam, the overflow land corresponding with this soil, has a larger acreage in corn. Potatoes yield from 150 to 300 bushels in a favorable season and rarely fail to produce a crop. Potatoes are heavily fertilized with 1 or 1½ tons an acre of a 5–3–5 mixture, containing potash in a sulphate form, as this land is rotated with tobacco.

Hay (timothy and clover) is grown on a small acreage, not because the land is less suited to hay but because it is used for other crops which require clean cultivation and grass does not fit in with the rotation. Hay yields from 1½ to 2 tons an acre. Rye is used as a cover crop. Alfalfa is a successful crop where the land is limed before seeding, but a very small acreage is grown. The yields range from 2 to 3 tons an acre. Grass does fairly well, but there is little permanent pasture. Asparagus occupies a fair acreage and is successfully grown, even competing in the Boston market with asparagus from near-by sections. Practically all the vegetables common to the region thrive on this land especially where heavy applications of fertilizer and manure are made, and no vegetables are grown without proper fertilization. The soil is used for market-garden crops in the vicinity of Springfield.

Hadley very fine sandy loam, overflow phase.—The overflow phase of this soil occurs along the Connecticut River and the lower course of Westfield River, where it is subject to inundation during spring freshets and at other flood stages of these streams. The phase is similar to the typical soil but on account of its location is used for different crops. It is used for corn and hay extensively, for vegetables to some extent, especially in the vicinity of Springfield, and for asparagus in other parts of the area. It is used for onions to a small extent but is not used for tobacco, as the danger from overflow is too great on the lower-lying soils for profitable production of the crop. The yields of all crops are lower than on the typical soil, but much less fertilizer is used in producing them.

Hadley loamy very fine sand.—Hadley loamy very fine sand, like the other soils of the Hadley series, is uniform in color and structure to a depth ranging from 5 to 10 feet below the surface. This soil is not extensive in the area surveyed. It occurs as low smooth swells throughout the other Hadley soils, usually along the stream edge of the terrace. In places, especially in narrow strips along the stream edge, the texture is loamy sand. Drainage is more thorough than on the other Hadley soils and crops may suffer from lack of moisture in dry seasons. This soil is used for the same crops as the other Hadley soils. Less tobacco and onions are grown and a relatively larger acreage of asparagus, tomatoes, melons, and other vegetables. Yields of tobacco, onions, potatoes, and other crops are lower than on Hadley very fine sandy loam, but yields of asparagus, tomatoes, and vegetables are very satisfactory. The low yields are due to naturally low productivity, loss of soil fertility from leaching in wet seasons, and lack of moisture in dry seasons. Asparagus, cucumbers, melons, and early vegetables seem to stand such conditions better than the other crops.

Hadley loamy fine sand, overflow phase.—The surface soil of the overflow phase of Hadley loamy fine sand ranges from loamy very fine sand to loamy fine sand and in some places to loamy sand. The land lies at a lower level than the typical soil, usually on the outer edge of the bends of Connecticut River. It occupies a comparatively small total area and is not highly important. It is used for pasture, corn, hay, and vegetables, asparagus being the leading vegetable crop, but tobacco and onions are not grown. Many areas are fallow, owing to an accumulation of rubbish and sand deposited during the 1927 flood. Crop yields are not high as little fertilizer is used and the natural productivity of the soil is not high.

Hadley silt loam.—Hadley silt loam occupies a much smaller total area than Hadley very fine sandy loam. Most of this soil is in Northampton, Hatfield, and Hadley Towns, where it occurs as back, or interior, areas of the terraces on which Hadley very fine sandy loam is developed. Here the deposits were heavier as evidenced by the silt loam texture of the soil. This soil in general is used slightly less than the very fine sandy loam for tobacco, as the leaf is apt to be of an inferior grade. It is used for onions, however, and to greater extent for corn, grains, hay, and grass. Hadley silt loam has a slightly smoother or more level surface and although well drained is not quite so well aerated as Hadley very fine sandy loam. It is a little more difficult to handle, and for this reason more than for any other the land is devoted to hay and grass.

Hadley silt loam, overflow phase.—The overflow phase of Hadley silt loam occupies the same relative position as the overflow phases of the other Hadley soils. Most of the land is better drained than the higher typical silt loam soil, as it occurs near the main streams, but a few small areas are poorly drained. The soil in these areas has a heavy bluish-gray silty clay loam substratum and a mottled gray, yellow, and brown subsoil. The overflow phase is used for corn and mowings. From fair to good yields of both corn and hay are obtained without the use of fertilizers.

Agawam fine sandy loam.—Agawam fine sandy loam ranks next in agricultural importance to Hadley very fine sandy loam. It occupies 11,200 acres. It occurs as high terraces along Connecticut River and the lower course of Westfield River, lying from 30 to 40 feet above the highest flood stage but well below the general terrace plain of the valley. It is developed most extensively in the towns of Hadley and Hatfield and in smaller areas in the towns of Northampton and Amherst, in Hampshire County, and in Agawam Town and Westfield in Hampden County. The area in Westfield is on the terraces of Westfield River.

Although an old alluvial soil, this is a comparatively new soil. It has developed a poorly defined profile, in that leaching has not progressed so far as in soils developed on the older terraces of the postglacial period, but the profile is more definite than that of the younger Hadley soils which have developed practically no profile.

Agawam fine sandy loam is characterized by a dark-brown mellow very fine sandy loam or fine sandy loam surface soil, from 8 to 10 inches deep, passing into yellowish-brown mellow slightly firm but not compact fine sandy loam, which at a depth of 2 feet becomes greenish yellow, and at a depth of 3 feet passes into gray loamy sand. The surface relief is fairly level, but owing to the elevation of the land, drainage is well established. The substratum is not sufficiently porous to cause excessive drainage, and the soil has good moisture-holding capacity.

About the same proportion of this soil is covered by city and town developments as of Hadley very fine sandy loam. The areas covered with buildings are in Westfield, Springfield, and Northampton. The remainder of the soil is under cultivation, and the crops grown, with some exceptions, are practically the same as on Hadley very fine sandy loam. The yields are slightly lower on Agawam fine sandy loam than on the Hadley soil. Corn for silage (little is grown for grain) does not yield so well as might be expected, except on the dairy farms where farm practices differ from those on other farms. Open-grown tobacco occupies about the same actual acreage on this soil as on the Hadley soil; onions, about 40 per cent less; asparagus, about 10 per cent more; and silage corn and hay from 30 to 40 per cent more. Market-garden crops are grown on a fair acreage in Agawam Town and Westfield, but potatoes and asparagus largely replace them in the northern part of the area. Fertilizers are used in approximately the same amounts as on Hadley very fine sandy loam.

Agawam loamy fine sand.—Agawam loamy fine sand has much the same soil profile as the fine sandy loam soil, except that the material is looser and more fluffy. It occurs only in the northern part of the valley in the towns of Hadley and Hatfield. The surface relief is slightly undulating or billowy, but in places it is more level. Drainage is well established and is inclined to be excessive.

About 50 per cent of the total area of this soil is cleared and used for crops, among which tobacco is the most important, although the proportion of the total tobacco crop grown on this land is not large. Some asparagus, potatoes, and rye are grown, but their total acreage is not large, and very little corn, hay, or grass is grown. Crop yields range much lower than on Agawam fine sandy loam, owing to the smaller amount of plant food contained in the soil and to its lower moisture-holding capacity, so that farming on this soil is not given the attention that it is on the fine sandy loam. Most of the tobacco is grown under shade. For this crop the quality of the leaf is more desirable than quantity of production, and a soil having the characteristics of this land makes almost an ideal medium in which to grow shade tobacco. The yield of shade tobacco ranges from 700 to 800 pounds an acre.

SOILS OF THE OLD GLACIAL TERRACES

The Connecticut Valley south of the Holyoke Range, which includes most of the valley outside the terrace and flood plain of Connecticut River, includes two dominant soil series, the Chicopee and Merrimac.

The Chicopee soils are developed on the old glacial terraces of the Connecticut Valley, the material of which was derived from the

Triassic sandstone. They have mellow brown surface soils, ranging from fine sandy loam to loamy sand, from 6 to 10 inches deep; yellowish-brown or reddish-brown firm but friable subsoils of the same texture, passing at a depth ranging from 20 to 24 inches into a loose gravelly and sandy substratum having a decided red cast. The surface relief is fairly level, and, owing to the open substratum, drainage is good. The depth to the gravelly substratum is slightly greater than in the Merrimac soils, which gives the Chicopee soils some advantage in crop production.

The Merrimac soils, although extensively developed in the Connecticut Valley, are the important terrace soils of the smaller-stream valleys. These soils represent a fair acreage of level well-drained stone-free land which is suited to cultivation.

On the valley soils, particularly on the Merrimac soils, there is little question that the better yields of grass are obtained only where the soils are maintained in a high state of cultivation. These soils are not inherently grass soils, as the surface soils have been subjected to leaching to a greater extent than the soils developed on glacial till, and these soils are derived from material from which, in the course of deposition, much of the finer material has been removed.

Chicopee fine sandy loam.—Chicopee fine sandy loam is developed in the "back valley," as the area west of the Holyoke Range is known. This soil is not strong but is more productive than the other sandy terrace soils. On account of the firmness of the lower part of the subsoil, the moisture-holding capacity is fairly good. Probably 70 per cent of the land is under cultivation. It is used for growing both open-grown and shade tobacco, fully one-fourth of the shade crop being grown on this soil. Silage corn, hay, and potatoes are grown in about the same proportion as on the Agawam soils, and vegetables are grown to less extent. In the town of Hadley some onions are grown on this land. Grass for mowing or pasture is grown on only a small acreage, because the land is better suited to more profitable crops. Crop yields are fairly good. Like the other valley soils, where the crop system does not include building up a reserve of organic matter in the soil, yields of corn are not particularly high, ranging from 40 to 60 bushels an acre of grain, and from 6 to 10 tons of silage. Open-grown tobacco yields from 1,200 to 1,800 pounds an acre, and shade tobacco from 1,000 to 1,200 pounds. Potatoes yield from 100 to 200 bushels, depending on the season and the amount of fertilizer used. Special crops are not grown without heavy fertilization, and few other crops are grown without the addition of fertilizer or manure.

Chicopee loamy coarse sand.—Chicopee loamy coarse sand occupies the sand plains in the back valley. This soil is more droughty than Chicopee fine sandy loam but not so droughty as Merrimac loamy sand. It contains a slightly larger amount of loamy material which imparts the red cast to the entire profile. This land is not used extensively for farming. Many fields that were under cultivation in recent years are now in broom sedge, and much of the land that was abandoned at an earlier date has grown up in birch sprouts. Cultivated areas return comparatively low yields. The land is not well suited to grass and is little used for mowing or pasture. Shade

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tobacco is successfully produced with heavy fertilization, the yields ranging from 800 to 1,000 pounds an acre of a fairly good grade of wrapper leaf. Rye and asparagus are other crops which succeed. Crops are usually grown on the interior parts of large bodies of this soil, as the moisture-holding capacity is better than along the outer edges.

Except for the gravel content, the gravelly areas are not essentially different from the remainder of the soil, and the gravel content is not sufficiently high to interfere with cultivation. The gravelly areas are used to some extent for tobacco but are not used for onions. The gravelly land is used for hay, corn, and pasture. More fallow fields occur on the gravelly areas than over the remainder of this soil.

Merrimac fine sandy loam.—Merrimac fine sandy loam, although not the most extensive soil of the Merrimac series, is the most important agriculturally. The surface soil is brown or dark-brown mellow fine sandy loam to a depth of 5 or 6 inches. The subsoil is yellowish-brown mellow fine sandy loam material, becoming pale yellow below a depth of 18 or 20 inches and passing at a depth ranging from 24 to 30 inches into loose grayish-yellow or gray sandy loam material which contains a quantity of rounded quartz gravel. In most places very little gravel occurs above a depth of 18 or 20 inches, but in other places a noticeable amount is scattered throughout the upper soil layers. The gravel does not occur in sufficient quantities on the surface to act as a mulch, nor is it large enough to interfere with cultivation. These gravelly areas, although suited to general farm crops, are better adapted to and are used in other sections for orchard crops, small fruits, and berries. The substratum consists of beds of sand and gravel.

In places the surface soil approaches a very fine sandy loam, especially on terraces along Swift, Ware, and Chicopee Rivers. Much of this soil, as developed on the terraces along Westfield River, contains little or no gravel in the soil profile and the substratum consists of gray or yellowish-gray sand.

Merrimac fine sandy loam occurs in scattered areas on the terraces of the eastern part of the area, mainly along the Chicopee-Quaboag-Ware-Swift River system, in the towns of Ware, Belchertown, Palmer, and Ludlow, and on a few high terraces in Monson Town. In the western part of the area it occurs only on small terraces along the Westfield River system and Mill River. Small areas occur on the outer edge of the Connecticut Valley, or lowland, at Amherst and in the western part of Hatfield Town.

