BULLETIN OF THE U.S. DEPARTMENT OF AGRICULTURE

No. 140

Contribution from the Bureau of Soils, Milton Whitney, Chief,
April 5, 1915.

SOILS OF MASSACHUSETTS AND CONNECTICUT, WITH ESPECIAL REFERENCE TO APPLES AND PEACHES.

By Henry J. Wilder, *Scientist in Soil Survey.*

SURFACE FEATURES.

Southern New England consists of a hilly plateau highest at the northwest and lowest along the seashore, the elevation showing a general range from less than 50 feet at the shore to 1,800 feet in the northwest, with an extreme altitude at Mount Greylock of 3,505 feet.

The surface features of this area are locally complex, but it is nevertheless naturally divided into three upland blocks and two lowland belts. These are, beginning at the west, the Taconic Mountain section, with general elevation of 1,200 to 2,800 feet; the Berkshire Valley; the Western Plateau, with general elevation ranging from sea level on the south to 1,800 feet; the Connecticut Valley; and the Eastern Plateau, extending from the Connecticut Basin to the coast with general elevation ranging from sea level on the east and south to 1,200 feet.

For convenience in discussing the relation of the soil factor to fruit growing, and because of the importance of the elevation factor in such study, the Eastern Plateau is further divided on the basis of elevation into the Coastal district; the Framingham-Boston lowlands; the Eastern and Southeastern Plateau, with general elevation of 200 to 700 feet; and the Eastern Highlands, with general elevation of 700 to 1,200 feet, the lower part of this section being superseded on the south by an extension of the Southeastern Plateau. Figure 1 shows the extent and relations of these several divisions.

THE COASTAL DISTRICT.

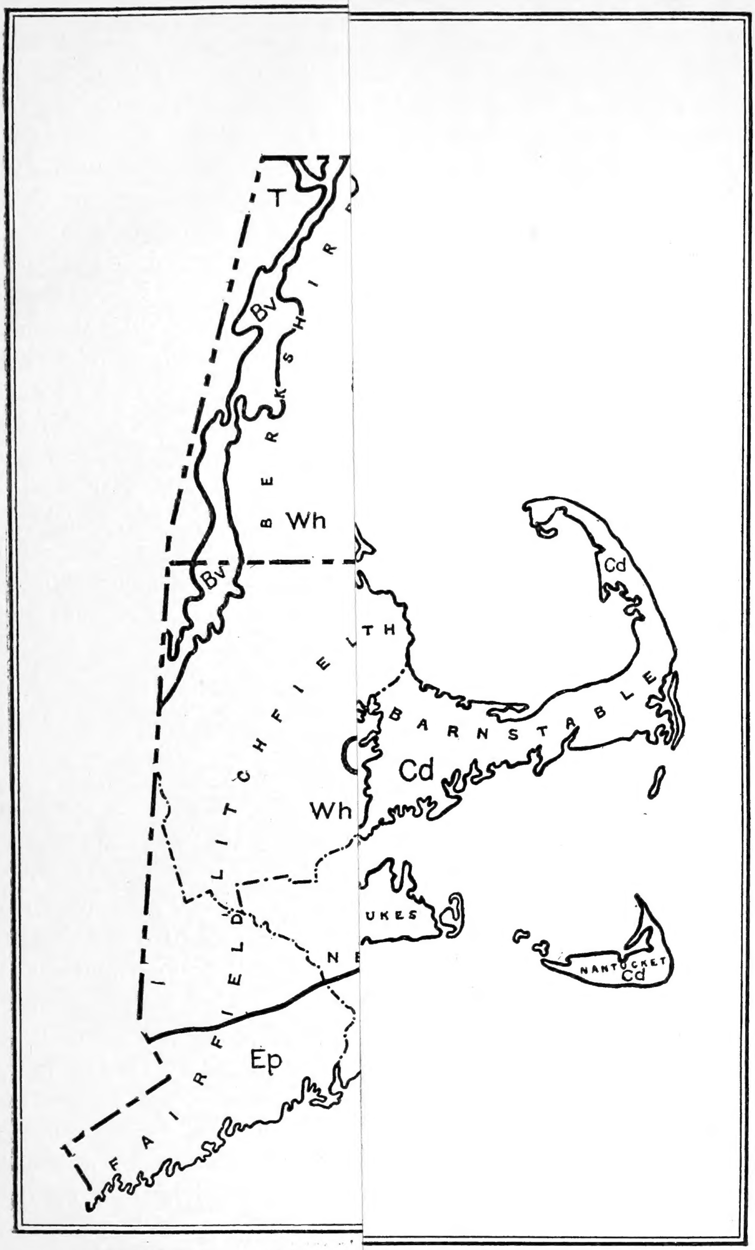
The Coastal Plain of the eastern United States does not extend northward, in typical development at least, to southern New England. The country from Plymouth-New Bedford eastward and northward, with its absence of rock outcrops and the predominance of sandy soils, is a near approach to it. East of a line drawn from the northeast corner of Rhode Island to Blue Hill the country is in elevation above the sea level and in relation to higher land westward similar to the Coastal Plain. The main body of this southeastern section is marked here and there by low hills and isolated ridges, giving it a gently rolling appearance, though in places it is almost plainlike. In general the topography east of this line consists of broad, low, rounded hills and ridges, with intervening smooth or faintly dissected plains. West of this line the hills and ridges are sharper, higher, and more thickly set on the landscape, while the smooth plains become narrower. East of it the plains are the predominant topographic feature. West of it the hills are predominant. The change, however, is gradual rather than abrupt, and the dividing line described above is only approximate.

The Framingham-Boston district includes an area topographically intermediate between the two areas described above, in which there are numerous low but steep hills and ridges standing in broad, smooth plains, a considerable part of which is swampy. This is a local district, which extends for a short distance into the more extensive Eastern Plateau, and west of Waltham it consists of a relatively narrow belt lying to the west of the Wellesley Hills.

THE EASTERN PLATEAU.

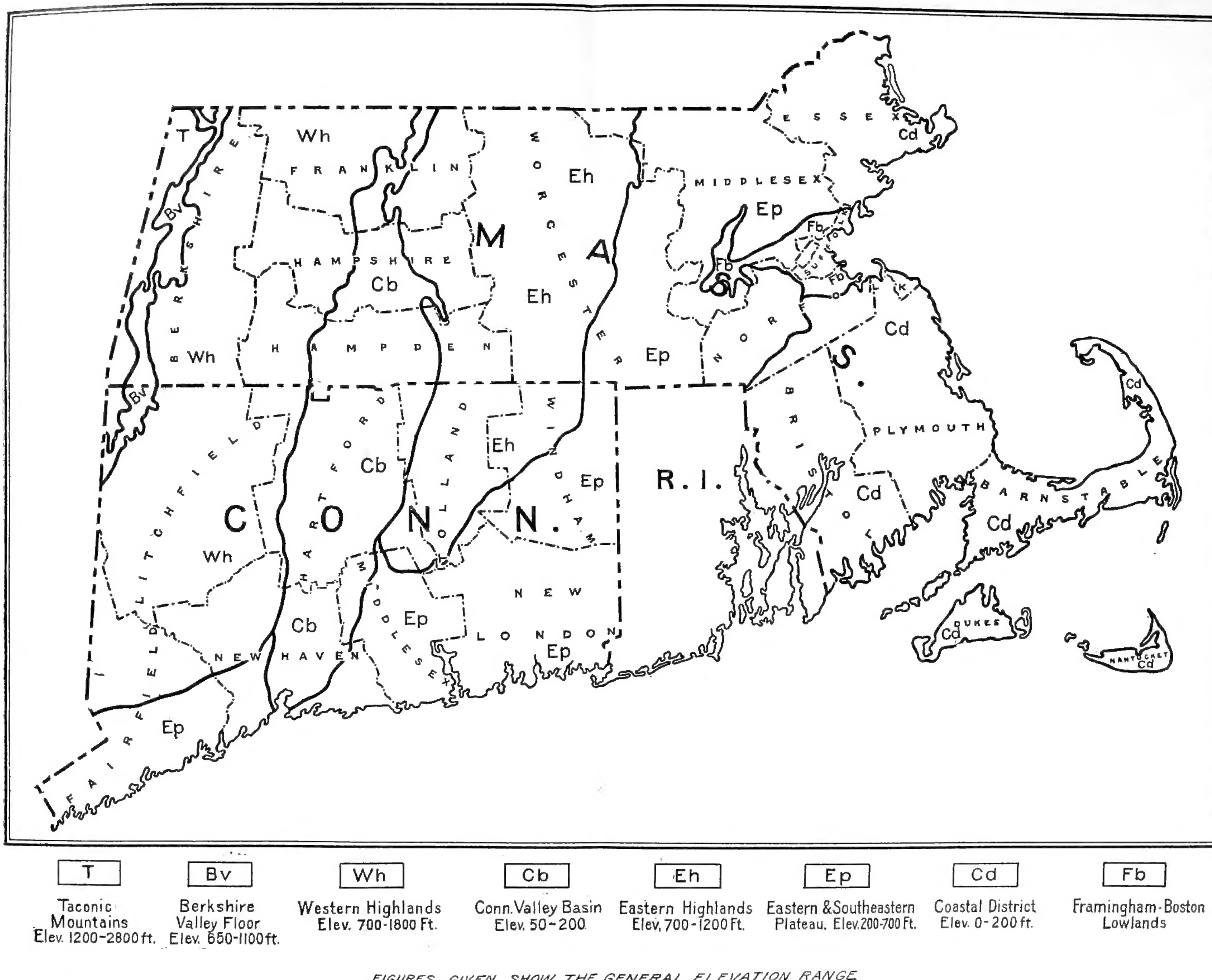
The boundaries of the Eastern Plateau are shown on the sketch map, figure 1, and need no further description here. The eastern boundary is so placed because of the much higher general altitude of the Highland district which lies to the west in Massachusetts and to the west and north in Connecticut. This district thus includes all the southeastern part of the latter State, in which it constitutes the largest topographic division. The elevation boundaries may be easily traced by the contour lines of the United States Geological Survey topographic sheets. The width of this section in Massachusetts is about 35 miles at the center of the State, but on a line with Cape Ann it is much more. The elevation of the principal hills along the east boundary of this region may be approximated as 200 feet, and along the western boundary as something above 600 feet, with isolated points about 700 feet. In Connecticut this district includes approximately the southeastern third of the State, including all of New London County and the greater part of Windham and Middlesex Counties.

Were all the valleys and depressions filled to the average height of the adjacent hills, there would result a high plain, sloping from the boundary of the eastern highland toward the sea. Some of the highest elevations, however, would rise above such plain, thus pro-



T	Bv	Cd	Fb
Taconic Mountains Elev. 1200-2800 ft.	Berkshi Valley Fl Elev. 650-	stal District v. 0-200 ft.	Framingham-Boston Lowlands

55570°—Bull. 140—15. (To f



55570°—Bull. 140—15. (To face p. 2.)

FIG. 1.—Sketch-map showing physiographic divisions of Southern New England.

ducing a gently rolling surface. Dissection of this plateau through a long period of time has been so pronounced that the existing surface is extremely irregular. It is a succession of much worn-down knobs and hills, with narrow intervening valleys. The hills are multiformed. Some are steep, and others not only steep but small, thus rendering cultivation expensive. Others, however, are dome-shaped, or at least sufficiently regular and smooth to afford many good farming areas and sites for orchards.[1] The higher parts consist of isolated hills or chains of hills, with much less definite direction than those of the Highland section adjoining on the west, where the trend ranges from north and south to northeast and southwest, as in all of both States farther west. The dome-shaped hills that frequently characterize this section are much more rare in the Western Plateau. The northern part of the Eastern Plateau is drained by the Merrimac River, of which the two principal branches are the Concord and the Nashua Rivers. Much of the Concord River basin is drained by its two important branches, the Sudbury and the Assabet Rivers. The southern part of the region is drained by the Charles, the Blackstone, and the French Rivers.

THE EASTERN HIGHLAND.

The Eastern Highland extends from the Eastern Plateau to the Connecticut Valley Basin. Its general slope is southerly, and the general range in elevation, barring exceptionally low and exceptionally high points, is from 700 to 1,200 feet. The high hills are somewhat broader in the northern part than in the southern, a fact which undoubtedly led in colonial days to the establishment of villages on several of these elevations ranging in altitude from 1,000 to 1,200 feet. Some of the villages in such locations are Shutesbury, Wendell, New Salem, Prescott, Pelham, Petersham, Phillipston, Templeton, Rutland, Oakham, New Braintree, Wilmington, Mansfield, Gilead, and Winchester.

The drainage of the Eastern Highland is mostly to the west and to the southwest. In the northern part Millers River rises in the vicinity of Gardner, flows due west, and enters the Connecticut near Millers Falls. In the central part the Swift, the Ware, and the Quabaug Rivers have their sources. These streams flow together at the town of Three Rivers, forming the Chicopee River, which enters the Connecticut at Chicopee. The extreme southeastern part of the

[1] The apple census of Massachusetts prepared by the State board of agriculture for the year 1905 shows the highest producing areas to be in those sections where this dome-shaped topography is most characteristic. This is an adaptation to conditions of topography and soil that had gradually come to be apparent, as the deepest and most productive soils of each section in southern New England are usually located in this favorable topographic position. Erosion also is not serious and tillage is relatively economical.

highland is drained by the headwaters of the Quinebaug River, which flows south into the State of Connecticut.

The general upland surface of this division is strikingly interrupted in its northern part by three prominent isolated mountains—Mount Watatic, Mount Grace, and Mount Wachusett—1,847, 1,628, and 2,108 feet in elevation, respectively.

THE CONNECTICUT VALLEY BASIN.

The Connecticut Valley region consists of a broad basin, which succeeds the Eastern Highland on the west and crosses both States from north to south. Approximately along its axial line lies the Connecticut Valley, a shallow, flat-bottomed trough, from less than 1 to more than 3 miles in width, through which meanders the river of the same name. The distance from the river due east to Boston is approximately 100 miles, and from the river due west to the New York line about 50 miles. The topography of the basin is generally smooth, becoming rolling locally, and is traversed by narrow but rugged ridges. It is a region of good soils and well-developed agriculture. The eastern boundary slope of the basin is more nearly a wall than a slope. The western slope is much more gradual than the eastern. It soon merges into the Western Highland section, which forms a broad, dissected plateau with easterly slope. In Connecticut the valley is wider than in Massachusetts, being one-sixth the width of the State at North Haven and north of Hartford one-fourth the width of the State. Beginning south of Northampton, Mass., is a series of sharp ridges traversing the valley and dividing it into an eastern and a western area, the former being the broader in the northern and central parts of the State of Connecticut, while the western arm is the broader in the southern part of the State. The latter is known as the Farmington-Southington Valley. Aside from the ridges, both arms of the valley are smooth to undulating; rarely can any portions be called hilly.

THE WESTERN HIGHLANDS.

The crest of this plateau, which lies along its western boundary, is marked by the Hoosic Range, which reaches a height of more than 2,800 feet, and from which all drainage easterly goes to the Connecticut River. This lofty plateau corresponds to the highlands of New York and New Jersey, to the Reading Hills and South Mountain in Pennsylvania (the latter name continuing through Maryland), and to the Blue Ridge of Virginia and North Carolina. Extending into Vermont it becomes more mountainous than in Massachusetts, and soon merges into the Green Mountain Range, which reaches a maximum height of 4,364 feet. On the west the Hoosic Range descends almost abruptly to the deep, narrow Berkshire Valley, but on the east it drops a little less steeply to the plateau into which it merges.

On the south the Hoosic Mountain becomes less well defined south of the incision by the Westfield River, and in northern Connecticut breaks up into a local group of hills.

The surface of the western plateau shows a wide range of variation. There are, however; many localities with areas of smooth to rolling country. These occur on the watershed ridges and along the eastern foot slope of the Hoosic Range, where the streams are yet too small to have cut deep into the plateau. In many cases they form covelike basins in the eastern side of the ridge. Around the heads of many of the small ravines within the plateau, before their streams have cut their way deep into it, there are broad basins of thickly accumulated drift which are usually occupied as farms.

One of the largest areas of smooth, undissected land at high-plateau level lies in parts of the towns of Hawley, Plainfield, and Cummington. The farm lands of the western plateau occur on the high-plateau top, in valley-head basins below the top, in valley bottoms, and on lower-valley slopes. In the eastern plateau it is mainly on the dome-shaped hills and rounded smooth ridges.

THE BERKSHIRE VALLEY.

The Berkshire Valley forms a link in the chain of great limestone valleys stretching across the United States from Canada to Alabama. At North Adams this valley is about 10 miles, at Pittsfield 7 miles, and at Great Barrington 5 miles from the New York line. Its surface is rolling to hilly, much more so than the unglaciated limestone valleys forming other links in the chain, and in marked contrast to the comparatively level topography of the Connecticut Valley. The southern two-thirds of this valley is drained by the Housatonic River and the northern third by the Hoosac River.

The Berkshire Valley from the Vermont line to Williamstown is usually less than a mile in width. South of Williamstown it divides, the Green River arm being narrow soon crosses the State line into New York, reentering the main valley near Pittsfield. From Williamstown east to Braytonville the eastern arm is well developed, but at the latter point it narrows rapidly and is nearly closed by Bald Mountain and Ragged Mountain, north of North Adams. From the latter point south to Adams the valley is deep and narrow, rarely exceeding a half mile, and much of that is talus slope. Thence south to Cheshire Harbor the valley is almost V-shaped, but it then broadens toward Cheshire until the local reservoir occupies its bottom as far south as Pontoosuc Lake. Thence to Shaker Village and Pittsfield the valley is several miles wide, and at the former village a spur valley extends southwest to the State line. From

Pittsfield to Stockbridge the main valley is 1 to 2 miles wide, but it then is closed in by mountains. Near Great Barrington and the Egremonts it is again 5 miles wide. Narrowing at Sheffield to 3 miles it again broadens to 6 miles at the State line, narrowing again a few miles to the south. Across the western end of Connecticut it is broken into a number of small isolated areas.

THE TACONIC MOUNTAIN GROUP.

West of the Hoosac Valley lies a thick local mountainous group with general elevation above 2,000 feet, known as the Taconic Mountains. These mountains are parallel to the Housatonic Valley and form its western boundary. They lie partly in Massachusetts and partly in the State of New York. Their steep slopes afford little good farming land. Their highest point in Massachusetts is approximately 2,800 feet. Geologically these mountains and the lower region west to the Catskills correspond to the broad band of shales, which give rise to the Berks soils of Pennsylvania, where they adjoin on the north the Lehigh, Lebanon, and Cumberland Valleys.

The highest mountain in southern New England, Mount Greylock, with elevation of 3,505 feet, lies between the two branches of the Berkshire Valley, southeast of Williamstown, Mass.

The general surface of the Western and Eastern Highlands and of the Southeastern Plateau is very irregular, yet the upland skyline is approximately even. The surface of this sloping region passes beneath the sea along the existing shore line with no sudden descent. The coast line merely marks the points of zero elevation along this tilted surface. The rise is gradual to a maximum of 2,000 feet in the northwest corner of Massachusetts.

THE SOIL MATERIAL.

The soil material found in southern New England is called glacial material by geologists, meaning that it was placed where it now lies by deposition from a former ice sheet. It was removed a short distance, however, and to all intents and purposes it is the product of the weathering, breaking up, and more or less grinding up of the rocks which occur in the region and constitute its foundation.

These consist, with the exception of the rocks in the Connecticut Valley, of ancient crystalline rocks, such as gneisses, schists, slates, and various igneous rocks. They are, so far as the soil material is concerned and considered in a broad way, essentially uniform over the whole State. In the Connecticut Valley the rocks consist of soft sandstones and shales with a few bands of hard igneous rocks which form the ridges already referred to.