The areas are level or gently undulating and lie at elevations ranging from 20 to 50 feet above stream level. A few ice-block holes occur in places. Drainage is so thorough that if it were not for the level surface relief crops would suffer from lack of moisture in moderately dry seasons. Seventy-five per cent of the land is cleared, and the small area remaining in forest is covered with second-growth white pine, gray birch, and white birch, together with some oak and chestnut. The farmed land is devoted principally to hay, corn (for silage and grain), potatoes, and pasture, and small acreages are in oats, millet, rye, buckwheat, and vegetables. Tobacco is grown on this soil only in the Connecticut Valley, and the total acreage in this crop is small.

Crop yields are only moderate, except where the land is heavily fertilized. Tobacco yields from 1,000 to 1,500 pounds an acre; hay, from 1 to 1½ tons; corn, from 40 to 60 bushels; oats, from 45 to 65 bushels; and potatoes, from 125 to 250 bushels.

Merrimac fine sandy loam is one of the easiest soils in the area to cultivate, as it is mellow and free from stones. It is usually plowed to a depth of 8 or 10 inches, and intertillage can be done shortly after rains, owing to the openness of the soil, although the moisture-absorbing and moisture-holding capacity are not so good as in some of the finer-textured soils. Easy root penetration is aided both by texture and structure. Both manure and commercial fertilizer are used.

Merrimac sandy loam.—Merrimac sandy loam is widely distributed on the terraces of the Connecticut Valley and to less extent on the terraces of the smaller stream valleys. It is similar in all respects, except texture, to Merrimac fine sandy loam. It has a slightly lower moisture-absorbing and moisture-holding capacity, which is reflected in slightly lower crop yields. In normal seasons this is hardly perceptible, but in dry seasons it is noticeable. From 60 to 70 per cent of the land is cleared and used for approximately the same crops as the fine sandy loam.

Rather extensive gravelly areas occur in this soil. They are similar to the gravelly areas in the fine sandy loam with the exception that much more gravel is found in the upper layers of this soil. In fields long under cultivation, a noticeable amount of gravel is on the surface, enough in places to form a surface mulch, but it does not interfere with cultivation. The gravelly areas are closely associated with the rest of the soil and are developed extensively on the eastern side of the Connecticut Valley around Amherst, in the southern part of Ludlow Town, and along the western edge of Westfield. The gravelly areas are not quite so desirable for general farming as the typical areas but probably are better suited to orchard fruits, small fruits, and berries than the remainder of the soil.

Merrimac sandy loam, deep phase.—Some areas of a deep phase of Merrimac sandy loam, which differs from the typical soil in that little or no gravel occurs in the profile, occurs in places. This phase as developed in Agawam Town is slightly better, agriculturally, than the rest of the soil.

Merrimac sandy loam, brown phase.—The surface soil of Merrimac sandy loam, brown phase, is dark rust-brown mellow sandy loam. It grades at a depth ranging from 5 to 10 inches into the subsoil which consists of rust-yellow or ocherous-yellow medium sandy loam becoming pale yellow below a depth of 18 or 20 inches and slightly lighter in texture as the depth increases. Below a depth of 24 inches the subsoil grades into rust-yellow loose gravelly sand which extends to a substratum of alternate beds of assorted sand and gravel, yellowish brown, rust brown, or reddish brown in color.

This brown phase of soil occurs on the level areas between the overflow land, or meadow, and the hills. The deposits were derived largely from the schist rocks from which the Brookfield soils are weathered. The soil is developed in small areas scattered over the southeastern corner of Hampden County and is important in that locality. As it lies outside the valley it is not used for tobacco but is used for all other crops that are grown on Merrimac fine sandy loam and Merrimac sandy loam.

Crop yields are slightly larger than on the typical soil, due in part to the position of the phase, to better general-farming practices, and also a better soil.

Merrimac coarse sandy loam.—Merrimac coarse sandy loam has a profile similar to the sandy loam member, except for the coarseness of the sand grains. This texture gives rise to a slightly more droughty soil which occupies rather high terraces on the outer, or hill, edges of the Connecticut Valley. Many areas are abandoned and grown up to gray birch sprouts. The cultivated areas, where properly tended, produce slightly lower yields than the sandy loam. In general, the soil is used for the same crops as the sandy loam, but it is used for tobacco to a very slight extent.

Merrimac loamy sand.—Merrimac loamy sand is the predominant soil of the sand plains of the Connecticut Valley and of the upper part of the valley of Swift River. Though extensive it is the least important soil, agriculturally, of the Merrimac series.

Merrimac loamy sand is essentially the same as the other Merrimac soils except that it is coarser textured, is fairly loose and incoherent throughout, and contains little or no gravel above a depth of 24 inches. The substratum is composed of beds of coarse sand or gravelly coarse sand. Extensive areas occur in which little or no gravel is present in the entire profile, even the substratum consisting of coarse sand. Over fairly large areas the texture of the surface soil particles is medium sand to a depth of about 20 or 24 inches. In smaller areas, in the town of Longmeadow, the sand particles of the surface material are fine in texture.

Merrimac loamy sand occurs in fairly large areas in the towns of Chicopee, Longmeadow, Agawam, Southampton, and Easthampton, in Springfield, north of Westfield, and in South Hadley, Enfield, Greenwich, and Prescott Towns. It occurs on broad level terraces. Drainage is excessive, the water passing rapidly down through the porous subsoil.

This soil is not important agriculturally, as less than 5 per cent of the land is cleared and used for cultivated crops. Most of it is cut-over land supporting a scant growth of scrub oak and lowbush blueberries. Where abandoned fields have become sprout land, gray birch and brown birch predominate, whereas other forested areas contain white pine, pitch pine, and some oak and chestnut. The original forest was largely white pine. The small cleared areas are used for mowings, pasture, tobacco (open and shade grown), sweet corn, potatoes, asparagus, and home gardens. Many abandoned fields are covered with broom sedge and cinquefoil. The land is extremely droughty, and crop yields are low except in wet seasons. Extensive areas are covered by city and town developments in the Connecticut Valley. Although, in favorable seasons, this soil is capable of producing an excellent grade of shade tobacco, yields are low.

SOILS OF THE KAMES

The soils developed on the kames, which are associated with the terraces, have much the same profile as the soils of the sandier and gravelly terraces, but they differ from those soils in having a hummocky surface relief whereas the terrace soils are uniformly smooth.

Soils of three series are weathered from kame deposits, the Manchester, in the Connecticut Valley, the Hinckley, mainly in the smaller valleys, and the Windsor, on the wind-blown kames of the valley.

Manchester gravelly fine sandy loam.—Manchester gravelly fine sandy loam is the most important soil of this group. It occurs in scattered areas throughout the valley, mainly on the outer edge. The individual areas are small, and the total area is not large. This is not a highly important soil agriculturally owing to its general leachiness which is caused mainly by the porous gravelly character of the subsoil.

About one-third of the land is cleared and used for orchards and pasture. About one-fifth of the orchard development of the valley is on this soil. Both apples and peaches are grown in the orchards, but apples predominate. Cover crops, such as buckwheat, rye, and grasses, are sown between the tree rows. Where heavily fertilized and properly handled the yield of fruit is fairly large. Pasture on this land is mediocre, but the land is used for pasture because it is less suited to tilled crops than the level terraces.

Hinckley gravelly sandy loam.—Hinckley gravelly sandy loam belongs in a slightly lower grade than the Manchester soil, as it is more leachy than the Manchester, although not so leachy as Hinckley loamy sand or the Windsor soils. Much of this land is in forest, the small acreage of cleared land being used for pasture. The grass stand is poor in all except wet seasons, and even then the growth is much inferior to that on the glacial-till soils. Several areas contain a large quantity of stone and are inferior to the stone-free areas.

Hinckley gravelly sandy loam, brown phase.—The brown phase of Hinckley gravelly sandy loam differs in color from the typical soil, but there is little difference agriculturally. The phase may be considered slightly better for grass.

Hinckley loamy sand.—Hinckley loamy sand occurs as kames and is similar to the other Hinckley soils, except that it contains little gravel throughout the profile. Small areas of this soil are scattered over the Connecticut Valley terraces. In the vicinity of Monson the soil contains a quantity of granite bowlders. The land is of low agricultural value and is little used for farming.

Windsor fine sand.—Windsor fine sand is the soil developed on the wind-blown kames of the valley. It is not extensive and is little used for agriculture on account of its inherently low productive power and its leachiness. The dunes are not shifting sand devoid of vegetation, but they support a tree growth of scrub oak and gray birch. Where forested or in grass they are stable and only tend to drift where under clean cultivation. Drifting was noticed in a few isolated places.

Windsor loamy fine sand.—Windsor loamy fine sand occurs on lower kames than Windsor fine sand, and it is associated with the fine-textured terrace soils of the upper part of the valley. Although it has a greater tendency to drift than the fine sand, the drifting seems to cause little deterioration, as it is cultivated in many places regardless of drifting. Few fields are composed entirely of this soil, but many fields include some of it and, although crop yields are not high, it is not a worthless soil. On many farms the farm buildings are located on this land, leaving the more valuable surrounding land for crops.

OTHER TERRACE SOILS

The other soils developed on the terraces, which are of small area but of some agricultural importance, are Enfield fine sandy loam, Melrose fine sandy loam, Suffield fine sandy loam, Suffield fine sandy loam, steep phase, Suffield silt loam, Suffield silt loam, steep phase, Suffield silt loam, heavy phase, and Scarboro loam. These soils occur almost entirely within the Connecticut Valley.

Enfield fine sandy loam.—Enfield fine sandy loam is much the same as Chicopee fine sandy loam to a depth ranging from 20 to 36 inches, at which depth it rests on red sandy clay, a glacial material derived from Triassic (red sandstone) material. Enfield fine sandy loam occupies an area of 6.9 square miles, and occurs in scattered areas throughout the valley region, where it was deposited in thin beds over the till or banked thinly over the till by wind action. It includes areas of sandy loam and loamy sand texture.

The type of agriculture developed on this soil is essentially the same as on Chicopee fine sandy loam. The subsoil of the Enfield soil, however, has a slightly better moisture-holding capacity. Drainage is well established, although in many places seepage water passes along the tops of the till beds, and in wet seasons the moisture content in most places is too high for the best development of crops.

Melrose fine sandy loam.—Melrose fine sandy loam occupies fairly level terraces. It is closely associated with the Chicopee soils but is distinguished from those soils by its slightly darker surface soil and mottled condition of the subsoil, which is caused by moisture held by the tight clay strata that underlie the soil at a depth ranging from 3 to 5 feet. These characteristics render this one of the best tobacco soils in the area and one well suited to onion culture. The land is used for the production of open-grown tobacco in nearly all parts of the valley, as tobacco makes heavy yields of a fair or good grade of leaf. Onions are grown on this land occurring in the onion belt in the northern part of the area.

Onion yields compare favorably with those on the best soils in normal seasons, but in wet seasons the yields are low or may fail entirely. This soil is adapted to grass and is used for hay and pasture. Corn and oats are grown to a small extent.

Suffield fine sandy loam.—Suffield fine sandy loam is characterized by sandy material overlying a clay bed. The surface soil is brown and the subsoil is yellowish brown and rests at a depth of about 2 feet on a green-tinged fairly heavy clay substratum. Although this soil is not extensive, it is recognized as one of the best onion soils of the area and is utilized for that crop. Onion yields compare favorably with those obtained on other soils, and some of the yields reported were heavier than on any other soil. In a good season onions average 1,000 bushels an acre, but such a yield depends much on the season, as the clay subsoil retards the downward movement of moisture, and in an excessively wet season all crops fail. This land is used for hay, corn, and oats, and, besides onions, for such vegetables as cabbage, kale, and beets. The clay substratum holds moisture, and crops rarely suffer in dry seasons. The largest areas are in the southern parts of Hadley and Amherst Towns, and small scattered areas are in other parts of the valley.

Suffield fine sandy loam, steep phase.—The steep phase of Suffield fine sandy loam occupies the edges of terraces and is of little crop value. The land is wooded or in pasture.

Suffield silt loam.—Suffield silt loam, although fairly extensive, is not agriculturally important, and it is the only heavy soil occurring on the terraces. It is derived from beds of clay. The surface relief in general is level. Drainage is retarded by the heavy clay subsoil and stratified clay substratum. This soil occurs in scattered areas in Agawam and South Hadley Towns, and throughout the valley the larger areas are in Hadley, Amherst, and Easthampton Towns. The land is utilized for hay and pasture. Hay cuts about 1 ton an acre, and pastures furnish good grazing. Small grains are grown mainly as nurse crops for grass when reseeding hay land.

Suffield silt loam, steep phase.—In a few areas of Suffield silt loam, erosion has cut into the beds of clay in such a way as to form a steep escarpment along the edges of areas of the typical soil. Such areas are mapped as a steep phase of Suffield silt loam.

Suffield silt loam, heavy phase.—Some areas of Suffield silt loam, which are really silty clay loam, occur in Easthampton Town. These areas are used solely for pasture. They are mapped as a heavy phase of the silt loam.