The Cape Cod region differs from the rest of the region in that the existing land and its elevation is not due to a solid rock foundation with a thin coating of soil material, but consists of an accumulation of unconsolidated rock material in which the rock foundation lies deep, seemingly below the level of the sea. It is in this respect similar to Long Island and to a certain extent to the Coastal Plain.

Southern New England has passed through a long history in reaching its present condition. It is unnecessary to recount even the broad phases of that history, since it can be obtained in any good geological description of the region. A late and the most important stage in that history, so far as the soils of the region are concerned, was the invasion of the region by the glaciers of the glacial period. This changed the details of surface relief, thoroughly mixed and rearranged and redistributed the preexisting coating of soil and soil material, making the formation of a new soil necessary. The existing soils, therefore, are the product of soil-making agencies that have been in operation since the glacial period and are therefore young.

The ice reshaped the details of the topography by rounding off sharp corners and filling basins with deposits. Although part of the country is mountainous it has been rounded so that most of it is easily accessible.

The ice modified the layer of soil material in several ways:

(1) It removed a coating that was due to weathering and therefore approximately uniform in thickness, and left one that is practically absent in some places and of great thickness in others.

(2) It left a layer of soil material usually mixed with stone fragments.

(3) Owing to the great amount of water that was released from the ice during the melting period many belts and areas were built up into flat plains by the deposition of gravel and sand. These lie in the low belts and their proportional area increases progressively eastward from the Connecticut Valley.

(4) In some areas a very irregular and a very stony deposit was made in which the irregularities are small, giving a rough, bumpy, topography. These areas are usually very stony and almost worthless for agriculture.

We have, therefore—

(1) The smooth, moderately stony surfaces that may be level, moderately steep, or rolling. The soils consist of loams, clay loams, and sands.

(2) Level, sandy, and gravelly areas.

(3) Bumpy stony gravelly or sandy areas.

(4) Very steep areas and rocky areas.

The agriculture of New England is mainly on No. 1.

CLIMATE.

The climate of southern New England is rigorous, but the seasons are of sufficient length for the securing of good crops, and seem especially favorable for a long list of varieties of apples. It is essential, of course, with all field crops, to select varieties that will mature in the prevailing length of season, but the yields obtained clearly demonstrate that this is no handicap. In fact, the range of crop varieties available is distinctly favorable. This is undoubtedly due in part to the long-continued line of horticulturists and seedsmen in the region who have been interested in varietal development, but the fact that the climate is suitable for a wide range of varieties, especially of horticultural varieties, is unquestionable. This is evidenced by the fact that 134 varieties have been listed by the United States Department of Agriculture [1] as having originated in Massachusetts. Prof. Beach, in "The Apples of New York," mentions 27 of these varieties, of which the following 5 may be termed commercial: Baldwin, Hubbardston, Roxbury, Sutton, and Williams. Connecticut is credited with 88 varieties,[1] of which one, the Twenty-ounce, is in the commercial list. It may be added for the sake of comparison that New York is credited with a far greater number, 176 varieties,[1] but of these only 6 are commercial, viz: Fall Pippin, Jonathan, Yellow Newtown, Northern Spy, Tompkins King, and Wagener. Rhode Island is credited with only 9 varieties,[1] but two of these are commercial—the Rhode Island Greening and the Tolman Sweet. A number of secondary varieties have also originated in most of these States, some of almost commercial importance and other highly desirable for family use.

To the peach growers of Connecticut the climatic conditions within that State are of much importance. No section is free from frost injury or occasional winter injuring due to low temperatures, but accumulated experience has led to the establishment of most of the commercial peach orchards along the lateral slopes of the Central Lowland belt or on local elevations within it. In the southern part of the State also, at elevations below 600 feet, occasional commercial orchards give excellent results, but the largest of these have been established by men of experience on good local elevations at least a few miles back from the shore. The loss of fruit from strong onshore winds seems to account for the last precaution. In the northeastern part of the State, at medium to higher elevations, peaches are grown with moderate financial success, but the average climatic risk is a little greater; only the occasional man engages in it, and even then usually as a money crop rather than as a main business. There is a general feeling, too, that the soils are somewhat less favorable for peaches than in the Central

[1] Bul. 56, Bureau of Plant Industry, U. S. Dept. of Agr.

Lowland district. In Massachusetts, however, in southeastern Worcester, southwestern Middlesex, and western Norfolk Counties, good results have been secured. In the northern two-thirds of the Western Highlands the climate is generally considered too severe for commercial peach orcharding, though scattering orchards are more or less successful. Isotherms of the weather maps indicate within rough limits the peach-growing sections and the nonpeach-growing sections as already outlined. But if weather conditions had been the only determining factor in the location of the peach industry, the orchards of the State would not have been distributed as they now are. In general the slopes along the west side of the Central basin have much fewer peach orchards than the slopes along the eastern side, and although there are very few orchards in the latter position between Hartford, Conn., and the Massachusetts line, an important development occurs just north of the State boundary in the Wilbraham district.

The development of peach orcharding has already proved that climatic conditions favoring the business obtain in considerable areas of the State, and that only a small percentage of such areas have been developed. It is true, of course, that only a small part of the soils of such climatic areas are the most desirable, but such tracts readily may be selected, and they include many undeveloped local areas of good peach soils.

Barring low-lying areas the climatic conditions of the whole State are well suited to apple growing, though the character of the fruit varies with the kind of soil and not improbably to some extent with the range in climate—i. e., a Baldwin grown on a certain soil 1,000 feet above sea level in the northwest part of the State matures a little later and it seems reasonable to suppose that it may possess a little better keeping qualities than one grown 40 miles farther south on the same character of soil at an elevation of 500 feet; and while this point is generally conceded by growers, it would be of greater value if supported by experimental data to measure as nearly as may be the amount of this difference.

SOILS OF SOUTHERN NEW ENGLAND.

The soil materials of southern New England, the rocks from which they have been derived, and the glacial processes by which they were accumulated in their present positions have been described. These are factors of great importance in determining the character of the soil, but they are not the exclusive ones. The most important additional factors are drainage, chemical change, and the accumulation of vegetable matter. These latter are equally as important in determining the productive power of the soil as are the former.

Since this report is not primarily a soil-survey report, the details of location and character of the different soils can not be given; but the main soil groups of southern New England are relatively simple, though the details are complex. Soil groups are given a name, the members in the group constituting what is technically called a soil series. A soil series includes all soils with the same origin, color, character of subsoil, and all other characteristics except texture, or the coarseness or fineness of the soil particles.

The most widely distributed soil series in southern New England has been named the Gloucester series. It is typically brown in color, grading toward a yellowish color on the one hand and a light-brown color on the other. The subsoil is typically yellowish brown in color and usually as heavy or heavier than the soil. In the heavier members of the series in the lower subsoil, from about 24 to 36 inches and deeper, the color sometimes changes to a drab or bluish color. The soils of the series are well drained and aerated, uniformly oxidized, and when they occur on smooth areas and have a fair to good supply of vegetable matter are productive. They are derived from the crystalline rocks of the region, and the material was accumulated by deposition from the ice of the glacial period. They occur on the rolling and hilly uplands of the region. They are usually stony, but do not have gravel or sand subsoils except possibly in rare cases. Their water-holding capacity is normally good. Occasionally the clay subsoil is rather compact, resembling a hardpan, but true chemical hardpans are practically unknown. The most prevalent members of the Gloucester series are the loam and the sandy loams, though the sand is not absent. These various members may occur in any part of the region, but the sandier members are more prevalent just east of the Connecticut Valley basin than elsewhere.

The most important and permanent agriculture in southern New England, aside from the Connecticut Valley basin and the market-garden areas around the large cities, has developed on the Gloucester soils, and in both States they are the leading apple soils.

The Bernardston soils are an upland series closely associated with the Gloucester soils. They are gray to bluish gray in the soil and subsoil. The dark color is due largely to the presence of small particles of the dark-gray slate from which the soils are derived. They are usually heavier than the other series as a whole. Grasses both for hay and pasture do well on these soils. They occur in a number of places in the western part of the region, the type locality being near the village of Bernardston, Mass.

The Whitman soils are dark gray to black in color, with gray to yellowish mottled subsoils. They occur in depressions or on flat areas where natural drainage is not good, the mottled subsoil being due to this. They are derived from the same rocks and by the same processes as the Gloucester soils, but differ from them in drainage and aeration. These soils are more prevalent in eastern Massachusetts than elsewhere. If drained, they would be of value for grass, corn, and some of the late truck crops, but they are not suitable for the tree fruits.

A group of soils, seemingly with restricted distribution and which has not yet been officially named, but which will be described here as the Essex series, includes soils that are dark brown to nearly black in the soil, with yellow to light-brown subsoils. They seem to lie intermediate between the Gloucester and Whitman. They are better drained and at present more productive than the Whitman.

The Merrimac soils are brown to yellowish brown, with yellowish-brown subsoils. They occur on flat surfaces and are due to the deposition of material from running water. They consist, therefore, of assorted material, often have porous gravelly or sandy subsoils, and are on that account deficient in moisture-holding capacity. Where the gravel bed is several feet below the surface they are not droughty. They occur most frequently and in larger areas east of the Connecticut River. They are the prevailing soils in the flat sandy and gravelly lowland belts and in the flat areas in the eastern and southeastern part of Massachusetts. They are not so prevalent in Connecticut as in Massachusetts, though they are found along most of the streams. They are not subject to overflow. The heavier members are productive soils, except those with very gravelly subsoils near the surface. They are usually free from stones, but are nearly always gravelly.

The Wethersfield soils are the predominant soils of the Connecticut Valley basin and the Pomperaug Valley, aside from the soils of the river and creek bottom lands. The soils of the sandy members are gray or yellowish gray, often with a slight salmon tinge. The surface soils of the heavier members of the series range from pale to deep salmon color. The subsoils are salmon, red, or yellowish red in color. They are all, except the sands, good soils, naturally productive. The region of their occurrence is well developed agriculturally.

The Middlefield series includes the glaciated Triassic sandstone and shale soils which are characteristically yellow or gray at the surface. The subsoils are usually yellow. The series is derived from the same geological formation as the Wethersfield formation with which it is closely associated, though the color contrast is strong. In places the soils are complexly intermixed.

There is another group of soils occurring on the trap ridges which have been derived from ironstone (diabase). They occur typically on Talcott Mountain and associated trap ridges. They are important fruit soils and for convenience in this report are referred to provisionally as the Talcott series. These soils have a rusty brownish-red surface with dull reddish subsoils, their structure differing markedly from that of the Gloucester soils, though they resemble somewhat the Mont Alto soils of Pennsylvania, which are also derived from ironstone. Loams and silt loams are the principal types. The ironstones consist of a series of concentric rings which not infrequently are so decayed that several layers may be peeled off readily with the fingers. These Connecticut ironstones are only now and then as red as those giving rise to the Mont Alto series, but grade from a very dull red to a rusty blue. The subsoil is usually lighter than the surface soil, but its definite structure makes the material at first seem stiff, though it crumbles readily in the hand.

The Dover soils occur only in the Berkshire Valley and its extension southward into Connecticut. They contain a considerable amount of limestone material in their composition, and are naturally productive where drainage is sufficient, but they are not as desirable for orcharding as the best Gloucester soils.

The alluvial soils are small in area except in the Connecticut Valley. Where associated with and derived from the Wethersfield soils they are called Hartford soils, and where derived from the upland soil materials they are called Ondawa soils. Where well drained they are productive.

It is evident from this enumeration of the principal soils of southern New England and their characteristics that they are not predominantly sterile soils, but, on the other hand, the soils themselves are as a whole at least moderately productive. Through the processes of their formation they are usually stony, a considerable part of the area has a rough surface, and on account of the geographic position of the region the staple grain crops and the crops adapted to a long growing season and a hot climate do not grow as well as in some other parts of the country. Where the land has been cleared of stones so that it can be cultivated, where the topography is smooth enough for cultivation, and where crops adapted to the soils, climate, and other conditions of the region are planted, satisfactory yields are obtained. The poorest soils for most crops are the very light ones, such as the sands and gravel soils. These do not constitute the predominant soils of the region. They probably have the smallest acreage of any of the soils. Sandy and gravelly soils are common, but they are for the most part the sandy and gravelly loams.

SOILS OF THE DIFFERENT SECTIONS OF THE STATES.

THE SOUTHEASTERN SECTION OF MASSACHUSETTS.

The general elevation of Cape Cod above sea level is from 10 to 100 feet, though west of Barnstable, toward Bourne, hills 200 feet high are not uncommon. Level areas of appreciable size are few. The position of the Cape in midocean, as it were, exposes her farms, especially north of the elbow, to strong winds which have caught up the sandy soil and blown it in swirls here and there, thus forming a succession of low hills, knolls, and hollows. Both elevations and depressions are small in area; hence the surface of the Cape, especially east of Barnstable, is hilly, notwithstanding the slight elevation above the sea.

Many of the hilltops are not covered with vegetation, and on them sand-carrying winds make impracticable the growth of any except the hardiest plants, shrubs, or trees. It is in the hollows and on protected hillsides that the crops are grown, and there also the farm buildings are usually located. For this reason a casual glance over the region reveals only a small part of the gardening and farming operations.

The soils of the hollows and protected slopes have not had the finer particles blown from the surface by the winds, and the accumulation of humus from decaying plant growth has left them generally productive, yet their small size and limited production, together with lack of transportation facilities or high carrying charges, have prevented any considerable development of farming interests to compete in general markets. The very important fisheries have constituted, moreover, the principal industry. Hence the chief agricultural problem has been to maintain a home, to grow all sorts of garden and farm crops for family use, and to grow feed for the necessary horses and neat stock. This is a very legitimate and proper development of the opportunities, in that home supplies have been produced, while a main industry (fishing) has been specialized.

The attractiveness of the Cape as a place of summer residence has brought there a large population during the warm weather. This has created a large and growing demand for garden produce, summer fruits, dressed poultry, eggs, etc., much of which is shipped to the Cape from the Boston markets.

On the best of the soils located as described above, namely, in the hollows and on protected slopes, there are many excellent opportunities to grow garden crops, small fruits, plums, peaches, summer apples, etc. The best soil types available for this purpose are fine sand and loamy fine sand, principally, though occasional areas of the fine sandy loam occur. Areas of compact medium sand can be used for early-season garden crops, and even the coarse sands bring remunerative return where so managed as to provide a good supply of humus. In wet seasons strawberries and the cane fruits also do well, but in dry seasons the fruit is too small, and by midsummer there is liable to be insufficient moisture to maintain a good growth of plants, thus weakening their vitality. The latter feature not infrequently is serious enough to lessen greatly the crop of fruit the following season. This is especially true on medium to coarse sands and sandy loams of loose structure. Of these some areas are made even more porous by the presence of fine gravel, which is likewise found to some extent with the finer grades of sand and sandy loam. Stony areas occur, but they are generally small in extent.

Hay for home use is cut principally from the marshes, of which some are salt and others fresh. From the latter the best hay is secured, while salt marsh overflowed intermittently yields a medium crop, and land daily overflowed the poorest crop.

West of Barnstable there are appreciable areas of soils somewhat heavier than those previously described. Light sandy loams, light loams, and even light silty loams are sometimes found. The subsoil of the uplands is principally stony fine sand, stony sand, or stony fine sandy loam. There are many areas, too, of light sandy surface soils compared to those nearer the point. Gravelly sandy soils also occur, but at the present time these are little used for farming.

Thus it is seen that few of the soils of the Cape are drought resistant and crops frequently suffer for lack of moisture. So characteristic is this tendency that every possible means should be used to conserve moisture. This necessitates not only a large supply of humus, but also very frequent cultivation. The last is now given by the best farmers, some of whom plan to give surface tillage at least weekly. Humus burns out of these soils rapidly, but notwithstanding this characteristic, a good supply must be maintained if good yields of the various crops are to be secured. Since little stock is kept the small quantities of stable manure available must be supplemented by the use of cover crops—that is, the greater part of the necessary humus must be grown. Red clover succeeds, likewise Canada field peas. Other legumes have not been tried to any extent, and it is not strange that the few spasmodic attempts with alfalfa in most cases have failed. Rarely has the land been brought to a condition of sufficient productiveness before sowing the seed to attain success with this crop. The vetches are promising and should be thoroughly tried. It is also worth while to test the early maturing varieties of cowpeas, such as the Whippoorwill and New Era, though these are doubtless less dependable in this climate than Canada field peas.

Scattered about the Cape are many low-lying areas upon which the great cranberry industry has been developed. No attempt was made to examine in a comprehensive way the soils of these bogs, but they are evidently miscellaneous in character, though probably more uniform in the large bogs than in the small ones. While this variation may have been brought about in part, or at least have been accentuated in some measure by the sanding of the bogs, their virgin condition must have shown wide range in the proportion of muck and sand of which they are largely composed. In fact the countless areas that have never been improved leave no room for doubt on this point. The assorting of the fine gravels and the sands as shown from the rim of some of the bogs toward the center marks the range of local sedimentation and in-wash. The surface soil of one bog examined is a light muck mixed with a great deal of sand, there being enough of the latter to constitute in some places a mucky sandy loam rather than a sandy muck. The subsoil is extremely variable, often differing widely in borings only 3 feet apart. Only in spots is the subsoil a black clay loam, and in most places the soil auger 3 feet long may be thrust down full length with little or no turning. A blue clay is said to lie underneath, but in the borings taken none happened to be encountered within 3 feet of the surface. The soil is well drained to a depth of at least 2 feet. The most serious feature is an intermittent layer of water-washed sand from 6 to 12 inches thick which is found in places at 2 to 10 inches beneath the surface. Not infrequently some peat is found in the lower subsoil. Many of these bogs not utilized at present for cranberries would produce timothy to advantage. In others onions might well be grown by installing drains. To mix thoroughly the different soil materials, subsoiling and deep preparation tillage should precede such cropping wherever the sands occur in beds. Otherwise shallow-rooted crops would be liable to drought injury.

In the southern half of Plymouth and Bristol Counties the topography, the soils, and the crop use of the latter closely resemble the conditions in northwest Barnstable County already described. The lowland areas constitute very important cranberry lands. The acreage of this crop could be increased, but it should be realized that competition with other producing districts, such as New Jersey and Wisconsin, is likely to become more keen than at present.

The soils of northern Plymouth, northern Bristol, and eastern Norfolk Counties differ from those of the southern half of the former counties principally in having a smaller percentage of sandy types of soil and in having a greater proportion of their area above the 100-foot contour. An important part of this section, however, including that occupied by the Eastons, the Bridgewaters, Whitman, and Brockton, approximates only 100 feet in elevation, and almost the whole section lies between 100 and 200 feet above sea level. The local hills, except where the soil is unfavorable, are suitable for orcharding. The surface soils include loams, sandy loams, and sands of various depths, with subsoils of sandy loams and sands. The color of the surface soil is brown to yellow, while the latter color is almost universal in the subsoil. The subsoils of loamy types are typically lighter than the surface soil, a characteristic which very often obtains in Massachusetts, especially in the eastern part. Gravel is not infrequently encountered, especially in the subsoils. Its quantity is sufficient in places to prevent boring very far beneath the surface, but in no place examined was it sufficiently compact to constitute a true hardpan, though it is often so designated in local parlance.

The lowlands of the Bridgewater-Brockton district often consist of heavy loams with retentive subsoil, and on such soils much of the farming has been done, especially that of milk and hay. Many of these lowland fields should be artificially drained. In a few cases this has been done, but there is great opportunity for an increase of the areas so improved. Such drainage would unquestionably pay where the land is not so rocky and stony as to increase to an unwarranted degree the cost of ditching. These soils are good for hay production, and the nearness to Boston markets and the low cost of carrying city manure back to the fields suggest a desirable use for these soils.

PLATEAU DISTRICT OF EASTERN MASSACHUSETTS AND SOUTHEASTERN CONNECTICUT.

Topographically, this district also includes much of Rhode Island, but the field work of this report did not include the soils of that State.

The average of the soils of this district in Massachusetts is somewhat more gravelly, sandy, and porous in the southeastern than in the southwestern part. In Connecticut the fine sandy loam is probably the predominating texture, most of the loam areas of Pomfret and Woodstock being in the Highland district. As detailed descriptions of the soils of this district may be seen in the detailed soil surveys of Windham County and New London County, they are not included here.

In Massachusetts the Blackstone River rises not far west of the city of Worcester and flows southeasterly to the corner of Worcester County. The Blackstone Valley is narrow and not particularly pronounced locally because of the broken surface features, but it is, nevertheless, a definite feature of the regional topography. The land is often stony and some of the lower areas along the stream are wet, so that much of the land is not farmed. There are some high terraces, however, as at North Uxbridge, where the surface soil of one considerable tract consists of open-structured fine sandy loam and light loam, with a few spots of fine sand. The subsoils in the same order are medium sandy loam, heavy sandy loam, and sand. These also are open structured, but as a rule not very leachy.

East of the Blackstone Valley in the Mendon section and extending thence north to Grafton, Hopkinton, and Sherborn, the land surface

TYPE OF PRESENT COMMERCIAL DEVELOPMENT.

[Soil is the Gloucester stony loam, the stones and rocks having been cleared and dumped on low ground at left in middle distance. Fitchburg, Mass.]

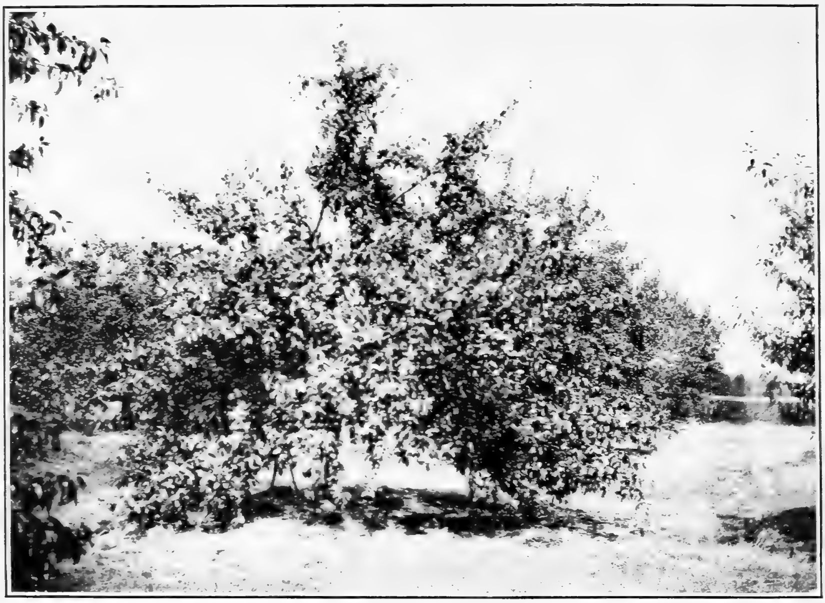
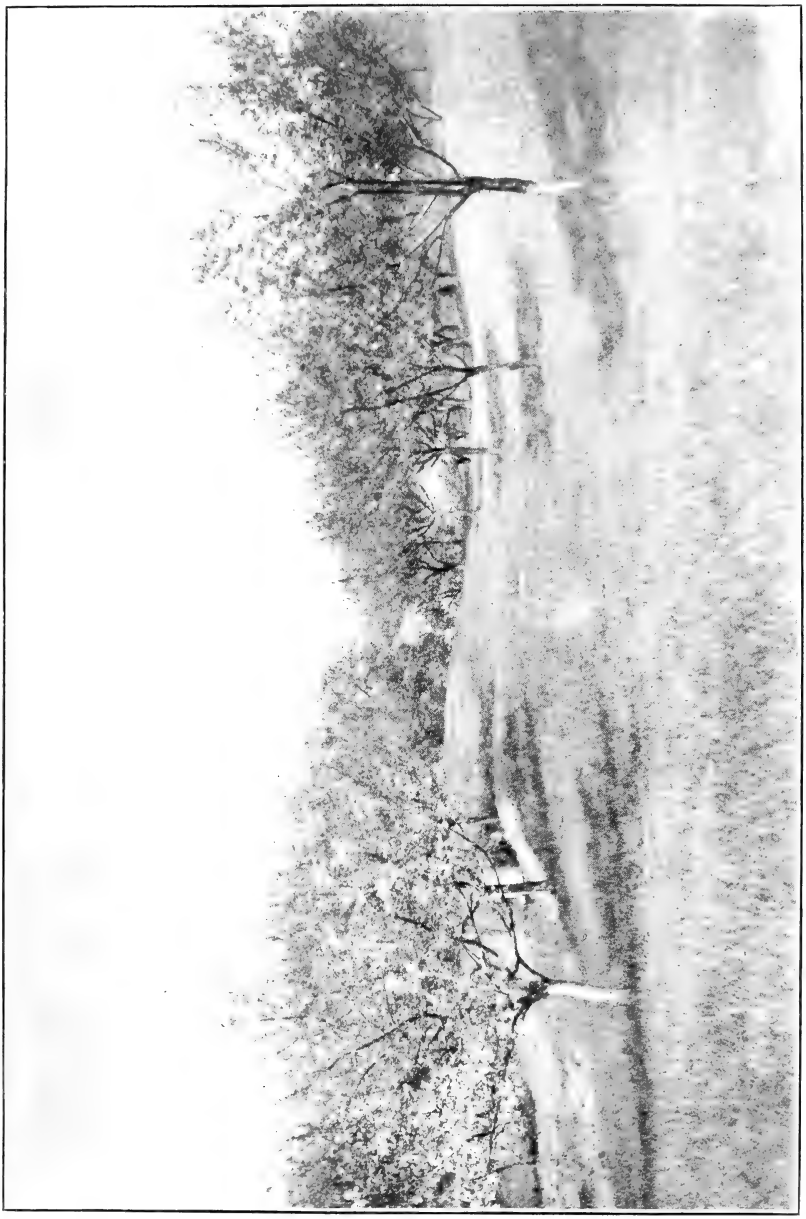


FIG. 1.—MODERATELY EFFECTIVE SOD MULCH ON GLOUCESTER LOAM.

[The mulch should be a little heavier.]

FIG. 2.—CUTTING DOWN FILLER PEACH TREES IN 5-YEAR ORCHARD OF APPLE STANDARDS.

[An unusual example of ability to carry out a purpose. Wallingford, Conn.]



APPLES A SUCCESSFUL MONEY CROP ON A DAIRY FARM IN THE BERKSHIRE HILLS, AT 1,000 FEET ELEVATION.

[Baldwin, 13 years old, on Gloucester loam. Crop rotation practiced in corn one year followed by grass about three years. Fertilized with both stable manure and chemicals.]

ROADSIDE PLANTING OF APPLES.

[Trees on right thrifty (see same in Pls. V and XX), but on the left undeveloped. Both lots cultivated when first set, but those on left have been owned by six different men and left in sod for last 20 years. Compare individual tree in Pl. V.]

is quite rolling, though the hills are not very high. Many of the hills are dome-shaped and afford excellent orchard sites. Their soils, too, are generally well suited to orcharding, often consisting of mellow, brown medium loams overlying a subsoil of friable sandy loam or light loam, yellow or brown in color.

Just west of the Blackstone Valley the land is more rough and stony until the general level of the uplands is attained, where it is moderately hilly westward to the French River.

Farther north in the town[1] of Sutton, where the apple of that name originated, the surface soils on a representative farm examined grade from heavy fine sandy loam in the "upper orchard" to a light silty loam in the "lower orchard." The subsoil grades from heavy sandy loam to light loam, and in places to silty loam. The color of the surface soil is brown and yellowish brown, and of the subsoil yellow, grayish-yellow, or light brown.

In North Grafton the surface soils in another orchard examined included loam, light loam, and sandy loam of brown or yellowish-brown color, while the subsoils consisted of yellowish loam and sandy loam. In large orchards of another farm were found the types above mentioned and also a heavier silt loam underlain by clay loam. In still another, a compact gravel layer was encountered at a depth of 2 to 3 feet. This condition is designated as hardpan, and while true hardpan undoubtedly occurs in spots, the term is often used in the State to indicate subsoil conditions much less serious than actual hardpan. These examples serve to show the local variability of the soils.

From the Sherborn-Hopkinton-Grafton district northward to Chelmsford and Groton the soils of the Eastern Plateau belt average a little heavier than in the southern part, though the total range in texture is just as wide. This district includes many prominent farming towns, and excellent orchards are frequently to be seen. Among these towns may be mentioned Shrewsbury, Northboro, Berlin, Hudson, Marlboro, Sudbury, the Actons, Concord, Stowe, Clinton, Lancaster, Bolton, Harvard, Littleton, Chelmsford, Westford, and Groton.

The most representative soils are loams and fine sandy loams. Silty loams are not infrequent, while now and then silt loams occur. The subsoils are seldom heavier than the surface soils, but are very often lighter. In some places the subsoil grades to a compact sand in its lower depths, and small gravelly areas are not uncommon. The well-drained and friable character of these soils has undoubtedly been a

[1] "Town" in New England is synonymous with township.

most important factor in the establishment of the numerous orchards. Most of these are small, to be sure, small orchards being countless, but there are also large plantings of both old and young trees.

The characteristic color of the above soils is some shade of brown or yellowish brown, but the heavier soils are sometimes grayish and the subsoils a grayish brown or gray. In some cases, but not in others, this indicates poor present drainage. It is evident that the grayish colors of some areas is due to deficient drainage before the land was cleared, the subsequent run-off of the surface and open ditches serving to bring the land to satisfactory condition for cropping.

The soil descriptions of the last district apply likewise to most of Essex County, though small areas of gravelly and sandy soils are perhaps a little more frequent, as are small areas of clay loams. In the Oldtown district, too, are some interesting loams carrying some well-developed orchards of Roxbury (*Roxbury Russet*). In describing soils for that variety these are classed as Essex loam.

North of Groton, and thence toward Hollis, N. H., a town just across the State line, there is another class of soil known locally as slate lands, and classed by the Bureau of Soils as the Hollis series. These have been derived from schistose rocks from which the "slaty" fragments in the soil have come. The soils are more moist than the corresponding types of the Gloucester series, and in crop use are similar to the Bernardston soils, being especially well-adapted to the production of grass and other forage crops. For the purpose of this report these soils may be grouped with the Bernardston series. The red varieties of apples do not color as well as those grown on the Gloucester soils, which on this account are more desirable for growing the red varieties.

North of the Merrimac River, and in northern Middlesex, northern Worcester, and northeastern Franklin Counties the topography is somewhat choppy, the soils are generally more sandy and porous, and farming is not extensively developed; and while sections of good farming lands and many good individual farms occur, the percentage of stony land is greater than in some parts of the Eastern Plateau of the Eastern Highland districts.

Land prices in the Eastern Plateau district are extremely variable, the average being much higher in Massachusetts than in Connecticut, largely because of the density of the population. Near towns and population centers, farm lands in Massachusetts are worth from $50 to $150 an acre, except in especially desirable locations, where they are much higher. At a distance from town land may be bought for much less than $50 an acre in both States.

THE EASTERN HIGHLANDS OF MASSACHUSETTS AND CONNECTICUT.

The upland soils of the Eastern Highlands are derived directly from glacial material. No exception to this was noted, and the glacial till is, for the most part, deep, even the hilltops having a thick mantle. The Gloucester series is by far the most extensive, but the Bernardston series is of importance in some localities. A striking feature is the stony character of the lowland soils. In this respect central Massachusetts, including much of the Eastern Plateau Belt, seems to differ from the glaciated districts west of New England, where the upland soils are generally more stony than the lowlands. In Worcester County and in places in eastern Massachusetts it is not unusual to find the lower-lying areas, which the railroads for the most part traverse, so stony that no attempt is made to cultivate them. Such lands were first cleared and used probably as pasture and then allowed to grow up in brush, a condition which now largely prevails. That such lands are not tilled leads the casual traveler to think them so unproductive as to be sterile or nearly so. An examination reveals good soils in many cases to be so stony that it is not practicable at present to put them in condition for cultivation. There are exceptions to this statement, of course, and some areas would become profitable if, the stones having been removed, they were artificially drained. Drainage, in fact, is an important problem in Massachusetts and to some extent also in Connecticut, and some time in the future many drains will be installed. Areas are not infrequently found that lack only drainage to permit profitable farming.

In much of Worcester County the largest areas of cultivated land lie on broad hills. The cultivated area often extends down a gradual slope or in other cases terminates abruptly as a sharper slope is approached. There is no uniformity in the selection of the areas for cultivation. The lay of the land even leads one to wonder why brushy fields adjoining those cultivated are not likewise tilled. An examination shows that some are as desirable for tillage and some of them even more so than the lands already farmed. Other areas of identical superficial appearance, however, show the good judgment of the owner in making no attempt to till them because of the stones.

The value of these lands or lack of it has had little to do apparently with their present use. Good lands were just as liable to be abandoned as poor lands.

That part of the Eastern Highlands extending from a line drawn from Leominster, Mass., through Princeton and Barre south to include Charlton and Warren, and also Woodstock, Pomfret, and part of Putnam, Conn., constitutes a good farming and orcharding section. Between Barre and Warren, Mass., this area should be extended westward to include the excellent town of Hardwick, to which reference has already been made. Yet even this locality has been improved and reasonably developed only in spots. From much more of the land is the production of crops and other farm products destined to be greatly increased and conditions are already ripe for the undertaking. Similar conditions obtain in the Pomfret-Woodstock section in northeastern Connecticut.

Good glacial loams, both medium and very heavy, produce good yields of corn and grass, the former being preferable for corn and the latter for grass. Both crops brought heavy yields in 1911, notwithstanding the droughty conditions that prevailed during much of the growing season. The medium and light loams are well adapted to orcharding, thrifty orchards here and there attesting to this fact, but they likewise are bringing good yields of forage for the production of market milk. Directly west from New Braintree, Mass., and toward Enfield the soils are more sandy, as they are to the southward in Hampden County east of a line connecting Three Rivers and the town of Hampden. These lighter soils also extend farther south into northern Tolland County, Conn., but in the southern half of that county the percentage of loamy areas increases somewhat.

Prescott, Mass., may be taken to represent one of the more undeveloped towns of eastern Hampshire County. Though hilly, this town has a sufficient area of soils that are capable of bringing good crops to warrant a much higher degree of farm improvement.

In northwestern Worcester, in the eastern parts of Franklin and Hampshire, in the southwest corner of Worcester, and in the southeastern part of Hampden County, Mass., and in northern Tolland County, Conn., the percentage of improved land is much less than in central Worcester County. Conditions differ somewhat, but the production of farm products is much lower than it should be. The elevation is high, the region is hilly, there is a considerable percentage of sandy and stony soils, distance from shipping points is relatively great, transportation over the existing highways is expensive, and hence large areas are in forest. Yet notwithstanding these adverse conditions, which are found in greater or lesser degree in most of the Eastern States, there are sufficient areas of good soils so located that they are easily capable of supporting a prosperous agriculture.

From the crest of the Eastern Highland to the Connecticut Valley there is a general slope, but its surface has been so dissected as to leave little semblance to anything plainlike. On the contrary, bold hills approximating 1,000 feet in elevation extend nearly to the Connecticut River, in the northern part of the State, near the Vermont line in east Northfield, and thence southward these high hills extend through the towns of Erving, Montague, Leverett, Pelham, and Enfield. Near the southern boundary of the town of Enfield the relief becomes much lower, and thence to the Connecticut line and far into Tolland County, Conn., the country spreads out into a succession of lower hills which are comparable to and connect with the eastern Hampden district. Much of this section is from 500 to 700 feet above sea level, though elevations up to 1,000 feet occur. The relief is characteristically much more gentle than that of the higher section to the north. The soils of the whole district are complex, often varying widely in short distances. They do not differ in kind from the rest of the Eastern Highland soils. but the percentage of sandy and porous areas is somewhat greater.

A description of the soils of a cross section from near the center of this north and south belt in Massachusetts follows: From East Leverett to within 1½ miles of Shutesbury the soils are extremely poor, being thin and sandy with some gravelly and leachy areas. Some of this material would have to be mapped as stony sand, the grades of sand being rather coarse. Formerly attempts were made to farm this section more or less, but the lack of adaptation of these soils to the production of the general farm crops which were tried necessitated their abandonment for that purpose. East of this belt, beginning about 1½ miles west of Shutesbury and including all of Shutesbury Hill from 1½ miles north of the center to 1½ miles southwest of the town much of the land should be farmed. Some of the soils of this district are heavy loams, with subsoils usually a little lighter than the surface soil. These can be classed as rather moist soils and are well adapted to hay as a money crop. On soils not quite so heavy, such as light loams and heavy fine sandy loams, a good corn crop was grown in the season of 1911; in fact, it compared well with the crop secured in the Connecticut Valley the same season. The lighter soils give good yields of potatoes, and this is grown as a money crop. The sandy loam types of the region are good for peaches, and with the light loams are hardly to be surpassed for the production of such varieties of red apples as are grown successfully in this part of the State. Such lands can be bought, without buildings, for $3 to $10 an acre.

The type of present commercial development in the section of the Eastern Highlands around Fitchburg is shown by the illustration, Plate I.

To the east of this belt there is a steep scarp to the west branch of Swift River along which there is another narrow belt of poor sandy soils. These, in turn, are succeeded by the more productive loams of Prescott Hill, already described.

THE CONNECTICUT VALLEY OF MASSACHUSETTS AND CONNECTICUT.

Walled in by the abrupt or broken slopes of the Eastern Highland

and the Western Highland, the productive and populous Connecticut River Valley is one of the most striking topographic features of Massachusetts and northern Connecticut. Approximately 2 miles in width in the northern part of Massachusetts, the valley broadens greatly about 2 miles south of Northfield Farms, where the river turns at a right angle and flows westerly toward Greenfield. There the valley is nearly 8 miles wide. Turning southward again, the river passes between Pocumtuck Mountain and Mount Toby. Together these mountains occupy about half the width of the valley. At the southern end of Mount Toby the valley steadily widens on the east side until it is crossed abruptly by a trap dike, the Mount Holyoke Range, which attains a height of 954 feet in the center of the valley at Mount Holyoke. Cutting through the range transversely the river pursues its way down through the central part of the main valley, leaving the southern extension of the Holyoke Range to the west. The latter turns directly south from Mount Tom, which is opposite Mount Holyoke, and, decreasing in height, forms a low divide far into the State of Connecticut. To the west of this divide is the valley of the Westfield and Farmington Rivers. The main valley continues about the same width to Hartford, below which it becomes narrower, is in part closed in, or is filled with dikes, and soon ends where the river breaks into the Eastern Highlands. Topographically it is succeeded by the New Haven Valley, which extends to Long Island Sound.

The alluvial and terrace soils of the Connecticut Valley are water sediments which have been deposited in currents of varying velocity. Near the present river the first terraces are most always silty, and silt soils extend for some distance up the immediate borders of the contributory streams. With increasing distance from the river, higher terraces were laid down when the stream was much wider than at present. These terraces consist largely of fine sandy loams, fine sands, and fewer loams. With increasing distance from the river the sediments become coarser until at the adjoining foothills coarse sands and fine gravelly sands prevail. The regular sequence of materials from fine to coarse has been often changed by the deposition of secondary valley streams.

The adaptation of the Connecticut Valley soils to onions and tobacco precludes their general use for orchard purposes. The tree fruits, furthermore, can be grown better on the hills, where land is comparatively cheap.

Viewed as a broad topographic and geologic division, the Connecticut Valley Basin includes not only the valley proper, but all the above-mentioned mountains within it and the foothills adjoining the valley on both sides as far back as the red and yellow sandstone and shale formations extend. On these elevations are found the soils of importance for fruit growing, as far as the Connecticut Valley Basin is concerned. Some of the prominent locations are the eastern side of Pocumtuck Mountain in Deerfield, Taylor Hill in the town of Montague, parts of the Mount Pisgah district in Gill, Mount Warner in Hadley, and some of the lower slopes and elevations of the Holyoke Range. In Connecticut sites just as favorable occur along the Talcott and Higby-Beseck Ranges, and the many smaller elevations.