Scarboro loam.—Scarboro loam is of only small extent and is not agriculturally important. It occupies flat or poorly drained depressions on the terraces of Connecticut Valley. The surface soil is dark and rather deep; the subsoil is dark yellowish brown; and the substratum is mottled yellow and gray sandy loam, passing below a depth of 2 feet into gray sand. Most of this land is in forest of soft maple. A few cleared and drained areas are used for oats, hay, and pasture.

HILL SOILS OF THE RIFT VALLEY

The soils of the hill region within the bounds of the Connecticut Valley include members of the Wethersfield, Cheshire, and Holyoke series, of which the Wethersfield and Cheshire are the dominant soils. The soils of the valley have weathered from till, with the exception of Holyoke stony fine sandy loam, and they are derived from red sandstone and shale. They have brown surface soils, reddish-brown subsoils, and pink or red substrata.

Cheshire fine sandy loam.—Cheshire fine sandy loam is the most important farming soil of this group. It has a brown mellow surface soil, a reddish-brown fairly firm subsoil, and a firm but not compact red till substratum lying below a depth of 2 feet. The subsoil can be penetrated readily by roots and is only mildly acid.

This soil occurs on low smooth hills near the center of the east and west sides of the valley. The largest areas are in East Longmeadow and the western part of Wilbraham Towns; smaller areas are in Southwick, the western part of Agawam, and in Amherst Towns, and scattered areas are in other valley towns.

About three-fourths of the land is cleared, and more than half the total area is used for crops, orchards, and pasture. Nearly one-half of the orchard acreage of the two counties is on this soil. The land is used for hay, silage corn, and alfalfa, and to a small extent for potatoes and other market-garden crops. Yields of both apples and peaches are good, hay and silage corn make fair yields, and clover and alfalfa, especially alfalfa, make good yields. The yields compare well with yields on other upland till soils. Hay yields from 1½ to 2 tons an acre; alfalfa, from 2 to 2½ tons; corn, about 12 tons of silage; and potatoes, from 150 to 200 bushels.

A few stony areas are included with this soil in mapping, in which small slabby fragments of the parent rock (red sandstone) occur in sufficient quantities to interfere to some extent with cultivation but not enough to prohibit the use of mowers. Most of the stony areas are in wood lots or pasture, and a few are used for peach and apple orchards.

Cheshire fine sandy loam, gravelly phase.—The gravelly phase of Cheshire fine sandy loam is not used for crops to an equal extent with the typical soil, but it is used to a greater extent for orcharding.

Cheshire fine sandy loam, shallow phase.—The shallow phase of Cheshire fine sandy loam is mostly in forest, and the small area cleared is used for mowing and pasture. The shallow phase is similar to the typical soil to a depth ranging from 15 to 24 inches where it rests on the red sandstone bedrock. These areas when cultivated are used mainly for mowing and small grain. They are much less productive than the typical soil.

Cheshire sandy loam.—Cheshire sandy loam is less extensive than Cheshire fine sandy loam, is less productive, and hence less used for farming. It has a pink subsoil instead of the red subsoil of the fine sandy loam, and the material is less firm. The relief is slightly more rolling than that of the fine sandy loam, and drainage is more thorough. This soil is rather extensively developed in Southwick and Granby Towns and to less extent over other parts of the valley. A smaller area of this soil than of the fine sandy loam is cleared. The cleared land is used mainly for mowing and pasture, and smaller areas are in orchard and other crops, including corn, oats, and potatoes.

Cheshire sandy loam, stony phase.—The stony phase of Cheshire sandy loam, aside from a small area in pasture, is not used for farming. It occurs in Ludlow, Granby, and other towns of the Connecticut Valley.

Wethersfield loam.—Wethersfield loam occupies the low smoothly rounded hills (drumlins) in the south-central part of the valley, occurring mainly in Agawam and East Longmeadow Towns. The surface soil is dark brown, and the subsoil is fairly heavy red sandy clay, passing at a depth ranging from 20 to 30 inches into tightly compact or rather tightly cemented red till. Drainage is well established. Nearly all the land is cleared and in mowing, pasture, and orchard, with a relatively small acreage in other crops. Clover is the predominating hay crop. As this soil resembles the Cheshire soils, on which alfalfa succeeds, some unsuccessful attempts have been made to grow alfalfa on this land. The failure may be traced to the tightly compact substratum underlying Wethersfield loam. Yields of most crops on Wethersfield loam are good, hay yielding from 1 to 1½ tons , and silage corn from 10 to 12 tons an acre. Some

A, An excellent crop of celery on Hadley silt loam. B, profile of Gloucester fine sandy loam, exposed in a railroad cut near Ludlow

nurseries, which specialize in ornamental shrubs, are located on this soil in Agawam Town.

Wethersfield loam, brown phase.—The brown phase of Wethersfield loam occurs on low smoothly rounded hills (drumlins) throughout the valley region. The subsoil is not quite so red and the substratum is more tightly compact than in the typical soil. The compact substratum resists the downward movement of water and causes it to flow along the top of the indurated substratum. A few gravelly areas are in West Springfield Town. The gravel is not sufficient in size or quantity to interfere with cultivation.

Most of this land is cleared and used mainly for hay, pasture, and silage corn. Some small grains are grown, but these crops occupy a small acreage. Crop yields are similar to those on the typical soil, with the exception that the brown phase gives heavier yields of hay, ranging from about 1 to 2 tons an acre.

Wethersfield fine sandy loam, brown phase.—Wethersfield fine sandy loam, brown phase, occurs on low rounded hills, or drumlins, throughout the valley. The subsoil is not quite so red as the subsoil of Wethersfield loam, but the substratum is equally compact. Larger quantities of stone bowlders occur on the surface and embedded in the substratum than in the loam member. This soil is used to less extent for farming than the loam. Most of the cleared area is in mowing, pasture, and orchards. On account of the stone, a larger area is in pasture than on the loam and a larger acreage is in orchards. The yields on the fine sandy loam, brown phase, areas are lower than on the loam areas.

Holyoke stony fine sandy loam.—Holyoke stony fine sandy loam has a dark-brown surface soil, and a brown, rust-brown, or reddish-brown mellow subsoil which grades at a depth of 30 inches into brown or yellowish-brown fairly firm heavy till. Both surface soil and subsoil are filled with fragments of trap rock from which the soil has weathered. This soil occurs along and near the base of the trap-rock dikes that extend through the valley and are known as the Holyoke Range. The surface relief ranges from sloping to steeply sloping and hilly. Drainage is well established. Nearly all this land is in forest, but a few small cleared areas are used for pasture and furnish fair grass.

SOILS OF THE EASTERN HILL REGION

The soils of the eastern hill region include members of the Gloucester, Essex, Brookfield, and Whitman series.

The soils of the Gloucester series predominate over the eastern hill region. They represent shallow till soils that have brown or dark-brown surface soils, from 6 to 10 inches deep, the depth varying with the soil type and plow depth. The surface soils are underlain by yellowish-brown mellow but firm subsoils which become paler with depth and merge at a depth of 2 feet into gray, light, gritty till showing little or no compaction. The surface relief ranges from gently rolling to hilly. All these soils contain varying quantities of stone (granitic bowlders) on the surface and throughout the soil mass. Drainage in most places is good.

The soils of the Essex series closely resemble the Gloucester soils except that they are underlain by a very compact substratum.

The Brookfield soils are weathered from comparatively shallow till, which has been derived from rust-brown soft schist, high in pyrites. Owing to the character of the material, weathering has penetrated deeper than in the soils derived from granitic material. The Brookfield soils have dark rust-brown surface soils and brown or ocherous-yellow firm but friable subsoils, which become paler with depth, grading at a depth of 3 feet or deeper into pale-yellow or pale greenish-yellow mealy till. Drainage is good, owing to the hilly relief and noncompact subsoils. These soils occupy long comparatively narrow parallel ridges and in places smoothly rounded hills. The forest growth consists chiefly of white oak, chestnut oak, and chestnut.

The Whitman soils are represented in this area by Whitman stony loam, known locally as stony swamp. This soil is well distributed over the area, occurring in small poorly drained depressions and in troughs between the hills.

Gloucester loam.—Gloucester loam is the most important agricultural soil, representing the largest acreage of comparatively stone-free land, in the eastern part of the area. From 75 to 80 per cent of the land is cleared and used for agriculture. The cultivated area is largely in mowing, with small areas in pasture and tilled crops, including corn for silage, grain, and fodder, sweet corn, oats, potatoes, vegetables, and apples. Some of the apples are grown in commercial orchards.

Gloucester loam is fairly productive, as it contains a good supply of plant food and is fairly retentive of moisture. Hay yields from 1 to 2½ tons an acre, silage corn from 10 to 15 tons, and oats make fairly good yields. Clover makes a good stand where lime is used. Apple trees make a healthy growth, and the fruit is of excellent quality where the orchards are well cared for. The heavy yields of hay reported on Gloucester loam and associated soils of the eastern upland are owing to the improvement of the soil rather than to a natural adaptability for grass. The available manure is used for corn and garden crops and is depended on to keep up fertility, as a much smaller amount of commercial fertilizer is used than in the valley. This soil like the rest of the soils of the eastern upland is strongly acid.

Gloucester stony loam.—Gloucester stony loam is similar in all respects to Gloucester loam, except that it carries a larger content of stone, which interferes with cultivation to such an extent that most areas of the stony loam are used for pasture. This is fair grassland, furnishing good bluegrass pasture when seeded and fairly good grass pasture under natural conditions.

Gloucester fine sandy loam.—Gloucester fine sandy loam is almost as extensive as Gloucester loam, and it is used for the same crops, but a smaller acreage is in tilled crops. Yields are slightly lower than on the loam. This soil is nearly as well suited to orcharding as the loam and is used for that purpose to some extent. Some included areas of sandy loam texture occurring in the northeastern part of the area are little used for farming. (Pl. 3, B.)

Gloucester stony fine sandy loam.—Gloucester stony fine sandy loam is extensive, covering much of the rougher hill land in the eastern part of the area and a few small bodies in the southwestern corner. Owing to its stoniness and low productive power much of this land remains in forest. The small cleared areas are used mainly for pasture and furnish good grass in all but dry seasons. The land is used to a small extent for orcharding and mowing. The comparatively large area of more sandy soil in the northeastern part of the area is in forest.

Essex loam.—Essex loam resembles Gloucester loam in all characteristics except that Essex loam is underlain by a very compact substratum which interferes with the downward movement of soil water to the extent that the water has a tendency to move along the top of the substratum. In a dry season this is an advantage in that it helps to conserve moisture, but in a wet season crops have a tendency to drown. This land is used for mowing, pasture, and to a small extent for corn and oats. Probably one-half of the land is in forest. In dry seasons the yields are about the same as on Gloucester loam, but in wet seasons they are lower.

Essex loam, stony phase.—The stony phase of Essex loam has about the same relation to the typical soil as the stony Gloucester soils bear to the nonstony types. Most of the soil of the stony phase is in forest, and the few cleared areas are used for pasture.

Brookfield loam.—Brookfield loam is the most important soil of the Brookfield series as it contains less stone than the other members and can, therefore, be more easily cultivated. It is agriculturally important in the region in which it occurs as it constitutes the areas which can be cultivated outside the terraces. About 60 or 70 per cent of the land is cleared. The crops grown are essentially the same as those on Gloucester loam, and they are grown on about the same relative acreage. Probably more clover is grown than on other soils of this region, and potatoes are grown in numerous small fields. This soil is handled in much the same manner as Gloucester loam. Hay yields from 1 to 1½ tons an acre; potatoes, from 100 to 250 bushels when fertilized; and corn, oats, and clover make fairly good yields.

Brookfield loam, heavy phase.—The heavy phase of Brookfield loam occurs on smoothly rounded hills, or drumlins, and is weathered from a deeper and heavier till deposit, but it is derived from the same rock material as the other Brookfield soils. The heavy phase contains less stone than the typical soil and in general is more desirable. It is better suited to grass which remains green even in dry seasons. Hay yields average one-half ton more than on the typical soil, and orchards are more profitable and occupy a larger acreage.

Brookfield stony loam.—Brookfield stony loam occupies steep hillsides and narrow ridges. Drainage is well established throughout the soil, much of the water passing off through surface channels. Many blocky fragments of stone are scattered over the surface, and ledges protrude or are close to the surface in places. From 75 to 85 per cent of this land is in forest, and the remainder is used for mowing and pasture. In former years a larger acreage was under cultivation, but in recent years much of the land has grown up to forest. Owing to the difficulty of operating mowing machines, more of the land is being used as permanent pasture each season.

Brookfield stony loam, heavy phase.—The heavy phase of Brookfield stony loam is used mainly for pasture, as it furnishes good grazing.

Whitman stony loam.—The surface soil of Whitman stony loam is dark-brown or black loam, approaching muck in places, to a depth of 5 or 6 inches. The subsoil is grayish-brown slightly firm loam, mottled with brown, yellow, and gray in the lower part, and it passes into gray light-textured till below a depth of 2 feet. The land is little used for farming, owing to its stone content and naturally poor drainage. The total area in crops is less than 15 per cent, most of which is used for mowing and pasture, with a small acreage in corn and oats. This land returns fair yields and furnishes good pasture in dry seasons only. Soft maple is the dominant forest growth.