The soils of these elevations, and also those of the Westfield-Farmington Valley Basin, have been derived from the glaciated residuum of the Triassic red sandstone and pinkish conglomerates. They are grouped as the Wethersfield, the Middlefield, and the Talcott series in the order of their extent. As some of these soils have been more extensively developed for peach growing than those of the other series the most important soil types are here described in detail.

In Massachusetts the most common type in the Wethersfield series is the sandy loam, but the loam is also of importance. The surface of the former consists of gray, salmon, or pinkish-gray sandy loam or loamy sand from 6 to 10 inches deep. The subsoil is variable, ranging from a sandy loam to a silty loam. The latter usually contains enough medium or coarse sand to make it somewhat gritty, the grains of sand being sharply contrasted in color with the heavier red matrix soil materials.

The Wethersfield loam consists of red silty loam to an average depth of 8 inches. It usually contains enough medium sand to be somewhat gritty. The subsoil is a gritty loam or sandy clay loam. In Massachusetts most of the series is somewhat stony, and a good bit of it is very much so. In Connecticut this series is much better developed. The average texture is heavier, the silty loam occurring in extensive areas, and a much smaller percentage is stony. Thus the average productiveness is much greater in Connecticut than in Massachusetts.

The Wethersfield soils are normally a little less productive than the Gloucester series. This difference is greater, however, in Massachusetts than in Connecticut. Not only is the forest growth lighter, but the percentage of soft-wood varieties is greater. Grasses do not hold as long either in meadow or in pasture, and it is generally considered that tilled crops require a little higher fertilization. The soils are well drained and crops mature a little earlier than on the Gloucester soils. The sandy loam is a favorite soil locally for early potatoes. In Massachusetts peaches have been grown successfully in some instances, and there is a good opportunity for the extension of the industry, as the soil is well adapted to their production, and the areas have good local markets.

In the Middlefield series the range of types is about the same as in the Wethersfield series, so separate description is not given. It is a companion series to the Wethersfield, from which it is separated primarily on the basis of color, though there is some variation in the productiveness and adaptedness when some of the corresponding soil types are compared. These soils are of much less importance in Massachusetts than in Connecticut, where they support good orchards, and their adaptedness is closely comparable to the Wethersfield series, the difference being of type rather than of series.

In the Talcott series a silty loam and a silt loam are the predominating types, but in them the presence of small ironstone fragments makes the friability of the soil mass greater than it would otherwise be.

A soil map of the valley and the hills immediately adjoining was published in 1903,[1] so the valley soils will not be described further in this report.

THE WESTERN HIGHLANDS OF MASSACHUSETTS AND CONNECTICUT.

From the Connecticut Valley the irregular surface of the western highland rises to the mountainlike crest of eastern Berkshire County for a distance of 20 to 30 miles. Across this easterly sloping plateau surface flows the Deerfield River in northern Massachusetts, the Westfield River in southern Massachusetts, and the Farmington River in northern Connecticut. All these are tributary to the Connecticut River. When the drainage of the western plateau becomes southerly the waters are carried chiefly in the Housatonic River and its important branch, the Naugatuck, though the Saugatuck River is also of importance. These rivers with their numerous tributaries have cut deep courses with fall sufficient in most cases to give rapid currents. Deep gorges are local characteristics, but the streams are usually swift even in the more prevalent open country. Between the stream cuts there are considerable areas of relatively smooth land, with medium-textured Gloucester soils.

Following the drainage basin of the Deerfield River westward from its junction with the Connecticut, the valley is dissected only to moderate depth in the towns of Shelburne, Conway, and West Deerfield, the adjoining irregular hills including much farming land, of which some is excellent.

In Charlemont, Buckland, Hawley, Florida, and Rowe dissection is much deeper, and with approach to the Hoosac Tunnel it is steep

[1] Soil Survey of the Connecticut Valley, Field Operations, Bureau of Soils, 1903.

SECTION OF ROW ON RIGHT IN PLATE IV.

[These trees are 96 years old and in 1910 yielded 100 barrels from 26 trees. Soil is the Essex loam. Compare individual trees in Pl. XX.]

FIG. 1.—WILD APPLE THICKET IN FOREGROUND, IN A LEYDEN PASTURE, BEING THINNED FOR GRAFTING. COLERAINE DISTRICT.

FIG. 2.—A DETAILED VIEW OF FIGURE 1.

[Taken after the grafting had been begun.]

or even precipitous. The valley of the Deerfield is not very wide after it enters the western highland, but in many places narrow bands of alluvial or high-terrace soils are well farmed.

On both sides of the Deerfield Valley, extending back for many miles, are hill towns with considerable areas of smooth land. Some of these already have good agricultural records for their output of farm stock and orchard products, and others seem worthy of further development. Even the best developed of these towns have made little more than a beginning, however, on the upbuilding of their opportunities. Of this broad section of good agricultural soils no general boundaries may be drawn, though the following-named towns are representative of the belt: Shelburne, Coleraine, Leyden, Heath, Charlemont, Buckland, Conway, Ashfield, Cummington, Worthington, and part of Plainfield.

It seems probable that the small amount of lime entering into the composition of some of the rocks from which the Gloucester soils of this section have been derived is partly responsible for their productiveness, which is apparently a little greater than that of the Gloucester soils of the Eastern Highlands, where lime does not seem to be present in the rocks. This comparison applies just as well to Vermont (the State where the mountains are green) and to New Hampshire (the State where the mountains are white), the latter corresponding to the Eastern Highlands and the former to the Western Highlands.

Three general soil types cover the principal areas of the best farm lands of this district. Of these, the Gloucester loam, a brown, mellow, medium loam, with subsoil of yellow or light-brown loam or light clay loam, is especially noticeable. This soil is naturally well adapted to the production of corn and clover, and when well handled gives excellent returns with these crops. A companion type, the Bernardston loam, consists of a very heavy loam, which is somewhat moist, and of grayish-brown or grayish-black color. The subsoil is gray or grayish. This is the best timothy soil of the region, and on it pasture grasses hold for a long time. As much of the type would be improved by artificial drainage, however, it will be recognized that this soil is not as well adapted to the clovers as the preceding type. In its present condition a good deal of this kind of soil needs lime. The third type, which is representative of the lighter soil areas, consists of a fine sandy loam, with a subsoil of loam, fine sandy loam, or sandy loam. Its area is much less than that of the two preceding types. All of these soils contain stony areas, some being so stony as to interfere with tillage, or at least to increase its expense.

Interspersed with the prevailing soil conditions described are many local areas of rougher topography. These include slopes to stream courses as above mentioned and also scattering sharp hills and ridges, from which slow, yet long-continued, erosion has removed considerable parts of the soil mantle. Most areas of this sort are stony, while some of them are very much so, and ledges often protrude. Along the latter the depth of the soil is far from uniform, as the tilt of the ledge plain varies all the way from nearly horizontal to perpendicular.

As "Apple Valley," in the towns of Ashfield and Buckland, has earned a somewhat noted and well-deserved reputation for its orchards, the character of its soils are of special interest. The soils range from light loams to heavy loams and clay loams, the textures of the subsoils being similar in range. The soils are all derived from deep glacial till. Some fields are comparatively free from stones and others are very stony, but most of the valley is moderately stony. The soils are productive, but the men of the section must be given credit for having used them skillfully. Soils as good for orcharding and farming occur in various places in the hill towns of western Franklin and western Hampshire counties that should be equally developed.

Orchard and farm lands can be bought in the Western Highland section of Massachusetts for $10 to $30 an acre, and on tracts of 100 acres or more very good farm buildings are often included at the latter price. Farms of 100 to 150 acres with good buildings are to be had for $5,000. These prices can be duplicated in western Connecticut, except where the purchase of farms by outside residents has led to a marked increase in prices. This applies more especially to the southwestern part of the State.

In the southeastern part of the Western Highlands in Massachusetts and in the northeastern part in Connecticut dissection has been very deep, especially in the towns of Russell, Blandford, Montgomery, Chester, and Huntington, where the slopes above the channel of the Westfield River are exceedingly steep, broken, and rocky, and in those towns of Connecticut along the break in the highlands toward the Connecticut and Farmington Valleys. Local areas are sometimes too rough even for feasible forestry planting, yet here and there are smooth, rounded hills or moderate slopes of sufficient area to afford good sites for orchards and other crops. The soils of one large tract examined in western Hampden County included loams—heavy, medium, and light—the subsoils rarely being as heavy as clay loams. Traces of hardpan sometimes occur, but suitable areas free from this difficulty are readily found. Spouty and seepy slopes, which are sometimes encompassed in desirable fields, it is practicable to drain artificially.

That part of Hampshire County between the Connecticut Valley and the upper Westfield River Basin is much less deeply dissected than the section traversed by the latter river, though withal it is hilly. The soils include a much larger percentage of sandy types than the Coleraine-Cummington region, but there are many good farming areas. Between Cummington and Northampton the loamy soils of the former town extend approximately to Swift River, east of which the soils are more sandy nearly to Williamsburg, and farming is less developed. A mile or two west of Williamsburg begins another strip of loamy and more productive soils, which extend to west Whately, southeastern Conway, and on to Patterson Four Corners. The road from Whately village north to Whately Glen indicates the eastern limits of this area.

In the Western Highlands of Connecticut, especially west of the gorge of the Naugatuck River, where dissection and erosion have been more kind than farther east, there are many good farming towns, especially in Litchfield County. Not all localities were examined in detail, hence various good towns were doubtless missed, but among those seen may be mentioned Canaan, Cornwall, Litchfield, Washington, Woodbury, Western Watertown, and Southbury in New Haven County, and Newtown, Redding, and Ridgefield in Fairfield County.

Passing northward to the foot of the Hoosic Range in northwestern Massachusetts, the soils up the eastern slope are much more sandy than those of the lower highlands. Going through the tunnel of the Boston & Maine Railway, in Hoosic Mountain, one approaches North Adams, which is located near the center of the Hoosac Valley. There the North Branch, flowing from Vermont, joins the Hoosac River as it comes from Berkshire County and flowing westward through the defile between the southern end of the Green Mountains on the north and Graylock on the south, passes out of the northwest corner of the State. The valley of the Hoosac is flanked on the south in the town of Williamstown by a secondary rolling valley, in which are many good farms.

The greater part of the Hoosac Valley is occupied mainly by old glacial terraces, of which the soils include many areas of loam, but there are also many sandy and gravelly knolls and ridges. In the North Branch Valley in the town of Clarksburg the soils are very stony or even rocky, and their nearness to the good markets of North Adams accounts for the relatively high price of land—said to be $50 to $100 an acre, where within a radius of 4 to 5 miles from the town.

The soils of the Williamstown Valley average somewhat heavier. There are many areas of loam and clay loam, though sandy and gravelly knolls and low hills frequently occur. Good dairy farms are to be seen, the milk in excess of the local demand being shipped to Boston. Both Williamstown and North Adams are good local markets for considerable amounts of milk, cream, some butter, and much garden produce. There are few orchards, though good orchard soils occur on some of the local elevations.

The Upper Hoosac Valley towards Cheshire is narrow, being in places little more than a defile between Mount Graylock and the Hoosic Range. This is a general farming district. The valley closes in on the south with the low hills forming the divide between it and the Housatonic Valley. At Lanesboro the latter broadens and occupies nearly the whole of Pittsfield Town. It then divides, one arm extending south through the towns of Lenox and Stockbridge and the other arm southward through the town of Richmond to West Stockbridge. From the latter town to Housatonic village, mountains nearly close the valley, the spaces between them being occupied by narrow stream beds.

A few miles south of Great Barrington the valley is again nearly 5 miles broad, and thence it extends south to the Connecticut line, including a large part of the towns of Egremont and Sheffield in Massachusetts and of North Canaan, Eastern Salisbury, and Western Sharon, in Connecticut. The valley floor near the Connecticut line is about 700 feet, and at Pittsfield, Mass., about 1,000 feet above sea level. The Berkshire Valley is underlain by limestone and although the surface soils are glacial deposits, sufficient limestone débris has entered into their composition to render them somewhat more productive than they would otherwise be. They constitute the Dover series, and vary greatly. Areas of well-drained loams and some light clay loams are interspersed with more sandy soils. Some of the latter are susceptible to drought and general crops are not considered very safe, but the heavier soils are sufficiently retentive of moisture to constitute excellent grass lands. In some cases, to an extent, the soils are cold owing to inadequate drainage, and the crop yields are correspondingly low. Artificial drainage would pay on some of these fields and will undoubtedly be installed in due time.

The valley walls are generally steep, though here and there smoother areas open back into the adjoining hills. The hill region east of the valley includes many good farming localities, but generally speaking it is capable of much higher development. From Pittsfield south the valley is walled in on the west by abrupt hills which occupy the northwestern part of the town of Salisbury, Conn., and the towns of Hancock and Mount Washington in the southwest corner of Massachusetts, but farther north they pass out of Massachusetts and for some distance extend along the New York boundary, leaving room for a considerable area of good agricultural land in the town of Egremont. A representative sample of these good soils consists of dark-brown to dark grayish-brown medium to heavy loam to a depth of 9 inches. The subsoil consists of heavy light-brown or grayish-brown loam. These soils are mellow, deep, friable, and productive.

Land prices in the Berkshire Valley vary greatly, the highest prices current being due to causes outside of agricultural development. The attractiveness of the region has led to the establishment of many summer homes by wealthy urban dwellers, and a few remain throughout the year. The greater part of such transfer of real estate is congregated in a few towns (townships), and has greatly increased land values in the district immediately surrounding, but aside from such centers land prices are still very low.

Several points of soil condition favorable to orcharding in Massachusetts and Connecticut have been mentioned. These are: An abundance of deep, friable, well-drained, well-oxidized and sufficiently productive soils; the low price of such soils; and the nearness to the best of markets. Such soil areas are most frequent in the Western Highlands, the Eastern Plateau, and the Eastern Highlands. Several disadvantages should also be mentioned. Many of the upland soils are more or less stony, and in some cases rocky lands are frequently divided into fields too small for economic working and surrounded by stone walls, the removal of which involves some expense, and some districts are handicapped by their distance from railway shipping points. The minor lowland areas, outside of the Connecticut and Merrimac Valleys, often consist of sandy glacial terrace débris that is more seriously affected by drought than the upland soils, and normally less productive.

ORCHARDING; GENERAL CONDITIONS IN THE FUTURE.

An analysis of the agricultural resources of Massachusetts, including the soils, and the availability of excellent markets can hardly fail to lead to the conviction that a great deal of good land now bringing little return must eventually support very profitable lines of farming. The tendency of the last quarter century to leave farm-homes somewhat distant from towns and social advantages, notwithstanding the excellent opportunities for money-making which such farms might possess, has been notable and marks a definite stage in the agricultural history of the region. The still better advised return to such of these lands as possess good possibilities is sure to come, for they hold good opportunities for those able to take advantage of them. But the higher development of these lands will be shaped according to their adaptation to produce crops and products under existing economic conditions, and to meet the demands of, and to take advantage of, the markets near at hand. Experience has already shown the futility of trying to compete with the Middle West in farm products for which the soil and field conditions of the latter are superior. Hence New England farmers should welcome such competition instead of regretting it, and meanwhile bend their energies to producing and marketing the higher forms of products for which their location gives them an advantage over any possible competitors. The normal increase of the population of the United States is sure to effect this development eventually, because the increasing price of foodstuffs will make it necessary to use the many kinds of soils for those crops only to which they are best, or at least reasonably well, adapted. In the following chapter the development of orchards on suitable soils, and the kinds of soil on which several of the different varieties of apples, peaches, and pears may be expected to give the best, or at least good, results is treated in some detail.

In regard to the relative importance of the personal factor of the orchardist himself, as compared with that of the adaptation of the soil, it may be said that a man who strongly likes to grow apples may grow very good ones in spite of adverse soil conditions, because he makes all other conditions of growth favorable. Similarly he who does not care for orcharding may not produce good apples, even though his soil be excellent, because he is not imbued with the interest in the subject which makes for success. Yet he who enjoys orcharding is most successful when the soil factor, as well as the other factors necessary for success, receives due consideration, and only those varieties are planted on any given soil which that soil is best adapted to produce.

A "stony" loam is often recommended as a desirable fruit soil. In fact it is one of the assertions most commonly heard in this connection. Many growers think there is virtue in stones for increasing or enhancing the value of a given soil for apple production. If a soil is too heavy (clayey) or too impervious it is made more pervious by stones, but in this case their effect is only that of an antidote to soil conditions otherwise undesirable. It is an easy matter, furthermore, to select soils free from stones, or practically so, that are equally pervious and desirable or even more so, and such soils would have an additional virtue in that they could be cultivated more cheaply. Any benefit from the disintegration and decomposition of the stones during the lifetime of an individual is certainly negligible. Hence, while stones may be advantageous in loosening a clay soil somewhat, just as they are disadvantageous to a porous sandy soil by lowering its moisture-holding capacity, they should not be considered, except as above indicated, a desirable attribute of soils to be planted in orchard. Much of the current belief that "stony" soils possess some peculiar advantage in their adaptability to orchard fruits has undoubtedly arisen from the success of many orchards located on stony hills. The facts that the soils were in a large number of cases friable, deep, and at least fairly productive, and that air drainage was excellent have apparently made less impression on the mind than has the stony appearance of the surface.

The fact that a soil is stony does not necessarily imply that it is productive, even though friable and deep. But if apples are to be grown with profit when competition is keen, as it is periodically certain to be, the soil must be productive, or at least capable of being economically brought to a productive state and so maintained. To this point too little attention has been given.

As to the adaptability of well-selected soils, the price of land, and good markets the opportunities for successful orcharding in southern New England are exceptionally good. To certain features of the business, however, attention should be called.

In the current rapid expansion of orchard acreage there is a strong tendency to reduce every project to a strictly commercial basis of large proportions. Hundred-acre orchards no longer cause surprise, as various individuals and companies operate several times this acreage, and many more very large projects have been begun. On undertakings of such magnitude is the cry of future overproduction chiefly based. There is no denying the probability that the average wholesale markets of the future will be materially affected by fruit from these extensive plantings. But the economic efficiency attained in the individual development of these orchards, and the grade of fruit marketed will be very important factors in determining the financial outcome.

The history of orcharding has shown, moreover, that extensive planting is spasmodic. High prices lead to such an increase of planting that prices are eventually forced down whenever a large percentage of localities in the whole country happen to bear a full crop because of favorable seasonal conditions. The high prices and extensive plantings of the last several years make it seem very probable that the crest of such a wave may be approaching, and that prices ere long will be lower. When such condition arrives the survival of the fittest is the universal law that applies. It is at this point that the importance of selection of orchard site, soil, and location with reference to markets or shipping facilities becomes most apparent. Adequate care after planting must be given in all cases, but it alone is not sufficient where competition becomes acute. Cheapness in production of fruit demanded by extensive markets determines the value of most orchard projects, and orchards that are deficient in these various attributes are soonest forced out of business. This is not taken to mean, however, that profitable orcharding may not be carried on by the general farmer when carefully done. The old time orchard must go, however, or be rejuvenated and given consistent care if it is to serve any purpose very useful in the economy of the farm. It must be admitted also that there are certain objections to the extremely large orchard. Many of the tender-fleshed and thin-skinned varieties which the best retail markets desire are not amenable to ordinary methods of handling. Skilled help can undoubtedly be secured in many cases, but it is exceedingly difficult through all the processes of care and attention to give all the orchard and all the fruit the personal attention which enables the individual grower of, say, 10 to 20 acres to secure the highest prices of special markets or of retail trade.

Another excellent opportunity of the present time is to bring the old orchards into good bearing condition as soon as possible. In this way a few very profitable crops may be secured before the larger orchards of recent and present plantings bear much fruit.

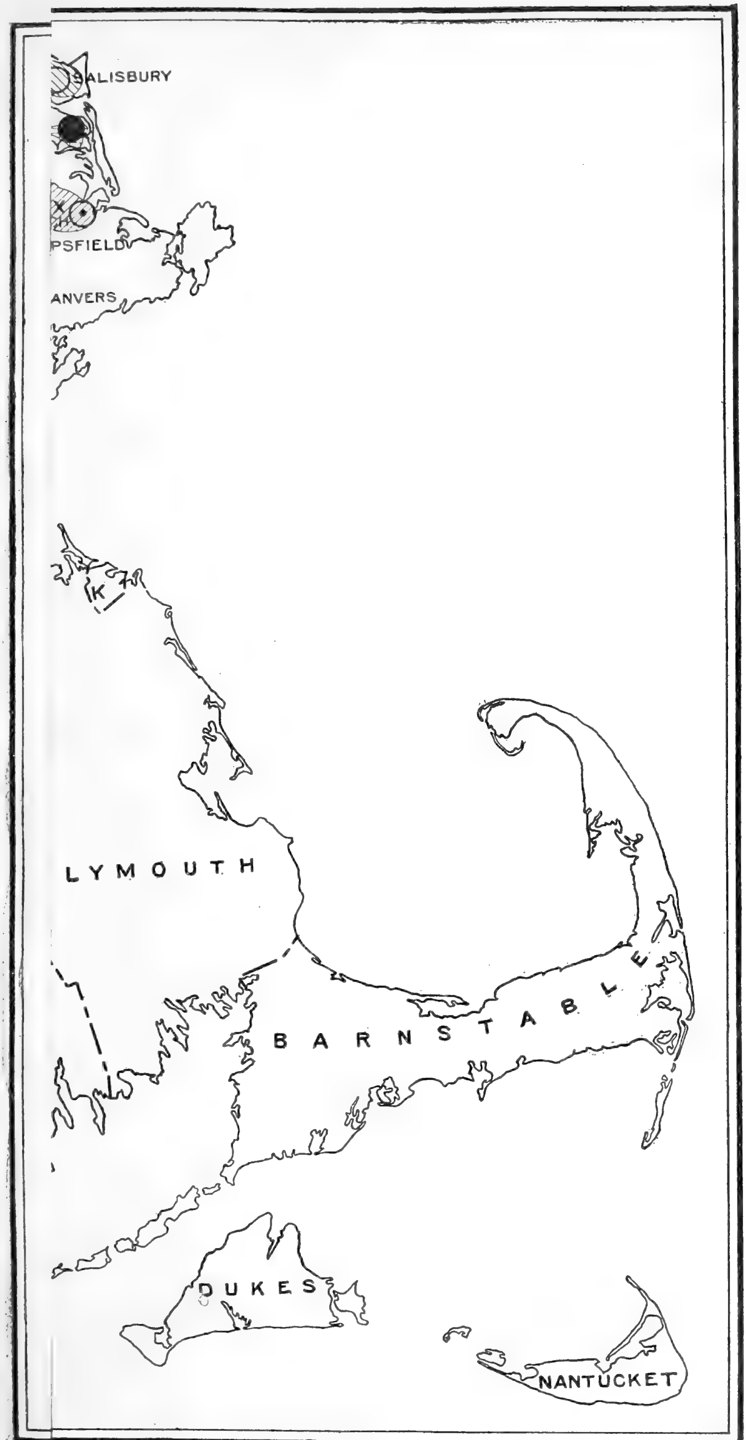
The diagram, figure 2, based upon estimates prepared by the State board of agriculture, so far as production is concerned, shows the relative importance of different parts of the State as apple-growing sections. In many of these towns important plantings have been made since the preparation of these estimates. Similar interest and activity in towns not included in these lists will bring them also above the 10,000-bushel minimum not many years hence. In the diagram (Fig. 2) the approximate location of these townships is represented by symbols. Surrounding areas—not townships—of relative but not necessarily equal production are indicated by a system of lines.

CULTURAL METHODS IN ORCHARDS.

It is not the purpose of this report to discuss orchard cultural methods beyond calling attention to prevailing practices.

The profitable peach orchards are almost always cultivated, and those most profitable are cultivated assiduously until midsummer, when an annual cover crop is grown. The crops used for this purpose are many—rye, buckwheat, rape, cow-horn turnips, crimson, red and alsike clovers, winter vetch, etc., being in common use. Rutabaga seed is often thickly broadcasted, the best roots being sold and the remainder left as a cover crop.

The best of the commercial apple orchards are also cultivated to midsummer and then laid by with some of the cover crops named above. The sod-mulch system is also practiced to some extent and gives very good results where the plan is consistently and thoroughly carried out. The most common difficulty with this method is the failure to apply sufficient mulch to prevent the growth of any grass or weeds within a circle which should extend for a few feet beyond


SALISBURY
PSFIELD
ANVERS
K
LYMOUTH
BARNSTABLE
DUKES
NANTUCKET

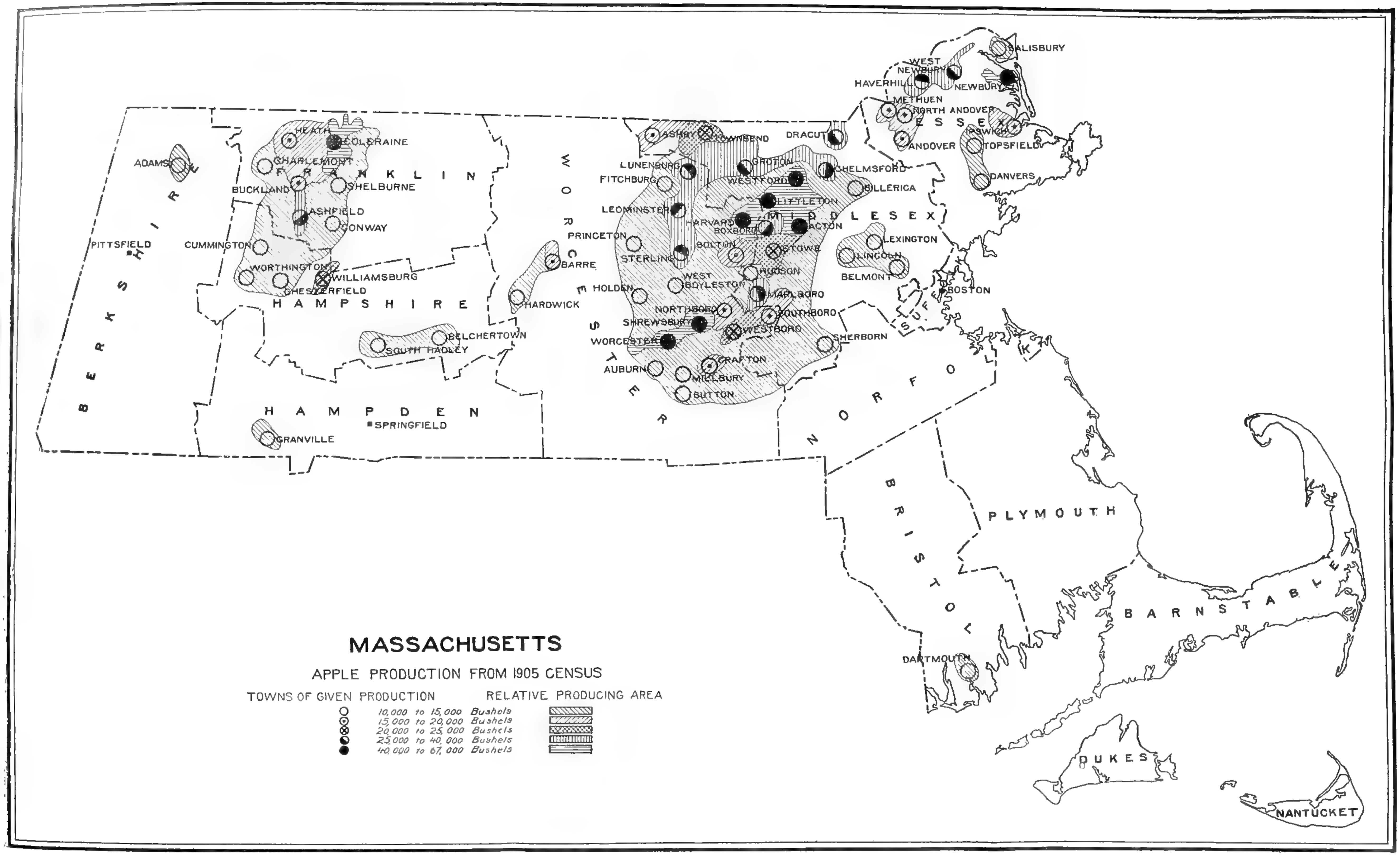


Fig. 2.—Relative importance of the apple-producing towns of Massachusetts.

the perimeter of the branches. In fact, the growth of grass just beyond the tips of the branches of a tree a few years old, or older, is far more serious than if near the trunk, where no feeding roots occur. Only by such thoroughness can mulching conserve even approximately as much moisture for the tree's use as thorough cultivation affords. Plate II, figure 1, shows a fairly good mulching, but even it should be a little heavier. Plate II, figure 2, shows there is at least one man who can remove peach fillers in time.

It must be admitted, however, that a large part of the aggregate number of apple trees in both Massachusetts and Connecticut regularly receive neither cultivation nor mulch. Of this great number of small orchards and miscellaneous trees some receive more or less cultivation when other crops are grown in the field where the trees happen to be, and in some cases the welfare of the trees is an important consideration, but more frequently it is purely accidental. Where the ground is well manured under the system of cropping followed—usually corn, oats, and grass in a 5-year rotation—very satisfactory results are secured. (See Pl. III.) A single row of apple trees along the fence or wall around fields (Pls. IV and V) is characteristic of many sections of both States, and from such trees very large quantities of fruit are produced, the aggregate being much larger in Massachusetts than in Connecticut. Many of the roadside trees were seedlings from which surrounding brush was cut away when the grafting was done. Often the grafting is not done until the seedlings are so large the scions are set in the limbs instead of in the trunk, with the result that the trees are usually headed 5 to 6 feet from the ground. The Baldwin is the variety almost universally used for this purpose. Most of the pasture trees were grown in the same way, though some are grouped around the cellar holes of former small farmsteads in the hills that do not now constitute economic farm units and so have been thrown into pasture. (See Pl. VI.)

There are thousands upon thousands of seedling trees in these States, with more annually springing up, that have not been propagated to improved varieties, although this is still a common practice in some sections, particularly in the Western Highlands. A large number of trees also occur in pastures where no cultivation or mulching is given. In this case the very close grazing of the grass by animals makes evaporation somewhat less than where hay is cut, and results are better than the careful orchardist would expect, but the method is to be recommended only where better methods are impracticable. This phase of orcharding also is somewhat more extensive in Massachusetts than in Connecticut. When results so good are obtained under such methods, the opportunities for the higher profits better care would bring are noteworthy. While similar roadside planting of trees is found in some of the noncommercial sections of New York, the custom is not so general there, nor are the results as a rule so satisfactory. In the heavy producing sections of New York large commercial plantings are the prominent feature, and the secondary plantings are of little importance.

The leading orchardists in southern New England use an annual application of commercial fertilizers in connection with a cover crop, or as a supplement to stable manure. Formerly mixed goods were used, but now many buy chemicals. There is much variation in the combination used. Basic slag is just now in popular favor and large quantities are used. Some acid phosphate is also used, but ground phosphate rock as a substitute is replacing it to some extent. Ground bone is preferred by some growers and tankage is in common use. The nitrates of soda or potash are employed as a source of ammonia when quick results are required. Potash is used in several forms—low-grade sulphate, high-grade sulphate, muriate, and kainit. The amounts used by different orchardists vary greatly and no attempt was made to cover the practice in a systematic way.

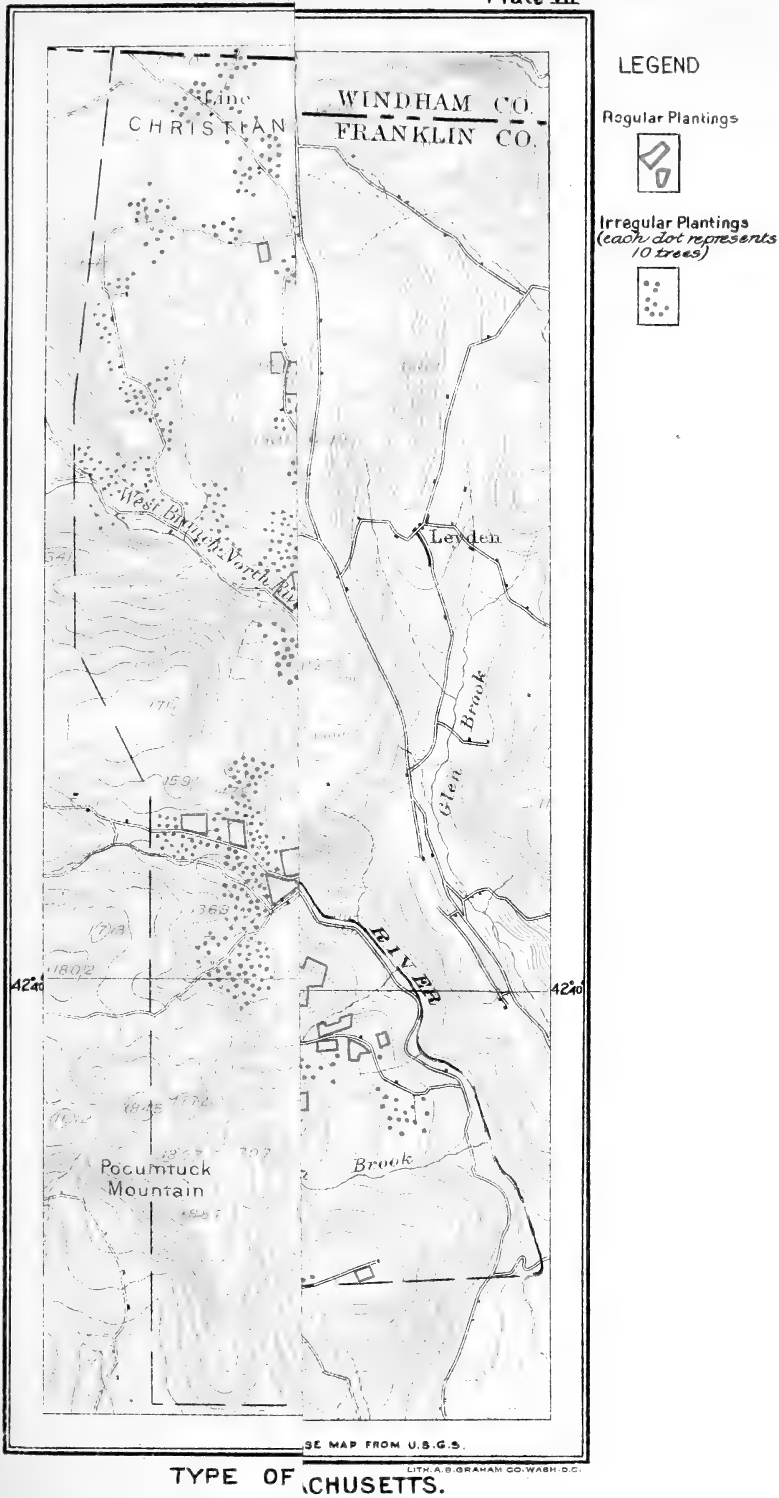
These different types of orchard distribution are brought out in Plates VII, VIII, and IX, which show the character of planting in Coleraine and Leominster, Mass., and in Parma, N. Y.

USUAL TYPE OF FARM-ORCHARD DEVELOPMENT IN MASSACHUSETTS AND IN WESTERN NEW YORK.

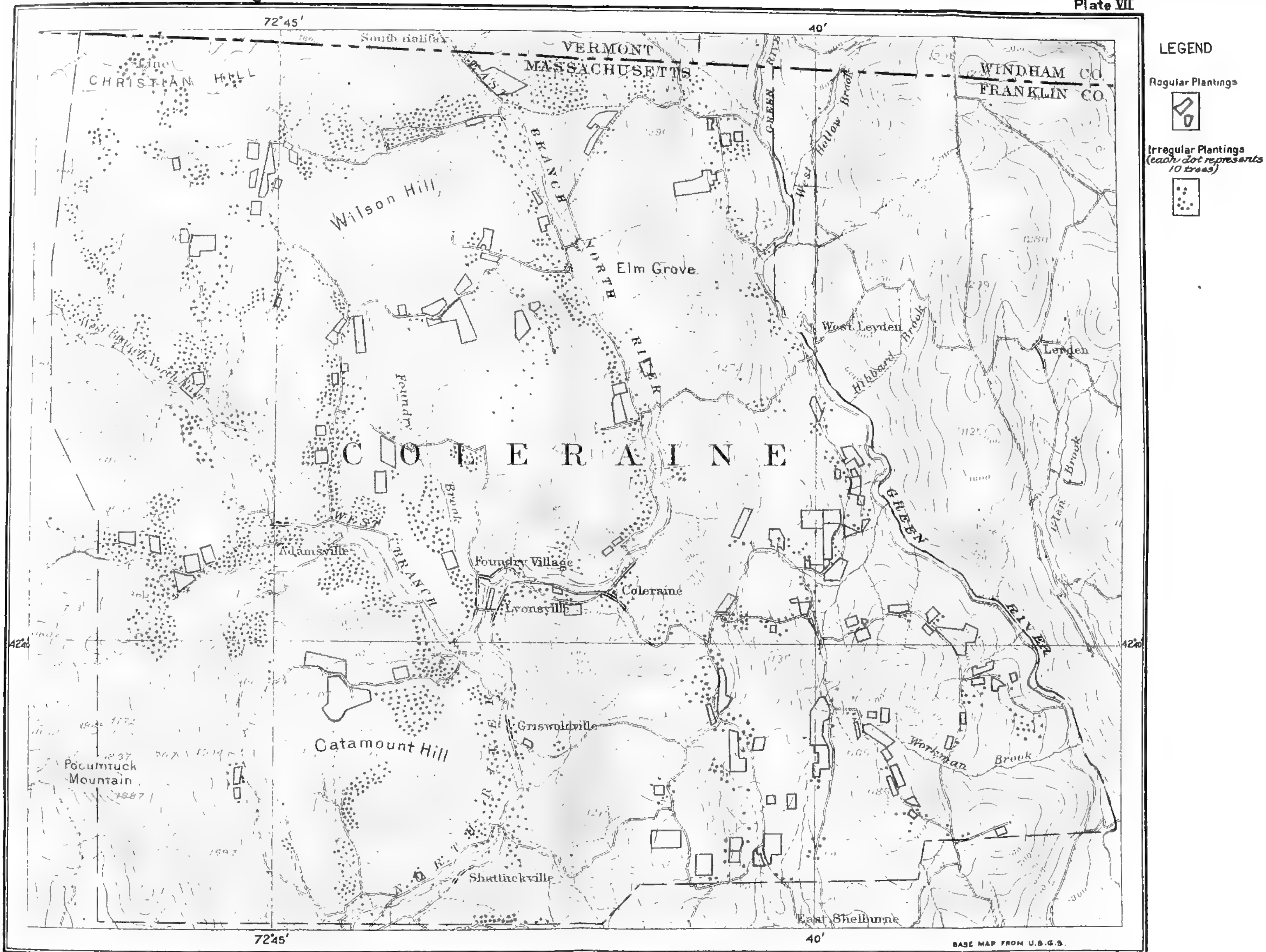
The character of orchard distribution in a town typical of central Massachusetts is shown in the map of Leominster. (Pl. VIII.) The western part of the town is so hilly and rough that there is little orcharding or farming. The rest of the town constitutes a good farming and fruit section. With general farming, some dairying, and a little trucking, apples are an important money crop in proportion to the land given over to orcharding, as appears in the census of production shown elsewhere, Leominster being in the group of towns that produce between 25,000 and 40,000 bushels of apples annually. There are no large commercial orchards, but there are a few of moderate size and many small ones.