SOILS OF THE WESTERN HIGHLAND

The soils of the western highland include members of the Worthington, Woodbridge, Shelburne, Becket, Berkshire, Blandford, Peru, and Hollis series. The Worthington soils are the most important agricultural soils and the Woodbridge soils are the most extensive soils on the western highland. The Woodbridge soils occupy much of the hillsides and foothills in the eastern two-thirds of the highland.

Worthington loam.—Worthington loam is the most important agricultural soil of the group, as it represents the largest area of comparatively stone-free soil with smooth surface relief in the western highland. It is developed on the flattened ridge tops of the northwestern part of the area, mainly in the towns of Worthington, Plainfield, Cummington, Goshen, and Chesterfield.

The surface soil of cleared fields is very dark brown loam from 6 to 10 inches deep, passing into a shallow brown subsoil which in few places extends deeper than 12 or 15 inches, where it grades into dark greenish-yellow or olive-colored till of medium heavy texture and slight compaction. The substratum does not prevent the penetration of roots and serves as a reservoir for holding moisture. This soil has been slightly influenced by limestone, and this influence becomes stronger toward the north. The stone content is small. These characteristics make for a good grass soil, and the dark surface color is caused partly by the accumulation of organic matter resulting from the growth and decay of grass.

Most of the land is cleared and is used for farming. Grass, both for pasture and hay, is the leading crop. Other crops are corn, apples, potatoes, buckwheat, and vegetables. Crops, especially corn and vegetables, are often injured by frost, so that crops on this soil as on other soils of the region are limited to quick-maturing crops. Yields are usually good, considering the fact that little attention is given farming in this region. Hay yields from 1 to 2 tons an acre, varying with the season; corn and oats make fair yields; potatoes yield from 150 to 200 bushels where they have received the normal amount of fertilizer; and buckwheat, from 18 to 24 bushels. Yields are usually low in wet seasons, but grass is comparatively good in both wet and dry seasons. The tendency of soils at this elevation is to accumulate organic matter on or near the surface, and as very little leaching has taken place the plant food is conserved in the upper part of the soil where it is readily reached by grass roots. The compact substratum, lying at a comparatively slight depth, is a detriment to some of the deeper-rooted crops but in no way interferes with the growth of grass.

Worthington loam, stony phase.—The stony phase of Worthington loam differs from the typical soil only in the quantity of slabby pieces of black schist scattered over it. It is utilized almost entirely for pasture.

Woodbridge loam.—Woodbridge loam is characterized by a dark-brown firm loamy subsoil and a greenish-yellow or greenish-gray tightly compact substratum. The subsoil passes rather abruptly into the till at a depth ranging from 20 to 24 inches below the surface. The compact character of the till, though not totally arresting the movement of water, retards it to the extent that the excess water moves along the top of the substratum. The surface relief is sufficiently sloping to readily drain off surface water. Much of the seepage water comes from higher ground.

Woodbridge loam is used for farming and practically the same crops are grown as on Worthington loam, but the yields of grass, hay, and grain are slightly smaller, although apples and potatoes seem to do better. Potatoes yield from 150 to 250 bushels an acre with a normal amount of fertilizer. A number of large orchards are on this soil. Fifty per cent of this land is in forest and much of the cleared area is in pasture, which furnishes fair or good grazing. Much brush grows in the pastures but grasses predominate.

Woodbridge stony loam.—Woodbridge stony loam is similar in all characteristics to Woodbridge loam, except in its higher content of stone. Its total area is double that of the loam. It is used for the same crops as the loam, but a larger proportion of the stony loam is in forest and pasture.

Shelburne loam.—In the north-central part of the area, north of Westfield River, the soils are slightly influenced by limestone, and this influence becomes very strong in the extreme northern part and in the northeastern corner of the highland and in the foothills in the towns of Goshen and Williamsburg. The soil here has been designated Shelburne loam. It is better soil than the corresponding Woodbridge soil. Shelburne loam is used for orcharding, hay, corn, and potatoes, and gives fair yields. A small area is forested.

Shelburne loam, stony phase.—The stony phase of Shelburne loam is extensively used for pasture, and a comparatively small area is forested.

Becket loam.—Becket loam is important in the agriculture of the southwestern corner of the area, where it occurs on the ridge tops. It has a brown or dark-brown surface soil and a slightly firm loam subsoil of deep rust-brown color, which extends to a depth of 2 feet where it passes into a tightly compact yellowish-gray or gray gritty till. The till, although compact in place, is pervious to water penetration, and, although it does not prevent the free movement of water, it has a fairly good moisture-holding capacity. It is derived mainly from granitic material and a large number of bowlders are scattered over the surface. A few small areas of fine sandy loam texture occur in places, but these are not extensive. The soil in these areas is lighter textured, and it does not have the moisture-holding capacity of the loam and hence is a slightly inferior soil.

About 75 per cent of Becket loam is cleared and used for hay land and pasture, hay land occupying about two-thirds of the cleared land. Small acreages are in corn, potatoes, small grains, and vegetables. Hay yields from one-half to 1 ton an acre, and pasture land furnishes fairly good grazing.

Becket loam, shallow phase.—In the shallow phase of Becket loam bedrock lies at a depth of less than 3 feet, but, owing to the absence of stone in the surface soil, the land can be cultivated and mowers can be used with ease for cutting hay. However, the moisture-storage basin is shallow and crops suffer in either wet or dry weather. Most of the land is used for growing hay.

Becket stony loam.—Becket stony loam is essentially the same as Becket loam except that it occupies hillsides and contains a larger quantity of stone. Where cleared it is used almost entirely for pasture. Much of the land was formerly farmed, but, owing to the difficulty of operating mowing machines, much of it has been abandoned. The shallow areas, in which bedrock lies near the surface and is exposed in places, are used for pasture where cleared.

Berkshire loam.—Berkshire loam is developed in the higher part of the western highland in a narrow belt along the western edge of the area north of Westfield River and to less extent just south of the river in Blandford Town. The surface soil and subsoil are of much the same appearance as the corresponding layers of Becket loam. The substratum, however, is olive yellow and consists of heavier material than the Becket substratum (being derived from schist) and in most places is not so tightly compact. Berkshire loam occurs on hillsides and in many places occupies the entire hill, but in some places the Blandford soils are developed on the ridge tops. Drainage is excellent over most of the Berkshire loam.

This soil is less extensive than Berkshire stony loam. From 60 to 65 per cent of the land is farmed. The crops commonly grown are grass (for hay and pasture), corn, potatoes, vegetables, and small grains. This land is better suited to grass and potatoes than to other crops. Hay yields from 1 to 1½ tons an acre, and potatoes yield from 150 to 250 bushels, with fertilization. The shallow areas, in which bedrock occurs within 3 feet of the surface, are comparatively free of stone and are used almost entirely for mowing.

Berkshire stony loam.—Berkshire stony loam differs from Berkshire loam only in carrying a larger amount of stone. It occupies hillsides. It is an inferior agricultural soil, and most of it is forested, although small cleared areas are in pasture.

Berkshire fine sandy loam.—Berkshire fine sandy loam is an inextensive soil occurring in the western part of the area. It is adapted to the same crops as Berkshire loam but is slightly less productive under normal conditions.

Blandford loam.—Blandford loam occupies the somewhat flattened ridges which are closely associated with the Berkshire soils. It has a dark-brown or brown surface soil and a yellowish-brown subsoil which extends to a depth ranging from 12 to 18 inches where it passes into a greenish-yellow or olive-colored fairly compact till. It is derived from schist and is a fairly heavy soil. It is used for about the same crops as the other soils of the western highland but has a somewhat lower productive power than Worthington loam.

Blandford loam, stony phase.—Blandford loam, stony phase, is similar in all respects to Blandford loam, except that it has a greater content of stone. It is used almost entirely for pasture.

Peru loam.—Peru loam occupies the imperfectly drained areas associated with the soils of the western highland. The surface soil is dark brown and the subsoil is yellowish brown, and both are mellow loams. The upper part of the substratum is fairly compact and mottled yellow, rust brown, and gray, and the deeper part is composed of compact greenish-gray gritty till. In most places it contains a noticeable quantity of stone but only in a few spots is the stone content large. Most of the land is cleared and used for pasture, and a comparatively small acreage is in mowing. The pastures contain much brush, as a result of the wet condition which favors sprouting of certain plants and shrubs, and the land is not favorable to plowing and reseeding to grass.

Hollis fine sandy loam.—Hollis fine sandy loam occurs mainly on the hillsides of the western highland. It has a dark-brown or brown surface soil, a yellowish-brown subsoil, and a fairly loose and open or fluffy substratum. It is derived from highly micaceous schist. Drainage is inclined to be excessive. Small areas of Hollis fine sandy loam are used for grass, hay, pasture, potatoes, vegetables, orchards, and small fruits. This is not a good grass soil, but it is fairly well suited to fruits and potatoes. It is not an important agricultural soil.

Hollis stony fine sandy loam.—Hollis stony fine sandy loam is similar in its characteristics to the fine sandy loam, except that it has a higher stone content. It is little used for farming except for pasture, and most of this is of indifferent quality.

MISCELLANEOUS SOIL MATERIALS

RECENT-ALLUVIAL SOILS

The overflow land along Connecticut River, with the exception of the Hadley soils, consists mainly of meadow. These soils are alluvial or recently deposited soils that have developed no profile. They are periodically inundated by overflow which enriches the soil. However, crops are sometimes damaged by floods and deposits of sand. In many places, the soil itself is washed away by the river. These soils are somewhat similar to the overflow phases of the Hadley soils. The texture varies considerably, ranging from loamy sand to silt loam and is not consistent within short distances, as small well-drained areas may be interspersed within a few yards by low marshy areas having poor drainage. The overflow land along the other streams is composed of Ondawa fine sandy loam and meadow.

Ondawa fine sandy loam.—Ondawa fine sandy loam has a brown surface soil, yellowish-brown mellow subsoil, and grayish-yellow light substratum below a depth of 2 feet. It includes areas of very fine sandy loam texture. It lies slightly above the normal overflow level and is well drained throughout. A large proportion of the land is cleared and used for hay and pasture. A small acreage is in corn, potatoes, and vegetables. This soil is less productive than similar-textured Hadley soils.

Meadow.—Meadow, besides occupying a small area in the first bottoms of Connecticut River, occupies a comparatively large area of the lower first bottoms along the smaller streams. It has a dark-brown or almost black surface soil containing a large quantity of organic matter, a bluish-gray, mottled or mixed with brown, subsoil, and a drab-gray substratum. The texture is variable, ranging from loam to light sandy material. Areas near the base of the western highlands contain some gravel and in places a noticeable amount of stone. Areas of meadow are used for pasture.

ORGANIC SOILS

Small areas of organic soils, muck and peat, occur in places in the stream bottoms and in old filled-in lakes. These soils consist of deposits of more or less decayed plant remains, mixed with variable quantities of mineral matter. The total area of organic soils is rather small.

Muck.—Muck occurs in the smaller stream bottoms and in shallow filled-in lakes. The areas are poorly drained, water standing at the surface level in many places. Only small areas are used for mowing, the grass consisting of native wild grasses of low value. Areas used for pasture contain much brush and aquatic shrubs.

Peat.—Peat is a deeper deposit than muck, and it occupies filled-in lakes scattered well over the area. It consists of deposits of brown fibrous peat from 3 to 10 feet deep. It is consistently poorly drained and is not used for farming in this area.

ROUGH STONY LAND

Rough stony land, although containing some small areas that can be used for farming, is in the main unsuited to agriculture. It is extensive in all parts of the area except the valley. The forest on this land furnishes much of the timber and cordwood cut within the area.

SOILS AND THEIR INTERPRETATION

Hampden and Hampshire Counties lie in a region where the true podzol soils of the North, having the gray layer with the brown orterde, merge with the brown forest soils of the East Central States. The climatic conditions over much of the area favor the accumulation of a moderate amount of raw humus on the surface of the soils. At the higher elevations, particularly on the western highlands at elevations ranging from 1,200 to 1,500 feet, this accumulation, owing to fogs and a longer cold season, is more rapid and the podzol soil is the result. Over the remainder of the upland, brown soils are developed with weak podzol horizons in favorable locations. In the Connecticut Valley, owing to summer heat, the organic matter is more rapidly disintegrated and disappears from the surface soil at a faster rate than elsewhere in the area. The contact zone between the podzols and brown soils is not very well defined. Many soils between the level of the valley and the upper reaches of the highlands show traces of a gray podzol layer, and in most virgin soils of the eastern part of the area a brown or coffee-colored layer is present even where the gray is missing. As nearly all the land in the area has been under the plow it is difficult to determine the extent of the original podzol soils. The eastern upland is a region in which white pine, oak, chestnut, and maple predominate; on the western highland beech, birch, hemlock, and spruce are dominant; and in the valley, white pine, pitch pine, oak, and gray birch are dominant.

The brown soils predominate, as most of the area lies below the general elevation of podzol development. They have, under forest conditions, a surface covering of leaf mold, or duff, 1 inch or more thick. The A_0 horizon rests on a dark-brown surface soil, the A horizon, which changes within an inch or two to the yellowish-brown

B horizon which, in turn, fades downward into yellow material at a depth of 18 or 20 inches. Below a depth of 24 inches the C horizon, or unweathered material, is reached. The podzol soil has a thicker raw humus layer on the surface, resting on a gray layer from one-half inch to 2 inches thick, but in many places thinner. This material passes rather abruptly into dark-brown or coffee-brown soil which within a depth of one-half or 1 inch becomes yellowish brown. The lower horizons are about the same as the B and C horizons of the brown soil described. The podzol soils have been formed by the action of the organic acids from the raw humus in removing the iron from the underlying soil and accumulating this material below in the orterde, or brown layer. The gray layer is usually proportional in thickness to the surface layer of organic matter, or duff, and ranges from about one-fourth to one-half the thickness of the raw humus layer. The orterde is rarely indurated.

On many of the flattened ridges at the higher elevations the total thickness of the A and B horizons in many places is less than 12 or 15 inches, but in some of the softer soils of the lower elevations the B horizon reaches a depth of 30 inches and deeper, but in few places exceeds a depth of 36 inches in the deepest-weathered soils. Weathering is not complete at this depth, as much of the original material remains in the lower part of the B horizon. Little eluviation has taken place, the light-textured soils being in general derived from light-textured material. These may be considered comparatively new soils, as much of the original mineral material remains as compared with the soils farther south.

For the purpose of comparison Table 9 gives the results of mechanical analyses of four soils from Massachusetts and of two soils from North Carolina.

TABLE 9.—*Mechanical analyses of four soils from Massachusetts and two soils from North Carolina*

Locality and soil type	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Massachusetts:	*Inches*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Brookfield loam	0-2	3.6	7.4	3.6	18.3	19.4	33.6	14.0
	2-6	4.0	8.3	4.0	19.2	18.6	33.6	12.3
	6-18	3.2	7.0	3.6	18.4	17.9	35.7	14.3
	18-30	2.7	6.4	2.1	17.8	16.9	37.8	16.2
	30-36	2.4	6.0	2.0	17.5	16.5	37.9	17.6
Bernardston silt loam	0-8	3.3	7.8	4.8	17.3	24.8	29.9	12.8
	8-15	5.0	7.6	4.6	18.0	24.2	33.1	7.9
	15-24	4.0	6.4	3.8	18.3	24.8	33.2	10.0
	24-36	7.0	10.9	6.2	25.2	22.4	22.8	6.2
Merrimac loamy coarse sand	0-4	13.2	37.0	13.0	18.4	4.5	8.4	6.2
	4-6	18.6	36.5	11.6	16.4	5.1	7.6	4.8
	6-20	20.3	38.9	12.0	15.0	3.8	7.0	3.4
	20-36	30.1	35.4	11.5	16.0	2.0	3.5	1.3
Gloucester loam	0-7	3.8	15.9	9.0	24.4	14.7	24.4	7.8
	7-20	2.0	9.5	5.6	21.2	19.4	33.3	9.0
	20-30	1.5	6.3	4.2	22.6	29.3	31.8	4.3
	30-36	8.2	17.5	9.8	37.3	15.9	9.1	2.1
North Carolina:								
Porters fine sandy loam	0-4	2.7	13.2	8.9	33.1	13.9	19.7	8.7
	4-14	3.9	9.7	6.5	30.1	10.0	20.5	13.8
	14-48	2.2	6.4	4.4	23.7	11.8	8.4	43.4
	48-60	4.8	11.5	7.1	32.5	15.2	22.9	6.4
	60-72	13.2	16.6	8.8	33.2	12.1	14.5	1.6
Cecil fine sandy loam	0-5	4.8	12.4	7.8	27.2	9.8	22.9	15.6
	5-36	2.8	4.6	2.8	11.7	5.5	21.4	51.2
	36-72	1.3	9.6	8.4	25.6	12.5	16.9	26.1
	72-96	1.8	12.7	11.7	37.7	8.0	14.2	14.2
	96-112	7.9	19.3	12.7	39.9	8.6	9.7	2.2

For the purpose of further comparison Table 10 gives the results of chemical analyses of Gloucester stony fine sandy loam from Berkshire County, Mass.; of Porters loam from Rutherford County, N. C.; and of Cecil fine sandy loam from Yadkin County, N. C.

TABLE 10.—*Chemical analyses of one soil from Massachusetts and two soils from North Carolina*

GLOUCESTER STONY FINE SANDY LOAM,[1] BERKSHIRE COUNTY, MASS.

Sample No.	Depth	SiO_2	TiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1307136	0- 3	65.91	0.66	3.82	8.97	0.112	1.18	0.77
1307137	3- 5	72.86	.68	3.91	10 53	.093	.91	.54
1307138	5-15	74.79	.72	3.32	11.09	.060	1.11	.85
1307139	15-24	74.13	.80	4 12	11.15	.070	1.52	.96
1307140	24-36	76.03	.54	2.80	10.76	.050	2.54	.84

Sample No.	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	N	H_2O at 110°
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1307136	2 50	1 34	0.13	0.11	14 26	99 76	0.344	2.03
1307137	2.33	1.37	.10	.08	6.32	99.72	.105	1.86
1307138	2.60	1.14	.15	.10	3.78	99.71	.050	1.15
1307139	2.64	1.38	.17	.04	2.52	99.50	.020	.85
1307140	2 29	2 40	.21	.04	.98	99.48	(2)	.25

PORTERS LOAM,[3] RUTHERFORD COUNTY, N. C.

Sample No.	Depth	SiO_2	TiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
236524	0- 2	71.59	0 39	1.79	11.57	0.021	0.20	0.09
236525	2-10	72.17	.45	2.61	14.68	.023	16	.13
236526	10-36	60 83	.56	4 48	22.25	.051	(4)	.78
236527	30-54	65.46	.52	3.97	19 37	.058	(4)	.53
236528	54	68.57	.46	3.21	17.35	.084	.09	.59

Sample No.	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	N	H_2O at 110°
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
236524	3.82	0.84	0.04	0.06	9.20	99.61	0.179	1.77
236525	3.94	.74	.03	.04	4.81	99 78	.040	1.43
236526	2.54	.35	.06	.03	7.69	99.62	.014	1.43
236527	4.26	.44	.01	.05	5.43	100 09	.005	1.11
236528	4.93	.62	(4)	.01	3.92	99 83	.000	.72

CECIL FINE SANDY LOAM,[5] YADKIN COUNTY, N. C.

Sample No.	Depth	SiO_2	TiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
236902	1- 4	86.62	0.49	1.45	5.71	0 013	(4)	0.17
236903	4- 7	87.04	.59	1.36	5.55	.013	(4)	.18
236904	7-10	72.92	.75	3.80	13.73	.013	(4)	.32
236905	10-14	66 07	.96	5 91	17.59	.013	(4)	.19
236906	14-40	34.24	1.31	11.18	35.42	.013	(4)	.17
236907	40	49.62	.80	8.43	27.45	.020	(4)	.63

[1] Analysts: G. Edgington and G. J. Hough.
[2] None.
[3] Analyst: G. Edgington.
[4] Trace.
[5] Analyst: G. J. Hough.

TABLE 10.—*Chemical analyses of one soil from Massachusetts and two soils from North Carolina*—Continued.

CECIL FINE LOAM,[8] YADKIN COUNTY, N. C.—Continued.

Sample No.	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	N	H_2O at 110°
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
236902	2.01	1.40	0.05	0.11	3.90	101.93	0.090	0.60
236903	2.10	1.42	.03	.15	2.36	101.38	.050	.25
236904	2.02	1.55	.07	.12	5.97	101.26	.070	1.05
236905	1.02	.78	.11	.14	8.46	101.24	.050	1.15
236906	.62	.73	.18	.10	17.07	101.03	.040	2.00
236907	2.08	1.04	.09	.12	10.74	101.02	.020	2.25

The parent material from which the soils are derived was accumulated by glacial action from the native rock and deposited by the receding glacier as till or as outwash material from the melting glacier. The till was little altered mineralogically, but the outwash material was altered to a noticeable degree by loss of fine material and minerals in solution. Under rapidly moving water most of the fine material was removed, and the heavier particles were deposited in glacial lakes and estuaries. The difference in parent material is clearly shown in Table 11 which gives the mechanical analyses of the C horizon of three soils—Wethersfield loam, derived from till; Merrimac fine sandy loam, from outwash; and Suffield silt loam, from lacustrine material.

TABLE 11.—*Mechanical analyses of the C horizons of three soils in Hampden and Hampshire Counties, Mass.*

Soil type	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Wethersfield loam	20–30	5.30	12.00	5.50	16.90	16.70	34.50	9.10
Do	30–36	2.20	9.00	5.50	18.10	20.00	32.00	13.20
Merrimac fine sandy loam	18–28	3.20	14.30	16.40	36.50	9.70	15.40	4.00
Suffield silt loam	12–36	.22	1.66	1.36	9.02	8.32	35.36	44.66

As the parent material was little altered by deposition and the soils are comparatively new, that is, they have been exposed to the agencies of weathering for only a short period, the mineralogical and lithological character of the parent rock material have a strong influence on the soils that have developed. The soft rocks, such as schist, shale, and sandstone, were reduced by the glacier to fine material more readily than the harder rocks, such as granite, gneiss, and trap rocks. The soft rocks have also weathered more rapidly since deposition than the resistant rocks. The harder material remains as bowlders in the till and as stone and gravel in the solum. The soils derived from the granitic material usually have loose substrata in till and terrace deposits, which allow better underdrainage, good aeration, and better oxidation than in the heavier till.

In Table 12, a comparison of the mechanical analyses of Brookfield loam, derived from schist, and Gloucester loam, derived from granite, will readily show the effects of different parent materials on the soil texture, particularly in the C horizon (*8*).

TABLE 12.—*Mechanical analyses of samples of Brookfield loam and Gloucester loam in Worcester County, Mass.*

Soil type	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Brookfield loam	0- 2	3.0	7.4	3.6	18.3	19.4	33 6	14.0
	2- 6	4.0	8 3	4.0	19.2	18.6	33.6	12.3
	6-18	3.2	7.0	3 6	18 4	17.9	35.7	14.3
	18-30	2.7	6 4	2 1	17.8	16.9	37.8	16.2
	30-36	2.4	6.0	2 0	17.5	16.5	37.9	17.6
Gloucester loam	0- 7	3.8	15 9	9.0	24.7	14.7	24.4	7.8
	7-20	2.0	9.5	5.6	21.2	19.4	33.3	9.0
	20-30	1.5	6 3	4.2	22.6	29.3	31.8	4.3
	30-36	8.2	17 5	9.8	37.3	15.9	9.1	2.1

Drainage over any area exerts a great influence on the soil-forming materials and is one of the factors in determining the resultant soil types. In poorly drained places little or no development of the soil profile has taken place; on the flattened ridge tops at the higher elevations a shallow B horizon has developed; and on the well-drained upland the soil profile has reached an early stage of maturity. The mature soil of the region is necessarily of recent maturity, in that it only approaches the maturity of the soils farther south. Gloucester loam is a typical example of a brown forest soil developed from granitic material that has reached the mature stage, and Becket loam is an analogous soil in the podzol soil group. The difference between these soils is mainly in the podzol surface soil (A horizon) and the compact C horizon of the Becket soil. The compact horizon of the Becket soil is due not to soil-forming processes but to the compactness of the glacial deposits from which the soil was formed.

Other soil profile descriptions show the relation of soils derived from different rock materials, modes of deposition, accumulation, relief, and drainage conditions, all of which influence the age of a soil.

The soils of this area although falling into three groups based on the physiographic division—the eastern upland, the western highland, and the valley—may also be divided into groups based on the mode of accumulation as well as the character of the parent material as follows: (1) Glacial till, (2) kame outwash, (3) terrace outwash, and (4) bottom land, or present flood plain. The soils derived from the terrace deposits vary with the character of the parent material and with the method of deposition. In swift-flowing water, gravelly and sandy deposits were made, and in still water the finer particles were laid down in heavier deposits.

The soils of the Gloucester series are the most widespread soils of the eastern upland. A 2 to 3 inch layer of leaf mold and forest debris, which is designated the A_0 horizon, has accumulated on the surface in forested places. This forest duff is less in hardwood forests. The true surface soil, or A horizon, consists of somewhat granular dark-brown fine sandy loam or light loam. The granulation is more noticeable under grass sod conditions. The Gloucester soils in general have a single-grain structure. The surface relief ranges from gently undulating to rolling, and drainage is well established.