On the sketch map the blocks of orchard are drawn to approximate scale and each dot represents 10 apple trees.

In parts of both States, but principally in Litchfield County, Conn., and that part of Massachusetts west of the Connecticut River, apples have long constituted an important money crop in conjunction with live-stock farming. Coleraine, Mass., is one of the



TYPE OF [...]CHUSETTS.



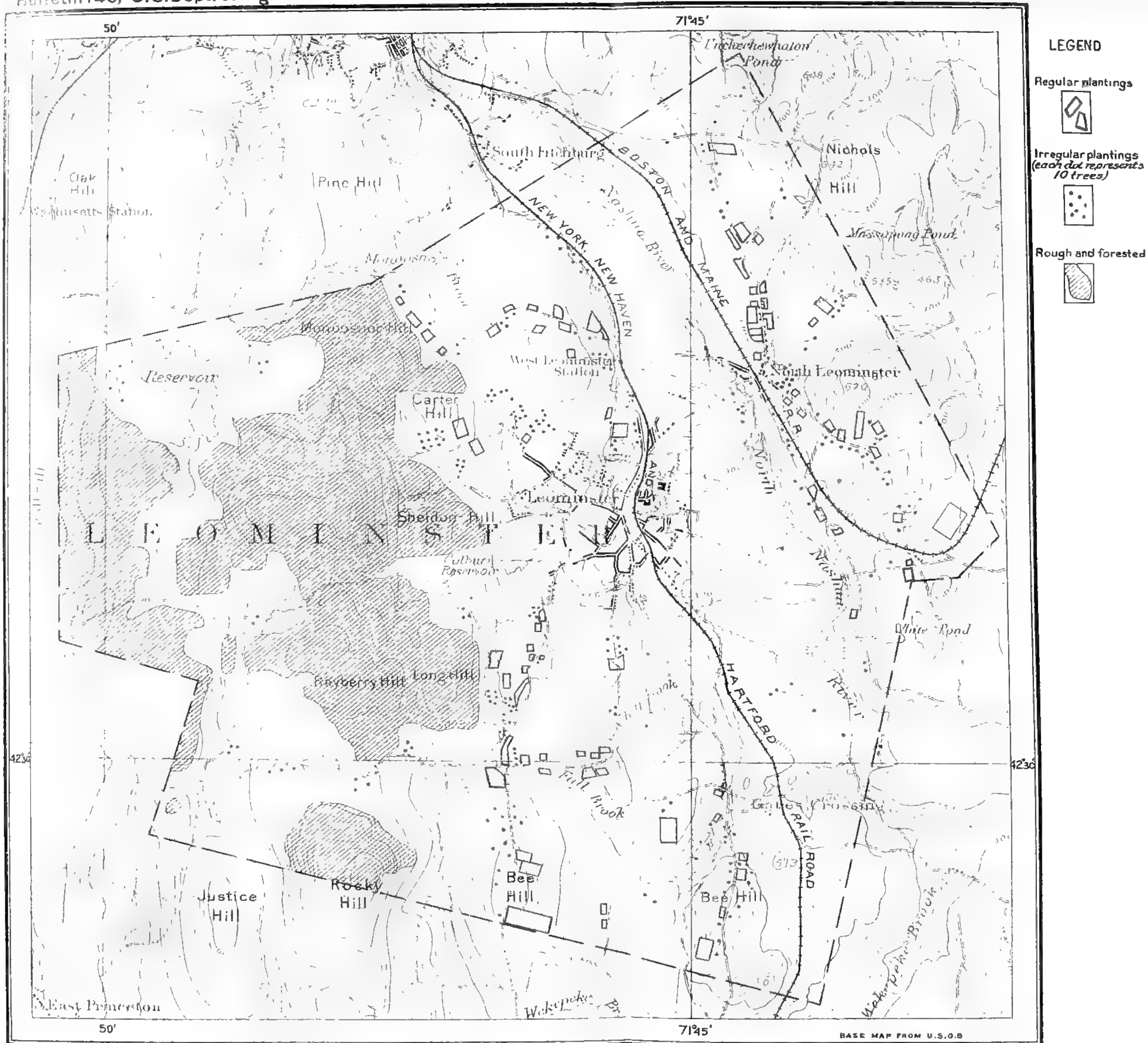
TYPE OF ORCHARD PLANTING FOR THE TOWN OF COLERAINE, FRANKLIN COUNTY, MASSACHUSETTS.

Scale $\frac{1}{62500}$

1 ½ 0 1 Miles

42

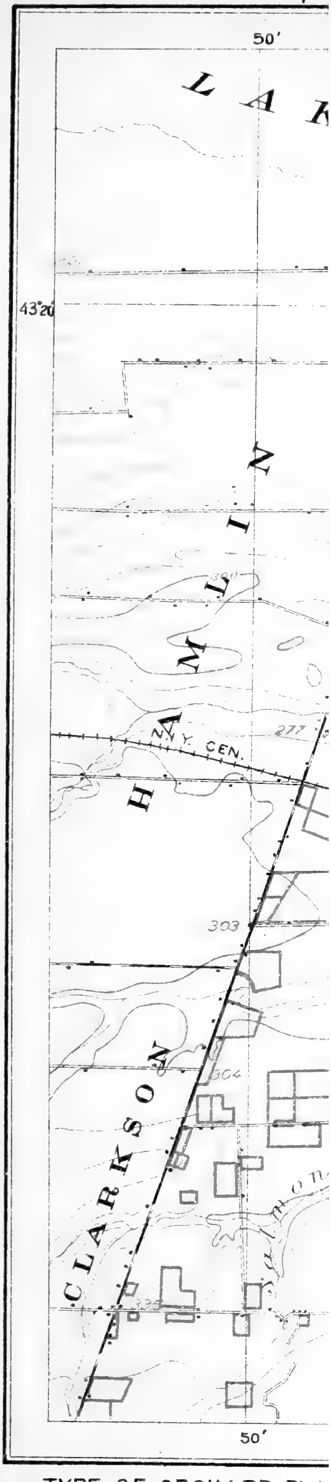
TY



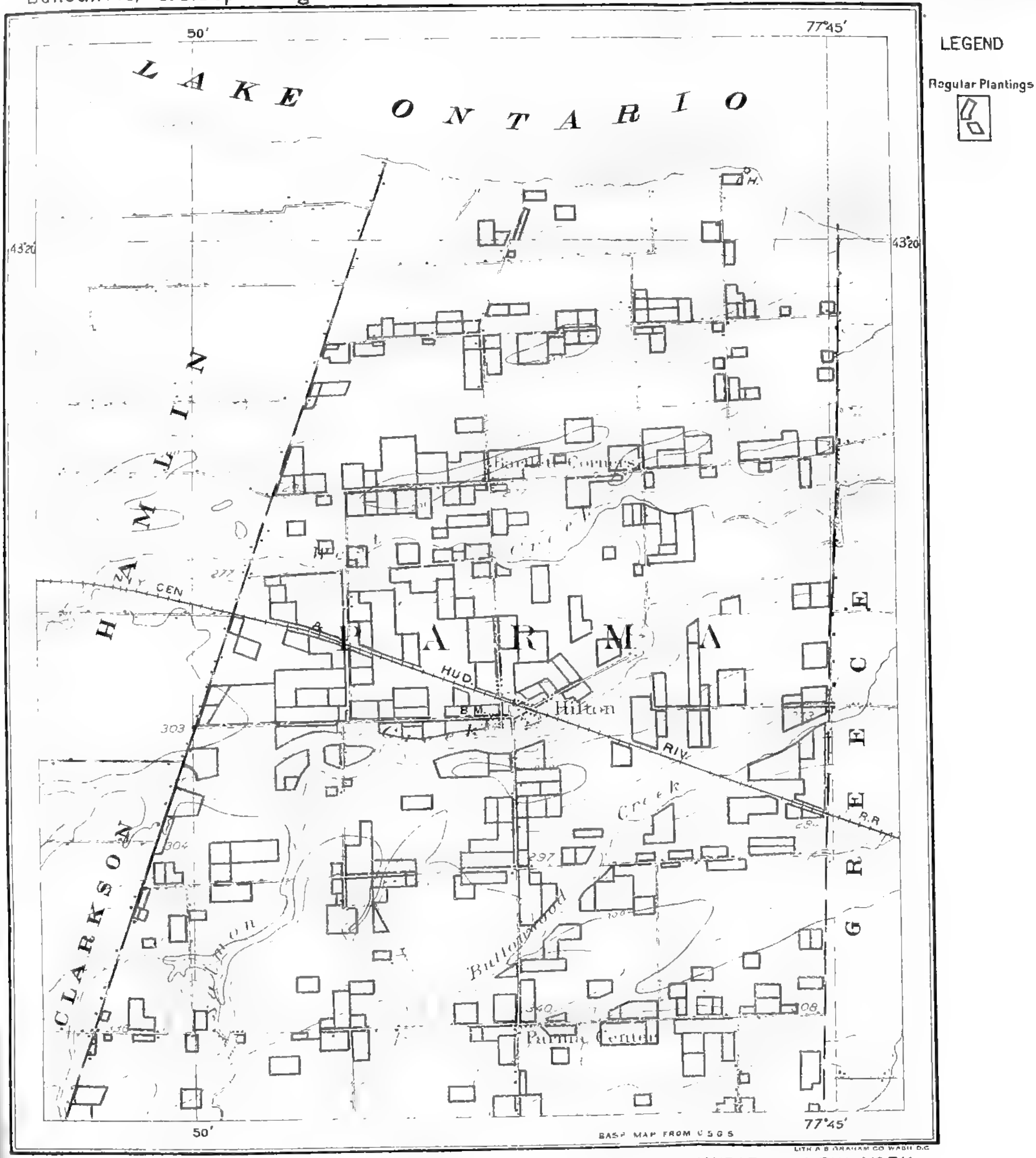
TYPE OF ORCHARD PLANTING FOR THE TOWN OF LEOMINSTER, WORCESTER COUNTY, MASSACHUSETTS.

Scale $\frac{1}{62500}$

1 ½ 0 1 Miles



TYPE OF ORCHARD PLA



TYPE OF ORCHARD PLANTING FOR PART OF THE TOWN OF PARMA, MONROE CO., NEW YORK.

Scale $\frac{1}{62500}$

1 ½ 0 1 Miles

prosperous towns of this class, and because of the intense development of this sort an orchard map was prepared to show conditions there. Definite blocks indicate for the most part trees grafted before they were planted or soon after, the trees being in regular rows. Orchards shown by dots have no regularity of arrangement. Of the trees the great majority have come up as seedlings where they now stand, and have been grafted as the owner could get to it or possibly hire some one to do it. A row of trees along a wall or fence surrounding tilled fields is a common feature, but probably more are located in pastures. Almost all grafting has been to Baldwin, no tree being considered too old for this purpose if in vigorous condition, though most of it is done before the trees are 20 years old. Five to ten years is considered a favorable time where the land is not to be grazed, as the scions can then be set high enough for teams to work underneath; but in pastures an older age is preferred so that cattle may graze without injuring the trees. Of so much importance are these irregular orchards that seedlings or nursery stock are not infrequently set in to fill any large gaps, thus by a little effort making a solid block of trees. This method of orcharding seems very strange to those unfamiliar with it; but the profits derived have been largely instrumental in the town's prosperity, and many Baldwins of exceptionally good quality are grown.

Countless thousands of seedling apple trees abound in Coleraine that are not yet grafted. Many farmers graft a few every spring as other work permits, or as outside grafters can be hired, but even so the number of trees is so great that many will never be grafted, notwithstanding the profit to be derived. It is doubtful if seedlings grow more profusely anywhere.

This system of orcharding, though unusual, is of much importance locally, and the profits derived are certain to lead to its steady development. From the ungrafted trees large quantities of cider are produced for vinegar, which constitutes no inconsiderable source of additional income.

RELATIVE PRODUCTION OF APPLES IN SOUTHERN NEW ENGLAND.

While it is often unsafe to draw definite conclusions as to the relative importance of fruit growing in different States, because of variations in weather conditions in any given year, age, and condition of trees, etc., such comparisons may nevertheless serve as a general index, and for this reason the figures below are taken from the United States census of 1910. It should be borne in mind that New York is by far the foremost State in the production of apples, having a greater yield than any other entire geographic group of States other than the one of which it forms a part; and in 1909 Michigan was the only other State exceeding Pennsylvania in the yield of this fruit.

Number of trees in orchards and production of orchard fruits in eight leading States for the years 1899 and 1909.

State.	Trees of bearing age.	Trees under bearing age.	Production.	
			1909	1899
			Bushels.	*Bushels.*
Massachusetts	1,698,220	591,796	2,763,679	3,158,781
Connecticut	1,369,515	604,296	1,874,242	3,839,105
New York	17,625,093	7,363,614	29,456,291	26,172,310
Pennsylvania	13,186,773	5,921,257	13,285,953	25,236,854
Michigan	12,842,827	6,679,949	15,220,104	9,859,862
Washington	4,944,889	6,951,251	4,244,670	1,180,357
Oregon	4,583,735	4,309,232	4,423,244	1,522,002
California	22,485,195	8,410,062	31,501,507	22,690,696

Number of trees in apple orchards, total production of apples in 1899 and 1909, and production per capita for the same years in selected States.

State.	Trees of bearing age.	Trees under bearing age.	Production.		Population, 1910.	Density of population per square mile, 1910.	Production per capita.	
			1909	1899			1909	1899
			Bushels.	*Bushels.*			*Bu.*	*Bu.*
Massachusetts	1,367,379	355,868	2,550,259	3,023,436	3,366,416	418	0.76	1.1
Connecticut	798,734	211,839	1,540,996	3,708,931	1,114,756	231	1.4	4
New York	11,248,203	2,828,515	25,409,324	24,111,257	9,113,614	191	2.8	3.3
New Jersey	1,053,626	519,749	1,406,778	4,640,896	2,537,167	337	0.5	2.4
Pennsylvania	8,000,456	2,501,185	11,048,430	24,060,651	7,665,111	171	1.7	3.8
Delaware	429,753	263,813	183,094	702,920	202,322	103	0.95	3.7
Georgia	1,878,209	822,327	895,613	670,889	2,609,121	44	0.34	0.3
Michigan	7,534,343	2,253,072	12,332,296	8,931,569	2,810,173	48.9	4.7	3.6
Illinois	9,900,627	2,548,301	3,093,321	9,178,150	5,638,591	100	0.55	1.9
Iowa	5,847,034	1,914,325	6,746,668	3,129,862	2,224,771	40	3	1.4
Washington	3,009,337	4,862,702	2,672,100	728,978	1,141,990	17.1	2.3	1.4
Oregon	2,029,913	2,240,636	1,930,926	873,980	672,765	7	2.8	2.1
California	2,482,762	1,054,107	4,935,073	3,488,208	2,377,549	15	2.6	2.3

Number of trees in peach orchards and production of this fruit in 1899 and 1909 in important States.

State.	Number of trees of bearing age.	Number under bearing age.	1909	1899
			Bushels.	*Bushels.*
Massachusetts	154,592	162,114	91,756	27,906
Connecticut	461,711	338,608	269,990	61,775
New York	2,457,187	2,216,907	1,736,483	466,850
New Jersey	1,216,476	1,363,632	441,440	620,928
Delaware	1,177,402	212,117	16,722	9,750
Pennsylvania	2,383,027	2,179,386	1,023,570	143,464
Michigan	2,907,170	2,991,090	1,686,586	339,637
Georgia	10,609,119	1,531,367	2,555,499	259,728
Washington	536,875	1,028,141	84,494	80,990
Oregon	273,162	508,179	179,030	101,190
California	7,829,011	4,409,562	267,118	8,563,427

Exports of apples from the United States at five principal eastern ports.

Port.	1912	1910
	Bushels.	*Bushels.*
Boston	437,611	170,013
New York	609,041	566,926
Philadelphia	649	39
Portland, Me.	158,717	67,748
Baltimore, Md	168	92

The States of Massachusetts, Connecticut, New York, New Jersey, and Pennsylvania include approximately one-fourth of the population of the United States, and it is apparent from the above figures that Massachusetts and Connecticut are very fortunate not only in home markets for fruits but also in facilities for exporting whenever prices at home make it advisable to ship apples out of the country. These States have, however, an unusually large proportion of non-agricultural population, and local markets are exceptionally good in that they are well distributed and consume a relatively large quantity of fruit for which remunerative prices are paid. This gives no small advantage over States that have to ship a much greater distance to these same markets, but in order to take full advantage of these excellent opportunities the grading and packing of fruit should be greatly improved. There are already sufficient exceptions to inferior grading and packing effectively to demonstrate the superior profit of better methods, and by them the general grower should be guided. The importance of the fruit industry in southern New England necessitates a better development of business methods in handling and marketing the crop, and there is already a very noticeable and commendable tendency to effect these ends.

RELATION OF SOIL CHARACTERS TO CROP AND VARIETAL ADAPTATION.

While the statement that "a given variety of apple, for the most successful growth within its general climatic region, requires a certain kind or condition of soil" seems incontrovertible, inasmuch as it is so well substantiated by orchard results under a wide range of conditions, the reason why this should be so is not so easily stated. It seems to depend fundamentally upon the water-holding capacity, or rather the moisture coefficient, of the soil. The capacity of a soil to hold capillary water, which is the only kind plant growth can use, depends on (1) the soil texture (i. e., the size of the soil grain); (2) the soil structure or the grouping of these tiny grains into clusters, thus making it granular; (3) the amount of humus in the soil; and (4) the degree of soil tilth, which is a combined effect of the foregoing and tillage.

The film of moisture which surrounds every soil particle up to the point where saturation begins varies in thickness according to the amount of water contained at any particular moment by a given volume of the soil. The soil-film moisture is removed, not by drainage, but only by transpiration through growing plants and by evaporation. As the last factor can be held under control to a considerable extent by the dust mulch system of crop cultivation, or by artificial mulches, the amount of soil moisture available to growing plants and trees depends upon the film moisture contained in the soil, and the amount of this depends in the first analysis upon the texture of the subsoil and to a lesser degree upon that of the surface soil. As every soil particle is surrounded by a film of moisture, it follows that the finer the soil the greater is the number of films, and likewise the greater the area or amount of moisture in a given volume of soil.

Whitney[1] found that the surface area of the soil particles in a cubic foot of the subsoil in the pine barrens land was about 24,000 square feet, in silty and fine sandy river terrace subsoils the area was 100,000 square feet or $2\frac{3}{10}$ acres, and in the much more clayey limestone subsoils 200,000 square feet. In commenting on this data, Wiley[2] states:

> This great extent of surface and surface attraction gives the soil great power to absorb moisture, and thus the soluble mineral ingredients, of which most soils contain only a little, are held too closely to allow of rapid loss by drainage, and still sufficiently available to answer the needs of vegetation, provided the store is large enough.

And again:

> The porosity of a soil depends upon the size of the soil particles (texture), the way in which these particles are grouped together (structure), and upon the space between the particles or groups of particles. If a soil be cemented together into a homogeneous mass, its porosity sinks to a minimum; if it be composed, however, of numerous fine particles, each preserving its own physical condition, the porosity of the soil will rise to a maximum. The porosity of a soil may be judged very closely by the percentage of fine particles it yields on mechanical analysis. A finely divided soil has a high capacity for absorbing moisture and holding it. The adaptation of a soil to different crops depends largely on the sizes of the particles composing it.

This is illustrated in the case of a certain soil containing about 30 per cent of clay, "which is strong enough and sufficiently retentive of moisture to make good grass land, but too close in texture and too retentive of moisture for the production of a high grade tobacco or to be profitable for market vegetables."