A typical profile of Gloucester loam, the most representative soil of the Gloucester series, observed in an area 2 miles east of Belchertown, consists of the following layers: A_0, from 0 to 2 inches, dark-brown organic matter on the surface with a slight admixture of inorganic soil material; A_1, from 2 to 6 inches, dark-brown or snuff-colored light loam or fine sandy loam; B_1, from 6 to 15 inches, yellowish-brown mellow loam which is only slightly firm; B_2, from 15 to 24 inches, pale yellowish-brown or pale-yellow light loam; C_1, from 24 to 36 inches, mixed gray and yellow till which is fairly light in texture and firm but not compact in structure; and C_2, 36 inches and deeper, gray sandy till which is firm in place but not noticeably compact. The entire profile contains some granitic rock fragments and bowlders. The lighter-textured Gloucester soils are less compact in the C horizon than the loam. A few narrow strips occur through Prescott and Monson Towns, which have browner A and B horizons than is typical of the Gloucester soils, and the C horizon is slightly heavier and more compact in places.

Table 13 shows the pH values of two Gloucester soils in this area.

TABLE 13.—*pH values of samples of Gloucester fine sandy loam and Gloucester loam*

Soil type	Depth	pH	Soil type	Depth	pH
	Inches			*Inches*	
Gloucester fine sandy loam	0- 3	4.35	Gloucester loam	0- 2	4.10
	3- 5	4 72		2- 6	4.40
	5-15	5 03		6-15	5.05
	15-24	5 25		10-24	5 85
	24-30	5 73		24-36	6.00

Table 13 shows acid soils grading downward to a less degree of acidity in the parent material.

The other soils of the Gloucester series differ from the loam in texture and consequently have a lower moisture-holding capacity. The fine sandy loam is a much lighter soil throughout the entire profile. The stony fine sandy loam differs from the other Gloucester soils mainly in containing a larger amount of partly rounded and subangular granitic bowlders scattered on the surface and throughout the soil profile to bedrock. The stony areas in general include comparatively shallow beds of till, in which the texture is fine sandy loam. These areas allow more thorough drainage. The fine sandy loam occupies areas of rougher surface relief than the loam, and this, in a measure, aids drainage. In general, less organic matter has accumulated on the surface, and the soil is less granular than the loam. Several areas of Gloucester fine sandy loam and Gloucester stony fine sandy loam lie at elevations and in positions that allow the formation of podzol surface soils. These soils have thin podzol layers and occupy a very small area on the edge of the northeastern part of the area in Pelham and Belchertown Towns and in the southwestern corner in Tolland and Blandford Towns.

The profile of Essex loam is similar to the profile of Gloucester loam. It is developed in the same topographic positions and is derived from the same rock material, granite. The surface soil is slightly darker from an accumulation of organic matter, and the B horizon is paler yellowish brown than the corresponding layers of Gloucester loam. The greatest difference between the two soils is in the C horizon and in the lower part of the B horizon, just above the parent material. The C horizon lying at a depth ranging from 24 to 30 inches below the surface, consists of very compact and tightly cemented gray till which breaks into platy pieces, has a vesicular structure, and crumbles readily when crushed between the fingers. Although gritty it contains a greater amount of fine material than the substratum of Gloucester loam. This stratum is not impervious to water and, although not a true hardpan, the excess water moves along the top of the bed, emerging on hillsides as seepage water. Lack of drainage has resulted in the faint brown and gray mottling of the lower part of the B horizon. The Essex soils are closely associated with the Gloucester soils, both in origin and geographical position. The stony phase of Essex loam, like the stony Gloucester soils, differs only in the amount of stone carried.

Whitman stony loam occurs only in low areas. This soil has a dark-brown mucky surface soil, a drab, mottled with yellow and brown, B horizon, and a drab-gray C horizon which is firm but not, as a rule, compact. Poor drainage and a stony surface are the outstanding features of this soil. It is developed in small scattered areas, mainly throughout areas of the Gloucester soils but also associated with soils derived from till in all parts of the area.

The Brookfield soils, occurring in the southeastern corner of Hampden County, differ from the Gloucester soils in that they are derived from rust-brown biotite schist which is high in iron pyrites. This gives rise to a much darker-brown or reddish-brown A horizon, an ocherous-yellow B horizon slightly heavier than the corresponding layer of the Gloucester soils, and in place of the loose gray C horizon the Brookfield soil has a firm yellow or greenish-yellow C horizon. The rock fragments are not so numerous as on the Gloucester soils, but the underlying rock material of the Brookfield soils lies near the surface and in the stony types is very ledgy, whereas most of the stone in the Gloucester soils consists of loose bowlders. The forest flora of the Brookfield soils is deciduous, and conditions do not favor the accumulation of leaf mold.

The pH values of Brookfield loam are as follows: From 0 to 4 inches, 4.59; from 4 to 10 inches, 4.80; from 10 to 20 inches, 5.15; and from 20 to 36 inches, 5.17. The parent material is acid and little variation in acidity is shown from the surface downward.

Brookfield loam is the most typical soil of the Brookfield series. In forested places the surface soil consists of a 3 or 4 inch layer of dark-brown or dark reddish-brown light loam, with a light layer of leaves on the surface, underlain by rust-brown or reddish-brown mellow loam which continues to a depth of 8 or 10 inches. The subsoil is ocherous-yellow firm but friable loam extending to a depth ranging from 20 to 24 inches, where it changes gradually to pale ocherous-yellow material of mealy structure. Below an average depth of 36 inches is the C horizon of pale greenish-yellow till which is little affected by weathering.

Brookfield loam, heavy phase, is weathered from deeper beds of till of a slightly heavier character, is prevailingly greenish yellow in color, and has definite compaction which is not noticeable in typical Brookfield loam.

Areas of Brookfield stony loam occur on the steeper hillsides where the glacial deposits are thin. Evidence of weathering of the soft bedrock is noticeable in places. The stone content consists of slabby pieces of schist, and ribs of bedrock are exposed in places. Brookfield loam is only about one-third as extensive as Brookfield stony loam.

The dominant soils of the western highland have heavy surface soils with compact substrata, as contrasted to the light surface soils and loose substrata that dominate the soils of the eastern upland and the remainder of the area.

Woodbridge stony loam, occurring mainly on the hillsides, is the dominant soil of the eastern part of the western highlands. In general it lies below the line of podzolization for heavy soils, but in favorable spots a thin podzol layer has developed. The forest growth consists of beech, birch, oak, chestnut, maple, and basswood, with some laurel and hemlock. A typical profile of Woodbridge loam, as observed in a representative forested area 2 miles west of Granville, is as follows: A_1, from 0 to 2 inches, a 1-inch layer of dark-brown or black leaf mold, passing into rust-brown or snuff-colored loam containing some organic matter; A_2, from 2 to 6 inches, dark-brown mellow loam or light loam; B_1, from 6 to 12 inches, brown or rust-brown mellow but slightly firm loam; B_2, from 12 to 20 inches, pale yellowish-brown firm loam with a greenish cast; C_1, from 20 to 36 inches, greenish-yellow or olive-colored slightly compact till having an irregular breakage and a vesicular structure; and C_2, from 36 to 48 inches, greenish-gray or olive-gray very slightly compact till having a horizontal platy cleavage with dark iron stains along the cleavage lines. The material in this layer is vesicular and when broken down is very gritty. When broken transversely the particles are ragged and have yellow or greenish-yellow linings. The till extends to a depth of 20 or 25 feet without change. The rocks in the till are schist, granite, and granitic gneiss.

The Woodbridge soils are derived from schist, and there is a slight admixture of granitic material in places. Over the west-central part of the western highland the parent material contains some limestone which increases in quantity northward and northeastward but does not occur in sufficient quantities to materially change the pH value.

Table 14 shows the pH values of two samples of Woodbridge loam, one collected in the southern part of the area, in an area mapped as Woodbridge stony loam, 2 miles west of Granville, in Hampden County, where the parent material is schist, and the other in the northern part of the area, 2 miles northeast of Williamsburg, Hampshire County, where the parent material is schist with some limestone influence.

TABLE 14.—*pH values of profile samples of Woodbridge loam*

Hampden County			Hampshire County		
Sample No.	Depth	pH	Sample No.	Depth	pH
	Inches			*Inches*	
131206	0- 2	3.98	131279	0- 1	4.96
131207	2- 6	4.57	131280	1- 5	4.79
131208	6-12	6.09	131281	5-15	4.85
131209	12-20	4 82	131282	15-25	5 00
131210	20-30	5 05	131283	25-36	5 19
131211	30-48	5 32			

The Woodbridge soils are weathered from deep till and in general contain less stone than the Gloucester soils. However, only comparatively small areas are stone free. In most places seepage water moves along the top of the C horizon as it does not readily penetrate this layer.

The profile of Shelburne loam, the representative soil of the Shelburne series, is similar to the profile of the Woodbridge soils with the exception that the Shelburne has a well-defined limestone influence which is expressed in the partly weathered rust-brown limestone fragments and the higher pH value, the Shelburne soils being a full point higher than the Woodbridge. In spots where the limestone fragments have lost their carbonates, the shell remains as a brown porous substance which aids materially in the free movement of ground water in an otherwise compact substratum. Shelburne stony loam areas have a noticeable amount of schist and limestone bowlders on the surface, together with some native schist and granitic bowlders.

The pH values of Shelburne loam as determined from samples taken from a representative area 1 mile east of Shelburne, Mass., are as follows: From 0 to 2 inches, 5.05; from 2 to 10 inches, 5.39; from 10 to 18 inches, 5.89; from 18 to 24 inches, 6.07; and from 24 to 48 inches, 6.32.

The soils of the Hollis series occur in scattered areas, mainly on the lower hillsides and low ridges of the northeastern part of the foothills. The relief ranges from steeply sloping on the stony soil to smooth ridge tops on the fine sandy loam. The profile resembles the profile of the Woodbridge soils in color only, and in many places the material is browner in the A and B horizons. The soil material is light and fluffy even in the C horizon, contains a noticeable amount of mica and platy schist fragments in the upper horizons, and large quantities of both in the C horizon. This is a comparatively shallow soil, bedrock lying within 36 inches of the surface in many places, in contrast to the Woodbridge soils which are derived from deep till. Drainage is well established.

The Becket soils are representative of the higher-lying soils of the western plateau, in that they have a podzol A horizon. Over a rather large area of these soils the gray podzol layer is thin or entirely lacking, but the dark-brown layer is present. These soils occupy the hills and ridges in the southwestern part of the area. The surface relief ranges from that of steep hillsides to flattened ridge tops. In general the stony loam occupies the steeper locations, and the loam occurs mainly on the ridge tops. Drainage of these soils is good even on the flattened ridge tops. Although the soil material is compact in the C horizon, it is porous enough to insure drainage and aeration.

The Becket soils are derived from granite gneiss, and many bowlders of this material are scattered over the surface of all areas, the stony loam having the largest amount of stone. The shallower areas are underlain by smooth hard bedrock at a depth of less than 3 feet below the surface. Becket loam shows the typical soil profile for the higher-lying region of the area. A typical profile of the virgin soil of Becket loam as observed 1½ miles west of North Blandford, is as follows: From 0 to 4 inches, dark-brown organic matter; from 4 to 6 inches, gray loose fine sandy loam; from 6 to 7 inches, a deep shade of brown or coffee-colored ring of fine, floury, fine sandy loam; from 1 to 15 inches, a deep shade of yellowish-brown firm but friable loam, grading imperceptibly into the next layer; from 15 to 24 inches, yellowish-brown or pale yellowish-brown loam, only slightly compact, passing rather abruptly into the layer below; from 24 to 48 inches, greenish-gray or gray compact till which becomes gritty when broken down into large angular or ragged pieces, is finely vesicular, a fresh break showing a greenish-yellow color, and an old exposed surface becomes indurated. From 48 to 60 inches the C horizon is a greenish-gray tightly compact raw till, which has a platy horizontal breakage, is vesicular, and very sandy when broken down. The underlying rock material is granite gneiss. The forest growth consists of hard maple, beech, white birch, hemlock, spruce, and larch.

Table 15 gives the results of mechanical analyses of samples of Becket loam, taken at various depths, in a representative area at Tolland, Hampden County.

TABLE 15.—*Mechanical analyses of Becket loam*

Sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
31119	0- 8	1.1	6.2	5.5	29.1	20.2	29.0	9.2
31120	8-18	.7	5.0	5.2	27.8	24.5	30.0	7.0
31121	18-30	1.8	6.0	5.3	26.3	21.4	22.9	16.0
31122	30-36	1.9	6.3	5.8	27.5	22.7	21.3	14.5

The pH values of Becket fine sandy loam as determined from samples taken from a representative area in Berkshire County, Mass., follow: From 0 to 2 inches, 3.78; from 2 to 3 inches, 4.18; from 3 to 4 inches, 4.10; from 6 to 20 inches, 4.98; from 20 to 24 inches, 5.10; and from 24 to 36 inches, 5.63.

The Berkshire soils occupying the high hill region in the northwestern part of the area are podzol soils developed under similar conditions as the Becket soils, with the exception that the surface relief of the Berkshire soils is more broken than that of the Becket soils. The Berkshire soils are derived from schist but have a similar profile to the Becket soils, with the exception that the Berkshire soils have a greenish-yellow subsoil and an olive-gray substratum which is much heavier and possibly less compact than the corresponding layer of the Becket soils.