Cameron and Gallagher[3] found that the optimum moisture content—i. e., the particular content at which a given soil can be put into

---

[1] Whitney, Md. Agr. Expt. Sta., 4th Ann. Rept., p. 282.
[2] Agricultural Analysis, pp. 131–132.
[3] Bul. 50, Bureau of Soils, U. S. Dept. of Agr.

its best possible condition for plant growth—varies widely with soils of different textures. In other words, from a given amount of rainfall one soil is more capable than another of furnishing optimum moisture to a given crop. Frear[1] states that—

Equally essential with the proper food supply for the growth of a crop are fitting temperature, moisture, and looseness of the soil for the root of the plant. While the soil temperature and moisture are strikingly affected by local climate, they depend also in very large measure upon the structure of the soil itself. If we could determine the structure of the soil accurately, we would probably be able ere long to make quite exact predictions as to the kinds and qualities of crops any soil whose structure was known could produce. * * * While no satisfactory means have been devised for determining soil structure with precision, the size of the particles of which it is composed affords valuable indications of its physical properties and especially of its moisture relations. Another important function must be added: The soil largely modifies the climate to which the plant is exposed. We are accustomed to regard atmospheric conditions as most largely influencing the life activities of plants, but careful observation has shown that within a wide range of temperature the warmth of the soil far more than the air determines the vigor of plant development.

With tillage conditions equal, the thickness of the film of moisture around each grain of soil depends, on the one hand, upon the supply of ground water at any particular time, and on the other, upon the rapidity with which the film of moisture is being removed by plant rootlets. Amendments may be added to the soil in the form of lime and humus, which also affect in varying degree the amount of film water in the soil which is available to plant rootlets. But the plant food in the soil is obtained by growing plants only as it is dissolved in the soil film moisture, hence it is apparent that the distribution and consequent availability of the moisture is a matter of the utmost importance.

Jeffery[2] found in his work on the water-holding capacity of soils that of water that was passed—

Through 100 ounces of air-dry clay soil, 56 ounces were retained.
Through 100 ounces of air-dry loam soil, 49 ounces were retained.
Through 100 ounces of air-dry sandy soil, 36 ounces were retained.
Through 100 ounces of air-dry muck soil, 170 ounces were retained.

In the first three cases the differences are due largely to the size of the soil grains. In the fourth case the great capacity of the soil for water is due to the large amount of organic matter present, which in this particular soil was over 69 per cent. It is thus apparent that any marked increase in the water-holding capacity of any one of the three first grades of soil in the above experiment would require some amendment, and for this purpose humus is the most efficient. In the case of the sandy soil, however, decayed organic

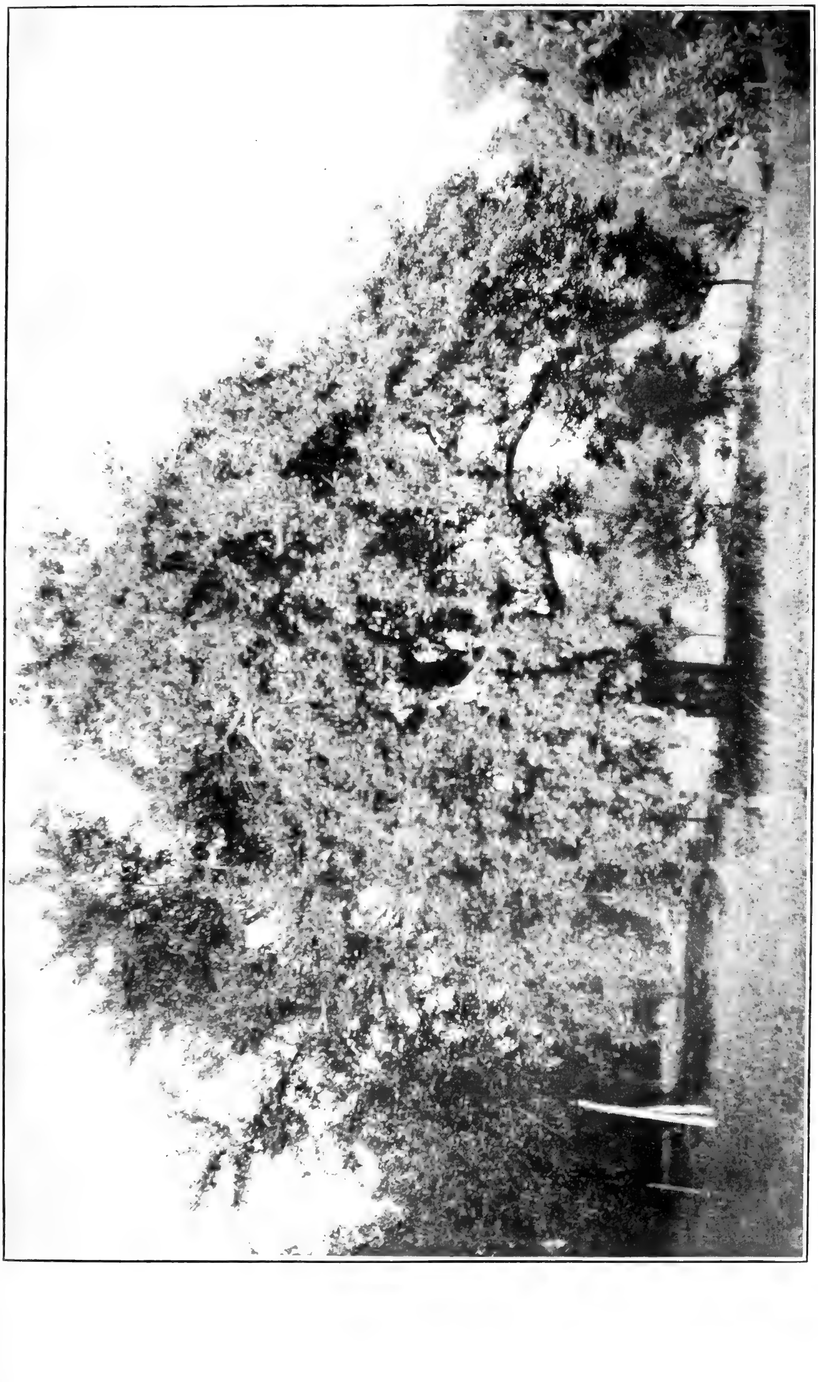
[1] Bul. 20, Pa. Agr. Expt. Sta.
[2] Bul. 219, Mich. Agr. Expt. Sta.

matter would be required in such excessive amounts as to upset the equilibrium of the fruiting and vegetative habits of the tree; that is, the sandy soil would actually become so "mucky" as to give an excessive vegetative growth at the expense of fruit yield, and an important percentage of the fruit obtained would be deficient in color. Humus is, nevertheless, the most important factor or agent, as the case may be, in modifying the physical condition of the soil mass so far as the mineral constituents are concerned. This it does by partly filling the spaces between the grains of sand, i. e., the coarse particles, and by holding apart the finer particles of clay. In these ways both sand and clay are made more loamy and favorable for plant growth. By increasing the number of particles in a given volume of soil, by helping to group the soil particles into clusters, thus increasing granularity, and also by actual absorption of moisture, humus increases the moisture-holding capacity of the soil and likewise the availability of the mineral fertilizing constituents.

To change, furthermore, by the addition of humus, the physical condition of a sandy soil to a depth reached by tree roots sufficiently to make its supply of available moisture the same as that of a heavier soil, such as a loam or a clay loam, is unquestionably an expensive process, even were it desirable; and orchards are grown for profit. Hence this phase of the whole problem is an economic one. It is good business to select soils naturally adapted to the different varieties, rather than to use soils that must be modified to make them suitable.

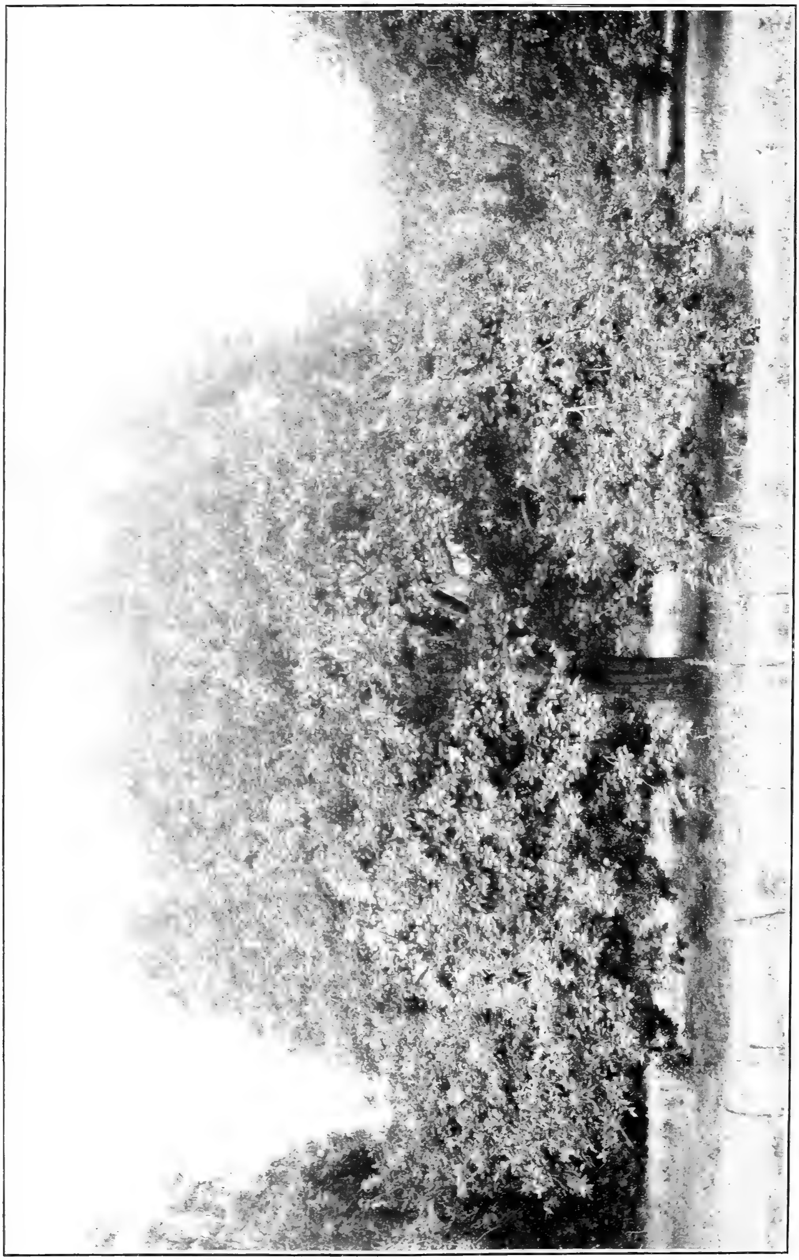
Soils so deficient in humus as to be leachy in case of sands, or stiff, intractable, and cloddy in the case of clays, clay loams, and loams should have their humus content increased until these unfavorable conditions for crop growth of any kind be overcome so far as possible. But there are marked limitations even to this fundamental kind of soil amendment, as it is not possible by the addition of plenty of humus so to change the physical and structural characteristics of a given soil that these inherent characters will become negligible so far as its adaptation to crops, or to different varieties of the same crop, is concerned. The agricultural practice of the eastern United States furnishes many examples of the special adaptation of particular soils to crop varieties.

In the Connecticut Valley of Massachusetts and Connecticut the physical character of the soil not only determines what specific crops shall be grown on the different types, but the adaptability of those soil types to such special crops has in turn been the principal basis of land valuation there for the last half century. The soils are all alluvial, and the variation in elevation is in no case more than a few feet. One of the sandy loams is the best type for the wrapper



ENORMOUS OLD BALDWIN ON GLOUCESTER LOAM AT IPSWICH, MASS.

[This tree is still yielding heavily.]



WELL-SHAPED OLD BALDWIN ON GLOUCESTER LOAM, GREENWICH, CONN.

[Notwithstanding its age this tree produces heavy yields.]

leaf tobacco; hence a normal price for many years has been $150 to $200 an acre, though it is now considerably higher than that. It is also a good onion soil, but brings no more profitable returns from that crop than a loam which, under identical cultural treatment, gives a cigar leaf so much thicker and poorer in quality that no one longer persists in trying to grow tobacco on it. Hence a relative price for this soil type is $100 an acre where one location is in every way equal to the other. It should be noted, too, that the best of the tobacco lands contain 1.5 to 2.75 per cent of organic matter. Hence the natural adaptation of that soil does not depend, it need hardly be said, on an unusual organic content; neither may other soils of that locality, though just as favorable for the growth of cigar leaf in every respect save that of texture and structure, be so amended by the addition of humus as to produce leaf satisfactory in quality.

Dr. Frear, in Bulletin No. 20 (above referred to), quotes Tscherbatscheff, a Russian tobacco specialist, who has studied with care tobacco culture in America, as follows:

> In Virginia and North Carolina the heavy or shipping tobacco is usually grown upon heavy loamy soils which for the most part have a red or dark brownish-red color and contain almost no humus. The tobacco of golden yellow color and pleasant aroma requires no thick layer of humus, so that for its culture * * * a sandy, or sandy loam, soil is selected.

The experience of growers is that this crop requires heat rather than moisture. In fact, in the presence of an excess of moisture it grows rapidly, the parenchyma thickens, and the leaf is larger, but at the expense of quality. Again, Mayor Ragland, of Virginia, is quoted as follows:

> A deep rich soil overlying a red or dark brown subsoil is best suited for the dark rich export type of tobacco. A gravelly or sandy soil with a red or light brown subsoil is the best adapted to the production of sweet fillers and stemming tobaccos. Alluvials and rich flats produce the best cigar stock. White Burley is most successfully grown on a dark rich limestone soil. For yellow wrappers, smokers, and cutters a gray sandy or slaty topsoil, with a yellowish porous subsoil, is preferable. The land must be loamy, dry, and warm, rather than close, clammy, and cold, and the finer and whiter the sand therein the surer the indication of its thorough adaptation to the yellow type. The soils so greatly affect the character and quality of the products that success is attainable only where the right selection of both soil and variety is made for each plant planted, and planters do well to heed this suggestion. Trial will determine what variety is best for any locality, as no one variety is best for all locations. To plant varieties unsuited to the type or on soil unadapted thereto is to invite failure every time.

In the rapid development of tobacco growing in Florida and near-by States during recent years soil selection has been one of the most important factors; indeed, within that very considerable district possessing a suitable climate soil selection has been of chiefest importance, and this phase of adaptation has been carried even to the point of breeding tobacco to suit local soil conditions.

The effect of soil influence on the quality and keeping characteristics of the particular variety of onion, Yellow Danvers, which has made the Connecticut Valley one of the leading centers in the United States in the production of this crop, also illustrates the principle of soil adaptation to specific variety. Grown on the sandy loam above referred to the bulbs are hard, fine-textured, and unexcelled in quality. When grown on the loam of the same series the texture of the onion is coarser, the necks do not cure down as well, and the bulbs are softer; because of these characteristics the latter are less desirable for storage purposes, and their culinary quality is inferior. The factor of edibility is not of sufficient importance to make any general difference in the selling price, but the hard onions are always sought by buyers for storage purposes, and on this account bring the top quotation when the market is dull, and sometimes even an advance price. When the crop moves slowly in the fall, moreover, the growers who store any part of their crop always select first for this purpose the hard onions. In actual practice this means those onions grown on the sandy loam soil. On heavier soils, with higher moisture content, the quality of the bulbs is correspondingly poorer.

In southwest Minnesota a shallow glacial valley some 3 miles wide divides the upland prairie which extends for many miles in a transverse direction. The irregular valley walls range in height from 15 to 30 feet or in some cases a little more. The valley soil is a clay loam, richly charged with humus. It is suited to grass and other forage crops, but wheat runs heavily to straw, none of the grain grading above No. 2, while much of it is No. 3. Wheat from the gray clay loam to the west of the valley, where the growth of straw and the filling of the heads is well balanced, gives a high percentage of No. 1 grain. Grown on the brown loam east of the valley, the grade is about half No. 1 and half No. 2. These lands have been farmed only 30 to 40 years, hence they have never been dressed to any appreciable extent with yard manure or commercial fertilizers. The superintendent of the elevator at the county seat where most of the grain is sold claims that he can tell on which of these three soil types a farmer, unknown to him, lives by the way his wheat grades. However this may be, the influence of the soil on the quality of the same varieties of grain is effectively shown by the money returns at the elevator.

In southeast Michigan the profit from sugar beets grown for the factory follows closely the character of the soil upon which the beets are grown. Beets from the light sandy soils have a high sugar content, with a high coefficient of purity, but the tonnage is relatively small. Moist, rich clay loams and loams yield a heavy tonnage, but the sugar content is low and the coefficient of purity very unsatisfactory. The farmers' goal is to secure the highest possible tonnage consistent with a high sugar content of satisfactory purity. This combination is best found there in a good strong sandy loam, underlain by a plastic light clay loam subsoil at a depth of 12 to 20 inches. Nearly as good is a deep, fine sandy loam extending to a depth of three feet or more.

Sea-Island cotton took its name from being grown on islands along the coast of South Carolina. Its long beautiful staple is now secured in northern Florida and other Gulf States when grown on deep, fine-textured loamy sands similar to those of the sea islands which it made famous. But on the heavy soils, or even shallow sandy loam surface soils underlain by heavy clay loam, it does not succeed and is replaced by the short-staple varieties.

In view of these definite cases in present agricultural practice, the different effects of varying amounts of soil moisture on soil temperatures and their apparent relationship to soil-crop adaptation is at least suggestive.

The greater the amount of moisture in a given soil and subsoil the lower is their temperature in summer. Hence, the more moisture, the larger the quantity of heat required to raise the temperature to any given degree. The removal of drainage waters is followed by rise in temperature at any given depth below the surface. Consequently capillary rise of moisture from this lower supply temporarily lowers the temperature of the layers of soil to which it ascends. The amount of capillary soil water held by the soil below the depth to which tillage has taken place does not in many cases depend primarily on the amount of humus in these lower layers of soil. A simple analysis of the case makes this point evident. When the forests were removed in the eastern States for crop planting the decaying roots left considerable amounts of humus to a depth of several feet. The depth varied greatly on different soils, because the different species of trees in the virgin forests showed very marked preferences for certain soil conditions. The local name "black walnut land" is still used where that hardy tree grows, to indicate a heavy type of soil. In southwest Michigan this is the Miami clay loam. The hickory thrives in the northeastern States on the heavier soils. Both black walnut and hickory are deep-rooted trees. In the same region "hemlock land" always indicates a sandy soil, and the hemlock is not a deep-rooted tree. In the orchard districts of West Virginia the leading peach growers will not tolerate "white-oak land," but a mixed growth of "rock oak and chestnut," about one-third of the former and two-thirds of the latter, indicate a soil which has been instrumental in making one of the most famous fruit districts in the world. The rock oak and chestnut growth indicates a soil somewhat stronger than that of chestnut alone, as a better supply of moisture is maintained; newly cleared, it is more productive, and even on old ground better results are secured from fertilization. The subsoil is finer textured, or more clayey, than the chestnut subsoils, but still is not so heavy as the white-oak soil. Yet on the latter some varieties of apples thrive.

Carrying the matter of soil adaptation to the different varieties of oak a step farther, it is a matter of common observation that poor and thin soils often support only the dwarfish blackjack oak and the post oak.

Shreve states in volume 3 of "The Plant Life of Maryland" that—

> While the general distribution of the loblolly pine is determined by historical and climatic factors, yet its relative abundance at different localities within its area is determined by the character of the soil. * * * It is most abundant on light sands and on the Elkton clay. While these soils may seem to be very dissimilar in their relation to the movement of soil water, yet the texture of the latter causes it to hold to its stores of water so tenaciously that plants growing in it often suffer drought when there is an abundance of water within very short distance but firmly held by the capillarity of the fine soil.