The pH values of samples of Berkshire loam taken from a representative area west of Goshen, are as follows: From 0 to 2 inches, 3.78; from 2 to 3 inches, 4.18; from 3 to 4 inches, 4.13; from 6 to 20 inches, 4.98; from 20 to 24 inches, 5.10; and from 24 to 36 inches, 5.58.

Peru loam is developed on the small imperfectly drained areas of the western highland, where the surface relief is level or gently sloping and the substratum is more or less impervious to the downward movement of water. This soil is associated with the Becket, Berkshire, Blandford, Worthington, and Woodbridge soils, all of which are compact-substratum soils.

The surface soil of Peru loam is dark brown, and the subsoil is brown in the upper part and is marked by mottlings of brown, yellow, and gray in the lower part. The parent material, which is tightly compact, is reached at a depth ranging from 18 to 30 inches below the surface. The soil carries a rather large quantity of stone.

Worthington loam occurs on the somewhat flattened ridge tops of the north-central part of the western highlands, where it has weathered from till derived from a dark graphitic schist interbedded with impure limestones. Weathering has been to a comparatively slight depth, as evidenced by the fact that the B horizon in few places extends deeper than 15 inches below the surface. The color of this soil is strongly influenced by the graphite from the schist, but the limestone influence fails to register with such a delicate test as the pH determination. The limestone disintegrating in the soil forms available mineral plant food at a faster rate than the more slowly disintegrating rocks. This is evidenced by the excellent grass sod growing on this land.

A typical profile of Worthington loam, observed in an area 2 miles north of Goshen, consists of the following layers: From 0 to 1 inch, brown organic matter (forest duff); from 1 to 2 inches, dark-brown or dark grayish-brown fine sandy loam or loam, having a purple tint; from 2 to 5 inches, dark yellowish-brown or deep rust-brown material, grading into pale yellowish-brown material; from 5 to 24 inches, greenish-yellow or olive-colored fairly compact loam which is only slightly affected by weathering; and from 24 to 48 inches, greenish-gray or olive-gray till, having a small platy breakage and vesicular structure.

The pH values of samples of Worthington loam taken at different depths are as follows: From 0 to 1 inch, 4.13; from 1 to 2 inches, 4.13; from 2 to 5 inches, 4 37; from 5 to 24 inches, 4.75; and from 24 to 48 inches, 5.22.

Blandford loam occurs in similar positions on the ridges of the southwestern part of the area in Hampden County and in the northwestern part in Hampshire County where there is little or no limestone influence in the schist material from which this soil is derived. The material is weathered to the same slight depth, but the soil is not so dark as the Worthington soil, particularly under sod conditions. Blandford loam occurs mainly in the towns of Blandford, Plainfield, and Chesterfield. Like Worthington loam this soil carries very little stone.

The soils of the Connecticut Valley, as already explained, are prevailingly light in texture, and, although they range from silt loam to sand, fine sandy loam predominates. Nearly all the soils have light gravelly or sandy C horizons below an average depth of 2 feet. They occupy the old glacial outwash terraces that cover most of the southern end of the Connecticut Valley and are fragmentary in the northern part and along other stream valleys.

In the lower or southern part of the valley the Merrimac and Chicopee soils predominate. The Chicopee soils occur in all parts of the valley but are more extensive in the back valley in the towns of Westfield and Southwick. The Merrimac soils are extensive east and south of the Holyoke Range and are developed to some extent on the terraces of the smaller stream valleys. The soils of the Merrimac series have a wide textural variation, ranging from fine sandy loam to loamy sand, and they include some coarse and gravelly areas. The surface relief is smooth, and drainage is thorough over all the Merrimac soils.

The following detailed profile of Merrimac fine sandy loam, as observed in an area 1 mile west of Westfield may be considered representative of soils of the Merrimac series: From 0 to 1 inch, dark-brown organic matter containing some sand grains; from 1 to 3 inches, dark-brown or dark yellowish-brown mellow fine sandy loam; from 3 to 12 inches, yellowish-brown firm fine sandy loam; from 12 to 18 inches, pale yellowish-brown sandy loam, containing some quartz and granitic gravel; and from 18 to 36 inches, a layer of mixed gray and yellow tarnished gravel and sand which is loose, open in structure, and stratified below a depth of 3 feet.

The pH values of samples of Merrimac fine sandy loam, taken 3 miles northeast of Three Rivers, are as follows: From 0 to 1 inch, 4.32; from 1 to 5 inches, 4.53; from 5 to 15 inches, 5.42; from 15 to 25 inches, 5.57; and from 24 to 36 inches, 5.89.

Table 16 shows the results of mechanical analyses of samples of Merrimac fine sandy loam taken at various depths.

TABLE 16.—*Mechanical analyses of Merrimac fine sandy loam*

Depth in inches	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
0 to 2½	3 1	14.1	15.1	42.8	4.7	11.1	8.7
2½ to 3½	2.7	13 0	16.5	47.6	3 7	9.6	7.0
3½ to 18	1.6	16.1	12.8	24.8	15.5	22.3	6.9
18 to 28	3 2	14.8	16.4	36.5	9.7	15.4	4.0

Gravel is present in most places at a depth ranging from 15 to 18 inches below the surface, but the solum above a depth of 20 inches is almost entirely free of gravel. In places the soil contains a quantity of gravel above a depth of 15 inches. In places along the Westfield River Valley little or no gravel occurs above a depth of 5 or 6 feet, but in such places the underlying soil material is composed of sand. Merrimac sandy loam is almost identical with Merrimac fine sandy loam, with the exception of texture which in the sandy loam ranges from medium to coarse sandy loam, whereas the fine sandy loam on the terraces in the valleys of Chicopee and Ware Rivers tends toward very fine sandy loam. Merrimac sandy loam has a deep phase and a brown phase. The deep phase is developed mainly in the Connecticut Valley and consists of coarse sandy material below a depth of 20 inches. The brown phase is derived from the rust-brown schist rocks which outcrop over the southwestern part of the area. It has a dark-brown A horizon, an ocherous-yellow B horizon, and a yellowish-brown C horizon. The color is caused largely by the weathering of iron pyrites. The brown phase is probably more strongly acid in the C horizon than the remainder of the soil, owing to the sulphuric acid released from the pyrites.

Merrimac loamy sand has a profile much the same as the other Merrimac soils except that there is less organic matter on the surface. Below the depth of weathering the soil consists almost exclusively of coarse sand which, although carrying a noticeable amount of rock minerals, is composed of a rather high proportion of quartz. Areas of both coarse and fine texture are included in mapping. This soil, owing to the sandier character of the surface soil, is somewhat excessively drained.

The Chicopee soils have the same general profile arrangement as the Merrimac soils, with the exception that the B horizon normally extends to a slightly greater depth. Little intergrade material occurs between the B and C horizons, the B horizon passing abruptly into the C horizon at an average depth of 20 inches. The Chicopee soils are derived from the red sandstone and shales of the Triassic formation and take their brown, reddish-brown, or pink color from those rocks. As this rock material offers less resistance to weathering than granitic material, the B horizon is more thoroughly weathered and hence slightly heavier than in the Merrimac soils, and there is less gravel in the solum. Although drainage is good, these soils have slightly better moisture-holding capacity than the Merrimac soils of the same texture.

The pH values of samples of Chicopee fine sandy loam, taken from a representative area 1¼ miles southeast of Southwick are as follows: From 0 to one-half inch, 4.00; from one-half inch to 7 inches, 4.45; from 7 to 15 inches, 4.79; from 15 to 18 inches, 5.45; from 18 to 30 inches, 5.47; and from 30 to 48 inches, 5.55.

Over the northern part of the valley of Connecticut River the Hadley and Agawam soils predominate. These soils in general are fine textured and are somewhat younger soils than those on the terraces of the valley, being developed on the low terraces and overflow land of Connecticut River in contrast to the old glacial outwash plain of the lowland known as the Connecticut Valley. These soils carry little or no gravel.

The Agawam soils have weakly developed profiles. The materials from which these soils are derived were deposited by the present stream, and the depth to gravel is much greater than in the old deposits, as a profile of Agawam fine sandy loam will show.

A typical soil profile of Agawam fine sandy loam, observed in an area 1 mile north of Agawam, shows the following layers: From 0 to 3 inches, dark-brown very fine sandy loam; from 3 to 10 inches, brown very fine sandy loam; from 10 to 20 inches, yellowish-brown very fine sandy loam; from 20 to 30 inches, yellowish-brown very fine sandy loam with a green cast; from 30 to 36 inches greenish-gray fine sandy loam which is slightly firm in place but has little consistence when taken out; and from 36 to 48 inches, gray loamy sand which contains much finely divided mica and is rather loose and fluffy. Above a depth of 30 inches the soil material is floury. The pH values of the different layers as determined in the field show this soil to be strongly acid throughout.

The loamy fine sand of the Agawam series has a slightly better developed profile, and being a lighter soil, it has been subjected to more leaching and has developed a slightly brown B horizon, but the C horizon is identical with the corresponding horizon of Agawam fine sandy loam. The surface soil of the loamy fine sand is influenced to some extent by fine wind-blown material and has a slightly more uneven surface than the fine sandy loam which has a very even surface.

The Hadley soils are young in that they have developed from recently deposited material that has not been perceptibly leached and has not developed a definite profile. They are greenish yellow in color, somewhat darker in the surface soil than elsewhere, and mellow and friable throughout. The substrata consist of loamy fine sand or loamy sand below a depth ranging from 30 to 40 inches. These soils are developed on the lowest complete terrace of Connecticut River, and, although lying above normal overflow, are subject in part to slight inundations at comparatively wide intervals, but they do not receive much material from overflows at present.

The pH values as determined from samples of Hadley very fine sandy loam taken from a representative area near Hadley are as follows: From 0 to 6 inches, 4.72; from 6 to 12 inches, 4.72; from 12 to 20 inches, 5.02; from 20 to 30 inches, 5.70; and from 30 to 36 inches, 5.50.

The overflow phases of these soils are subject to annual inundations and receive much material from this source, but not to such an extent as does the bottom land along the piedmont section of the Southern States. The soil material over the watershed of the Connecticut River, from which these soils are derived, contains much argillite, graphitic schist, and dark impure limestone which is responsible for the differences in the character of these soils and those along the other streams of the area.

The Ondawa soils are developed along the smaller streams where the bottom land is sufficiently well drained and soil development has proceeded to such an extent as to show a resemblance of a soil profile. These soils are much browner than the Hadley soils. They have a yellowish-brown subsoil and a pale-yellow or gray substratum.

The other soils developed on the old terraces of the Connecticut Valley are correlated in the Suffield, Melrose, Scarboro, and Enfield series. They are scattered in comparatively small areas over the valley and have many characteristics in common. They all have heavy subsoils and substrata, and, although differing in depth below the surface, these heavy layers serve to retard underdrainage. The surface relief is smooth, and, although subdrainage is retarded, the surface material is such that fair drainage conditions prevail on all but the Scarboro soils.

The forest growth on soils of this group consists of elm, soft maple, wild cherry, sassafras, gray birch, and some oak.

Table 17 gives the results of mechanical analyses of samples of Suffield clay, which in this area is mapped as the heavy phase of Suffield silt loam, taken from an area 2½ miles from Amherst.

TABLE 17.—*Mechanical analyses of Suffield clay*

Sample No.	Organic matter	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
9097	1.05	0.88	2.50	2.70	21 20	18.50	30.46	23.38
	1.08	.22	1.06	1.36	9 02	8 32	35.36	44.66

Suffield silt loam is different in texture from the other soils. It is acid in the A and B horizons and ranges from neutral to alkaline below a depth of 30 inches.

A typical profile of Suffield silt loam, which is representative of this group, consists of the following layers: From 0 to 6 inches, dark-brown mellow fine sandy loam or loam; from 6 to 18 inches, yellowish-brown fairly firm fine sandy loam or loam, grading through the last few inches into the layer below; from 18 to 24 inches, greenish-yellow light clay loam or heavy loam, which is firm but not compact; and from 24 to 48 inches, greenish-colored clay or silty clay loam of irregular angular breakage, which below a depth of 4 feet consists of laminated greenish-colored clay.

The surface relief is fairly level or gently sloping, and drainage is good except along the top of the clay strata, where seepage occurs.

Melrose fine sandy loam is similar to Suffield fine sandy loam, but the depth to the clay strata ranges from 36 to 40 inches. The surface relief of the soil is level, and moisture is held above the clay strata and causes faint mottles in the lower part of the subsoil.

Scarboro loam areas are extremely flat, and drainage is poor. The entire profile is darker and shows more mottling than in the Melrose soils. The clay beds lie approximately the same depth below the surface.

Enfield fine sandy loam is a much browner soil and has better drainage than the other soils of this group. It contains red Triassic material at a depth ranging from 24 to 36 inches below the surface. This stratum has the effect of conserving moisture.

The Hinckley, Manchester, and Windsor soils are developed on the outwash kames and wind-blown dunes in the Connecticut Valley and other stream valleys. These soils are characterized by a hummocky surface relief and extremely light or loose sandy or gravelly subsoils. Much scrub oak and pitch pine, also a few white pine grow on these soils.

The Hinckley soils are scattered in all parts of the area and have soil profiles similar to those of the Merrimac soils. The Manchester soils occur only in the Connecticut Valley and are derived from Triassic material. They have a profile similar to that of the Chicopee soils.

The Windsor soils have profiles similar to those of the Merrimac soils, but they consist of loamy sand and loamy fine sand, largely of wind-blown origin. They occur only in small areas in the Connecticut Valley.

The upland soils throughout the valley include Wethersfield, Cheshire, and Holyoke soils. They range from fine sandy loams to loams, are mainly brown or reddish brown in color, and in most areas are well drained and aerated. The red color is due to the rock color of the parent material rather than to oxidation of the iron through soil development. The parent material ranges from mildly acid to neutral.

Wethersfield loam occurs on low smoothly rounded hills or drumlins in scattered areas throughout the southern part of the valley. It is derived from Triassic shale and sandstone and takes its color from this rock material. Following is a description of a typical profile of Wethersfield loam observed in a forested area one-fourth mile southeast of Feeding Hills: From 0 to 2 inches, dark-brown mellow loam of granular structure; from 2 to 5 inches, reddish-brown mellow loam; from 5 to 20 inches, reddish-brown firm but friable loam; from 20 to 30 inches, red partly weathered loam which is firmly compact and has a platy breakage and vesicular structure; and from 30 to more than 36 inches, unweathered compact red till of the same structure as the layer above, and which, although gritty, is a loam when broken down. The till extends to a depth ranging from 20 to 30 feet. The entire profile contains some gravel but little stone.

Table 18 gives the pH values as determined from profile samples of Wethersfield loam taken from a forested area, and of Wethersfield loam, brown phase, taken from an abandoned field.

TABLE 18.—*pH values of profile samples of Wethersfield loam and Wethersfield loam, brown phase*

Wethersfield loam			Wethersfield loam, brown phase		
Sample No	Depth	pH	Sample No.	Depth	pH
	Inches			*Inches*	
131105	0- 2	5.17	131189	0-10	4 80
131106	0- 5	4 92	131190	10-20	5 29
131107	5-20	4 80	131191	20-28	4.22
131108	20-30	4 90	131192	28-36	6.23
131109	30-36+	5.02			

Table 19 gives the results of mechanical analyses of samples of Wethersfield loam taken from a representative area 1¼ miles southeast of Feeding Hills.

TABLE 19.—*Mechanical analyses of Wethersfield loam*

Sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
131106	2- 5	6.1	9 1	5.1	15.9	14.4	38.0	11.4
131107	5-20	4.0	10 9	5.8	20 4	15.6	30.8	12.5
131108	20-30	5.3	12.0	5.5	16.9	16.7	34.5	9.1
131109	30-36	2 2	9.0	5.5	18.1	20 0	32.0	13.2

It is very evident that the C horizon has been affected by weathering to such an extent that the hardpan has been broken, and moisture easily penetrates the material below.

Wethersfield loam, brown phase, occupies similar positions but is not so red as typical Wethersfield loam. Most areas of this soil have a lighter-textured A horizon, and the upper part of the C horizon is a tightly compact layer, similar to a hardpan, which holds the moisture above to the extent that faint mottlings occur in the lower part of the B horizon. Wethersfield loam, brown phase, ranges from loam to fine sandy loam in texture and in places carries much stone, consisting of mixed Triassic sandstone and conglomerate, also some erratic granite and trap bowlders.

The forest growth consists of chestnut, birch, walnut, hickory, oak, maple, and white pine. Pastures are grown up with sweetfern, briers, alder, and upland willow. In places much red cedar (*Juniperus virginiana*) grows.

Cheshire fine sandy loam is weathered from glacial till derived mainly from Triassic sandstone, and it contains scattered sandstone fragments. The surface relief ranges from smoothly sloping to rolling. This soil occurs on the low, broad, smoothly sloping hills on the outer edges of the valley. It is not so red as the Wethersfield soils but has a somewhat red cast throughout the entire profile.

A typical profile of Cheshire fine sandy loam, observed in an area 1½ miles south of Sixteen Acres, consists of the following layers: From 0 to 3 inches, dark-brown mellow fine sandy loam; from 3 to 12 inches, yellowish-brown firm but friable fine sandy loam; from 12 to 24 inches, pale yellowish-brown or yellow fine sandy loam of the same structure as the layer above; and from 24 to 36 inches, red sandy till which is firm but not compact and contains some pieces of red sandstone.

Table 20 gives the pH values as determined from profile samples of Cheshire fine sandy loam taken from a forested area and from a cultivated field.

TABLE 20.—*pH values of profile samples of Cheshire fine sandy loam*

Forested area			Cultivated field		
Sample No.	Depth	pH	Sample No.	Depth	pH
	Inches			*Inches*	
131105	0- 3	4.67	131143	0- 6	5.73
131106	3-12	4.52	131144	6-12	4.70
131107	12-24	5.02	131145	12-24	4.73
131108	24-36	5.35	131146	24-36	5.02

The forest growth consists of red oak, white oak, and some hickory, chestnut, and birch.

Cheshire sandy loam is weathered from Triassic arkose, or conglomerate. The C horizon is pink, is loose in structure, and coarse in texture, but the upper horizons are of the same color and thickness as the corresponding layers of Cheshire fine sandy loam. The stony phase of Cheshire sandy loam is more extensive than the stony areas of the fine sandy loam. In places Cheshire sandy loam merges with Gloucester fine sandy loam, and in certain areas, particularly along the outer or hill edges of the valley, the two soils are differentiated with difficulty.

Holyoke stony fine sandy loam is not extensive, it occurs along the base of the trap-rock outcrops from which it is derived. The surface relief is characterized by steep slopes which afford good drainage. This soil is weathered partly from glacial till and partly from talus material from the cliffs. It has a dark-brown mellow loam surface soil, a reddish-brown mellow subsoil, and a substratum of rust yellowish brown, passing at a depth of 18 or 20 inches into pale yellowish-brown fairly compact medium-heavy till. The substratum consists of smooth material with a fine flaky breakage, and below a depth of 30 inches is pale-yellow or pale yellowish-brown compact heavy loam with angular breakage. The entire profile contains quantities of blocky pieces of trap rock and is strongly acid. The forest growth is predominantly white oak, with some chestnut, walnut, and hard maple.

Land classed as meadow is widespread over the area along the smaller stream bottoms where drainage is imperfect. No profile development has taken place in this class of land. The texture ranges from loamy sand to loam and may vary within short distances. The surface soil, owing to an accumulation of organic matter, is dark brown. It is underlain, at a depth ranging from 5 to 12 or more inches by a mottled subsoil which rests on a dark-gray or bluish-gray substratum at a depth ranging from 20 to 30 inches. This land is subject to inundations and receives much wash material in places. The forest growth consists of soft maple, elm, sycamore, willow, alder, and blueberries.

Muck, as mapped in this area, consists of fairly well decomposed organic matter mixed with mineral soil material, and it extends to a depth ranging from 18 to 36 inches or slightly deeper. Most muck areas are underlain by a sandy substratum. Muck occurs in small stream bottoms and shallow filled-in lakes and is usually water-logged. Peat, on the other hand, consists of a deposit of brown fibrous peat ranging from 3 to 10 feet in depth. It occurs in filled-in lakes in the highlands. The forest cover on the muck and peat areas is mainly soft maple, alder, and tamarack.

Rough stony land includes all land too rough and too stony for profitable farming. In the eastern part of the area Gloucester soils predominate in the rough stony land and in the western part, Berkshire and Becket soils. In many places, however, rough stony land consists of rock outcrop with little or no soil material. Such areas occur mainly in the Holyoke Range. Rough stony land is the most extensive classification mapped in this area.

SUMMARY

Hampden and Hampshire Counties, comprising a total area of 1,205 square miles, are in the southwestern part of Massachusetts.

Physiographically, the area is a plateau cut by a broad valley. East of the valley the plateau is not only severely dissected but has reached an advanced stage of erosion, as the smoothly rounded hills indicate. The plateau west of the valley is higher, severely dissected, and includes narrow V-shaped valleys and fairly broad somewhat flattened ridges. The valley for the most part is composed of level terraces which are cut in places by narrow but shallow stream valleys, interspersed with low rounded hills and by the broad Connecticut River Valley.

The population is concentrated in the Connecticut Valley where the manufacturing towns furnish excellent markets for farm products.

The climate is humid, with long cold winters and short warm summers. There is a decided difference in temperature between the valley and the western highlands, which is shown by the difference in flora and crop maturity.

Hay, the crop occupying the largest acreage, corn for silage and grain, potatoes, small grains, and vegetables are grown in all parts of the area. Apple orchards and pastures are confined to the upland or hill regions of the valley and the foothills of the western highland and the eastern upland. Tobacco and onions, the most important cash crops, are grown only on the valley soils. The normal crop rotation of New England, consisting of corn and hay (timothy and clover), is practiced over all the area except the valley, and with a small addition of fertilizer is depended on to keep up fertility. In the valley, especially on the tobacco and onion farms, rotations are not followed and commercial fertilizers are depended on mainly to keep up fertility. Heavy applications of lime are used with onions, but only a small amount, and that only when needed, is used on tobacco.

Dairying is well distributed over the area, reaching its highest development in the east-central part. Other forms of livestock farming are not developed.

Dairying, or the growing of crops used in the dairy industry; orcharding, the growing of apples and to a less extent peaches and other small fruits; and market gardening give greater promise of future expansion than other lines of agriculture. Tobacco growing has been very remunerative in the past on the valley farms, and although the disease known as root rot, that at one time threatened the industry, is fairly well under control, the decreasing demand for cigar tobacco is a real menace to the industry. Onion growing in the upper part of the valley has been profitable for a number of years and may continue, but the possibility of competition from areas of lower production cost is ever present.

The soils have weathered from glacial drift in the upland and from glacial-outwash material and stream deposits in the valleys. This deposited material is strongly influenced by the basal rock formations from which it is derived and also by the mode of deposition.

The soils, with the exception of the podzol soils occurring in the higher parts of the western highlands, belong to the brown forest soils of the Northeastern States. The surface soils of the podzol soils consist of an accumulation of organic matter underlain by a gray layer which passes below into brown or yellowish-brown soil material. The valley soils have little tendency to accumulate organic matter on the surface, and weathering has taken place to the comparatively slight depth of 2½ feet. The valley soils, aside from those on the low hills within the valley, consist mainly of light-textured soils derived from outwash material.

The Chicopee and Merrimac soils are prevailingly light-textured soils, such as fine sandy loam, sandy loam, and loamy sand, and they have gravelly substrata. They are developed in the southern part of the valley and cover a large area adapted to tobacco, in fact, a larger area than probably could be used for this crop unless tobacco growing should be abandoned in the northern part of the valley. Although these soils are highly suited to tobacco they are not so well suited to such staple crops as hay and corn. Large areas of these soils, especially of Merrimac loamy sand, will, in a few years, be covered by city and town extensions and may not be an important factor in the agriculture of the area. These soils can be used for potatoes, market gardening, and dairying.

Smaller areas of soils derived from heavy deposits, or influenced by such deposits, are the Suffield, Melrose, and Scarboro soils, which range in texture from silt loam to fine sandy loam. These soils are well distributed over the valley.

The soils of the upper part of the valley, the Agawam and Hadley soils, including mainly very fine sandy loams and loamy fine sands, which are now used for the production of tobacco and onions, are adapted to a wide range of crops. In the event that either tobacco or onions should prove unprofitable, the growing of crops utilized in the dairy industry and market-garden crops can always be relied on to bring good returns, as the industrial towns of the valley and near-by cities, such as Boston, can absorb large quantities of milk and vegetables.

The soils developed on the hill land throughout the valley have weathered from till, derived from the Triassic rocks and influenced by the red color of these formations. This material gives rise to Wethersfield loam, Cheshire fine sandy loam, and Cheshire sandy loam, soils carrying very little stone. The nonstony soils and those containing a small amount of stone are used for agriculture. These soils, together with the Manchester and Hinckley soils, can be used for orcharding, especially for peaches and small fruits, and for dairying.

The nonstony soils of the eastern upland, the Gloucester and Brookfield soils, which make up a small proportion of the total area, can be used to advantage for apples, and for dairying, and the stony soils can be used for pasture to some extent.

The soils of the western highlands have compact substrata. Worthington loam and Shelburne loam, both of which have a slight limestone influence, and Woodbridge, Berkshire, and Becket loams, all of which are good grassland, can be used for dairying, potato growing, and orcharding. The hardy varieties of apples can be grown at the higher elevations. The Hollis soils, having light substrata, occur at lower elevations and are well suited to orcharding and to growing potatoes.

The soils of the eastern upland, which are derived from till (originally granitic material) belong to the Gloucester series. These are stony soils, in general consisting of loam and fine sandy loam and having loose substrata.

Large areas of stony land should be left in forest or allowed to grow up in forest. The cleared areas advantageously located can be used for pastures and even for orcharding. Large areas classed as rough stony land should remain in forest. Under present economic conditions the drainage of muck or peat areas for farm purposes is not warranted, unless the areas are advantageously located.

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