This statement indicates that this particular variety of pine flourishes on soils that furnish relatively small amounts of moisture to vegetation. In comparison, it may be commonly observed that the white pine flourishes best on heavy sandy loams and on very light mellow loams, soils on which the minimum supply of capillary moisture available to plants does not descend as low as with the loblolly pine soils.

Since the time when the forests of the eastern States were first cleared away for crops, the most common rotation has been corn, oats, wheat, and grass. Clover has very often been seeded with the grasses. Potatoes, buckwheat, and garden crops have also been of importance. All of these crops have shallow root systems except clover, and possibly corn which may be classed as medium in root penetration. Not enough of the deep-rooted clover has been grown on many farms to keep up the supply of subsoil humus, in conjunction with the humus supply of the surface soil—plant roots, stubble, and stable manure, which do not get below plow depth to any appreciable extent. This system of cropping with decreasing yields makes it apparent that the humus content of the subsoil on most farms has been for a long time at a minimum point. Were such a supply available to crops the average yield of corn would be much increased, and the greater amount of capillary subsoil moisture would in marked degree lessen drought injury to shallow rooted crops.

It becomes evident then, that the capacity of a subsoil to furnish capillary or usable moisture to crops depends, under average conditions, primarily on the natural character of the subsoil itself, *i. e.*, on the size of the soil grains, and that it is practically independent of the supply of humus. The supply of humus in the surface soil, on the other hand, greatly lessens the loss from evaporation and increases the moisture-holding capacity, both as referred to the rise of the capillary water and to light rainfall. Below the depth of a foot, moreover, surface heat penetrates very slowly. Hence, it is reasonable to suppose, in want of definite experimental data to prove the point, that the water-holding capacity of the subsoil, as determined chiefly by its texture, has an important bearing on the temperatures surrounding the roots of trees and plants. It is to be regretted that accurate experimental data are not available on this subject. The extensive series of observations upon soil temperatures at different depths, carried out in different parts of the United States and in foreign countries, have neglected to take account of the moisture content of the soil at various depths where the temperatures were measured. It is a well-observed fact, however, that in irrigated orchards any overirrigation prevents good color on either apples or peaches.

Dr. D. T. MacDougal, in his research work for the Carnegie Institution, of Washington (1908), concludes that—

> The facts disclosed as to the actual temperatures in the soil, the diurnal and seasonable changes therein, lead to the belief that the differences in temperature of the aerial and underground portions of plants can not fail to be of very great importance in the physical and chemical processes upon which growth, cell division, nutrition, and propagation depend.

Desert soils have a low humus content, and, consequently, they offer excellent opportunity to observe the effects of variation in texture and structure of the mineral particles themselves. Eliminating soils influenced by alkali, Dr. MacDougal remarks:

> On all other soils in which clay, loam, sand, or rocks predominate the feature which has the greatest determining influence (on adaptation to plants) is that of the amount and disposition of the moisture. Many striking dispositions of the root systems are being discovered which can only be correlated with the moisture factor.

E. S. Goff[1] adduces observations to show that the temperature of the water at the time it enters into the roots from the soil has some relation to the temperature of the stem of the plant for a short distance above the surface soil, and that the distance up the stem to which this temperature is felt depends upon the rapidity of the flow

[1] Agr. Sci., Vol. I, p. 134, Bul. 36, U. S. Weather Bureau.

of the sap and, therefore, ultimately on the rapidity of transpiration from the leaves. And again:

A warm summer is always accompanied by a high temperature of the ground or by a rise of its temperature. The increase is the more decided the more the excess in the temperature of the air is accompanied by a large quantity of rain or has been immediately preceded by it. In warm and comparatively dry summers the rise of the earth's temperature does not perceptibly exceed the normal. * * * The dampness of the soil is sufficient to allow the variations in the temperature of the air in winter and spring to exercise a decided influence upon those of the soil, whereas, in summer an excess of rain would be necessary to accomplish this, and that, too, to a greater degree if the soil be covered with vegetation.

Quetelet, as far back as 1849, in his "Climate of Belgium," expressed regret that he had been unable in his crop-climate studies to consider the influence of the temperature of the soil, although "it is absolutely necessary so to do in order to treat the phenomena of vegetation in a complete manner."

Mr. Knight[1] has observed that "varieties of the same species of fruit tree do not succeed equally in the same soil, or with the same manure," and further, that this applies to the peach, pear, and apple, "as defects of opposite kinds occur in the varieties of every species of fruit, those qualities of soil which are beneficial in some cases will be found injurious in others. In those districts where the apple and pear are cultivated for cider and perry, much of the success of the planter is found to depend on his skill or good fortune in adapting his fruit to his soil.[2]

McClatchie and Coit,[3] in discussing varieties, state that—

The same variety reacts very differently to the various stimuli produced by different environments. Hence, we arrive at the commonly held and correct idea that each climatological area has its own peculiar set of varieties which succeed best under its own climate and soil conditions.

Hence it follows that the supply of soil moisture available to plants and the temperature of the soil to depth equaling or exceeding that of the root zone of plants and trees, seem to account in part at least for the phenomena of the soil-varietal adaptations. These two factors constitute the soil climate and in subsoils they are governed indirectly but chiefly by the texture and structure as related to the moisture supply. In the surface soil these have been or may be modified to some extent by the addition of humus, but the latter influence is entirely insufficient to control the matter of inherent adaptation of soil types to crops, or to different varieties of the same crop.

It is evident, then, that many of our crops bear testimony, both from experimentation and from well-established agricultural practice, to

[1] Lindley's Theory of Horticulture. 1841. Chap. 20.
[2] Bul. 61, Arizona Agr. Expt. Sta.
[3] Trans. Royal Hort. Soc., I, 6.

the influence of the soil factor, not only upon general crop production but also to some extent distinctively upon the different varieties of the same crop.

THE ADAPTEDNESS OF SOILS TO DIFFERENT VARIETIES OF APPLES.

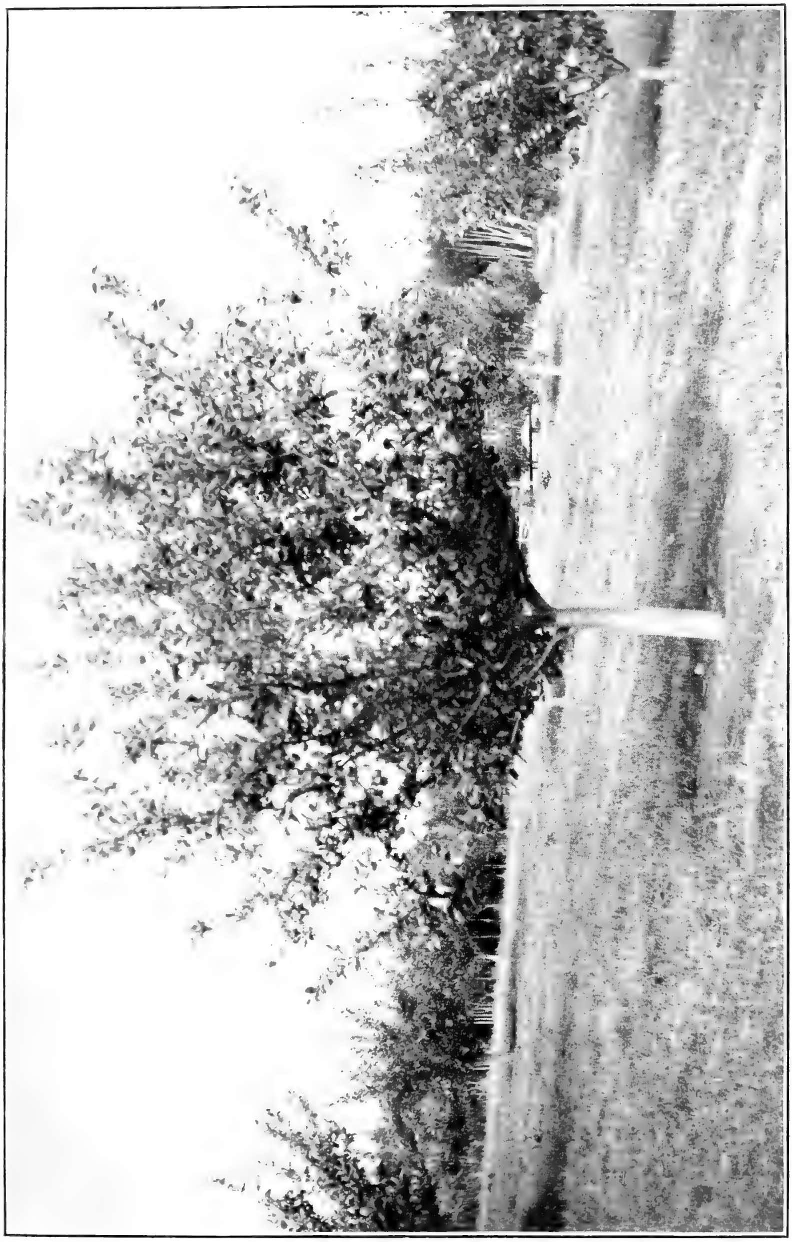
The character of the soil is only one of several factors that influence orcharding or other crop growth, and its importance in relation to the other agencies of climate, including temperatures, exposure, rainfall, surface drainage, etc., should not be overestimated. If, for example, the climatic conditions in any district are not favorable for a given variety, the character of the soil is of no importance to the practical grower unless it serves to offset in some degree the unfavorable tendency of the local climate. It is only within the climatic limits which favor a given variety that its behavior as influenced by the character of the soil may be studied. In like manner, surface drainage must be adequate, the water table far below the surface, and the exposures identical, or approximately so, before soil comparisons of value may be drawn. Apples ripen a bit later upon a northerly slope than on a southern one, the elevation, cultivation, fertilization, the soil, the age of trees, etc., being the same; but an earlier soil on the north side of the hill, such as a sandy loam, may mature fruit as early as a heavier soil on the south side, though most of these differences are comparatively slight.

The necessity for good depth of subsoil can not be emphasized too strongly. This applies to every variety of apple or other tree fruit and to every type of soil in every series. Shallow soils should be assiduously avoided for orchard purposes wherever they occur. The presence of unbroken rock, large ledges, or hardpan within 3 feet of the surface should be considered prohibitive. A soil depth of at least 6 feet should be insisted upon wherever possible and an even greater depth is highly desirable. Soils with the underlying rock too near the surface have been responsible not infrequently for the failure of commercial orchards in some sections of the country. This is due directly to the incapacity of the subsoil, on account of its limited depth and volume, to store sufficient moisture for the tree's needs when droughty conditions prevail or to get rid of excess moisture early enough in the spring or following extended summer rains. Subsoils devoid of stones are not infrequently found that are so clayey in texture or so stiff in structure as to produce results similar in kind even though usually less in degree.

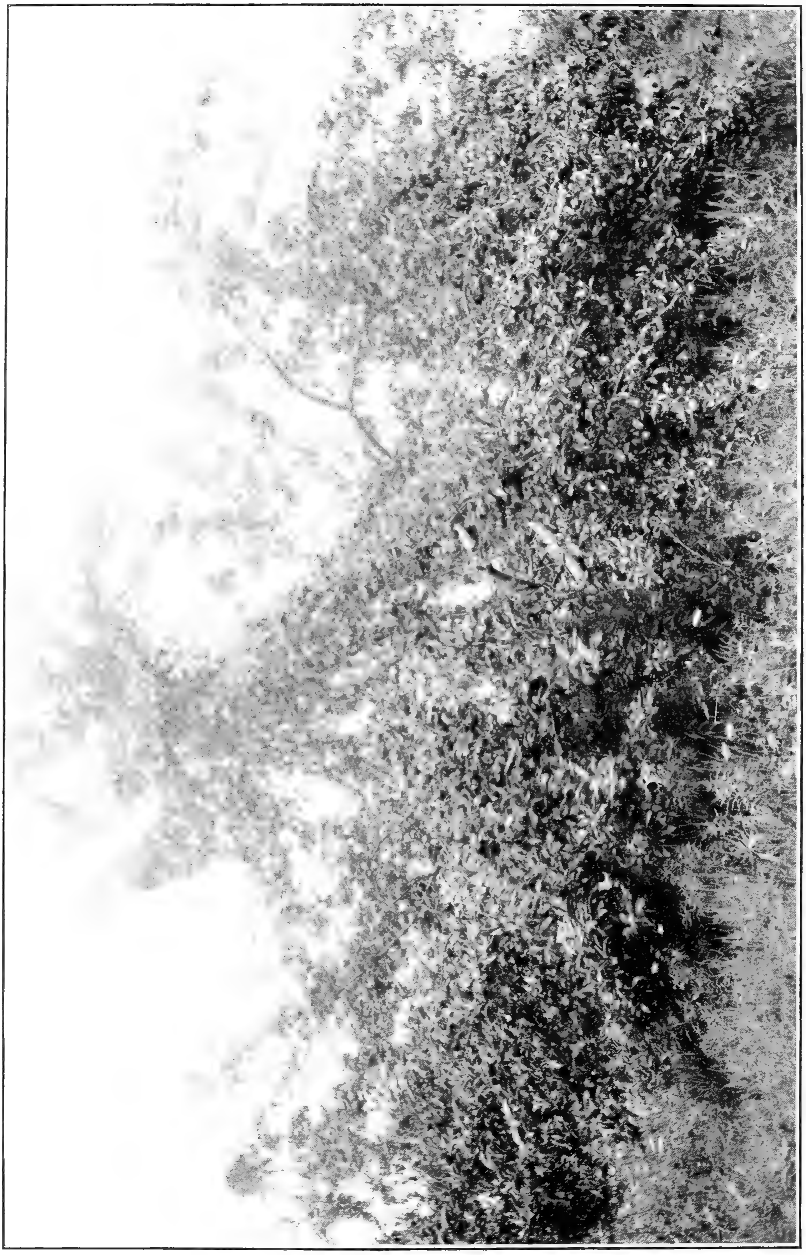
If, on the other hand, soils and subsoils of the proper texture and structure have been selected, the presence of loose stones in the subsoil in distinction from underlying rock is immaterial so long as their quantity is insufficient to interfere to any great extent with the upward capillary movement of moisture. When soils have been chosen to advantage with a view to their adaptation to any given crop there is no virtue, it may be repeated, in the presence therein of stones, popular opinion as often expressed with regard to tree fruits notwithstanding. This fact may be no better demonstrated possibly than by some subsoils which are so clayey and stiff that they would have little value for tree fruits were it not for the presence of stones which in part offset their excessive compactness. Such a subsoil condition may make it feasible to plant an area that otherwise would be impracticable. But it is a difficult condition to determine; in most cases it is an unwise risk to run; and, furthermore, the soil and subsoil section should be of such character with regard to both texture and structure that no stones are needed to render them sufficiently pervious for the satisfactory movement of capillary moisture.

The common statement that stones conserve moisture in the soil, as is "proved" by its condensation on the underside of stones in its upward movement from the subsoil toward the surface, is very misleading. Granting that moisture is conserved to the extent of the area of the dimensions of the stones, the amount so controlled is not sufficient to render cultivation unnecessary for the conservation of more moisture, hence the dust mulch is still necessary to accomplish this end in cultivated orchards. In uncultivated orchards, where mulching is effectively practiced by hauling in relatively large quantities of material from outside the orchard, the presence of stones on or near the surface is usually of some assistance in conserving moisture, and this advantage is increased as the effectiveness of the artificial mulch (because too little in quantity) decreases. Stones are of most assistance in conserving moisture in neglected orchards where neither cultivation nor mulching is practiced, but even in this case the benefit is negligible.

The term hardpan is in common use to designate a subsoil condition which delays the ready percolation of moisture. Its common use, however, has led to marked misunderstanding at least in the eastern States, as it unfortunately includes everything ranging from true hardpan to a clay loam which may constitute a desirable subsoil for orchard purposes. A true hardpan consists not of a subsoil containing sufficient clay to make it retentive of moisture, but of a mixture of sand, gravel, silt, and clay with more or less cementing material which so binds these ingredients together that the movement of soil moisture either downward or upward is seriously impeded; or a hardpan may consist of a thin layer of mineral matter formed by deposition of salts of iron, lime, or other minerals in solution after the formation of the soil or during the process. Such conditions within several feet of the surface are very undesirable. They sometimes occur in both Massachusetts and Connecticut,



SIX-YEAR-OLD BALDWIN ON GLOUCESTER STONY LOAM, CARRYING A GOOD CROP. FITCHBURG, MASS.



LOW-HEADED 14-YEAR-OLD BALDWIN ON GLOUCESTER LOAM, PRODUCING 7 BARRELS OF HIGH-GRADE APPLES IN 1912. SEYMOUR, CONN.

A SPRAY OF TREE IN PLATE X, SHOWING POSSIBILITIES OF FRUIT GROWING IN THE EAST.

RHODE ISLAND GREENING ON HEAVY PHASE OF GLOUCESTER LOAM—A FAVORABLE SOIL. GREENWICH, CONN.

though somewhat more extensively in the latter State. The percentage of such hardpan areas is not great. It is probable that they may be remedied by dynamite used in sufficient quantities to break up the hardpan effectively, this to be followed and supplemented by the use of deep-rooted leguminous cover crops to keep the shattered hardpan friable, but until the price of naturally good orchard land in the East is much higher than now it is unquestionably better economics to select soils which do not need the dynamite treatment to render them fit for planting fruit trees.

In a given block of orchard where a layer of hardpan is found at depths ranging from 15 to 30 inches, careful records for a number of years indicate that poor color with both Baldwin and Northern Spy is characteristic. In other cases, not alone in Connecticut, Yellow Bellflower is usually knotty when grown on hardpan soils.

In several orchards with surface soil of Gloucester loam but underlain in places with hardpan at depths of 18 to 24 inches and combined with a somewhat retentive subsoil, it is found impossible to grow Baldwin with good color if the orchard is cultivated. The character of the deep-soil section is such that the soil would be classed as somewhat moist, better for grass than for corn or potatoes, and so less conducive to good color of Baldwin than a soil less moist and warmer. This the owner wisely recognizes and so keeps his orchard in sod and removes the hay—a method usually condemned and properly so—but in this case well adapted to the conditions, for by transpiration of moisture through the grass plants the excess of soil moisture is reduced, thus making the soil warmer, and while the fruit is dark and dull colored at harvest time it reaches a beautiful color in midwinter, the flavor is well developed, the texture fine, and the keeping qualities remarkably good.

This case is mentioned in some detail because it illustrates so aptly the fact that cultural methods should always be flexible rather than absolute, and so fit the soil conditions of the individual orchard. If the soil is too retentive of moisture, evaporation should be hastened by noncultivation and also, if necessary, by transpiration through growing a crop. If the soil tends to dry out too quickly, cultivation should be frequent and a good supply of humus maintained to conserve the moisture. While such manipulation of method to suit the circumstances in the individual orchards should constantly be made use of, it has its limitations and does not do away at all with the desirability of selecting the soils best adapted to the individual variety; that is, those soils which will require a minimum of manipulation to effect the best soil environment. Such soil adaptation serves as a guidance, furthermore, to the moisture requirements of the different varieties, and so to the character of cultivation the different varieties should have.

Orchard fruits differ from annual crops in that they occupy the ground for a long term of years and are subjected to climatic conditions for 12 months in each year, and the transition periods from active to dormant in the fall, and especially from dormant to active in the spring are not infrequently a severe test upon the trees. It may be said, however, that the best results from orcharding are obtained only when all contributing influences are favorable. The soil, which is one of these, is the subject of this report, and a discussion of the other factors mentioned is not within its province except as their relationship to the soil is involved.

The condition of tree growth and fruit yields in large numbers of orchards makes it evident that soils for any kind of orchard planting should at least be deep, well drained and friable, yet not so porous as to be droughty. For the red varieties in New England both soil and subsoil should also be well oxidized as indicated by brown or yellow solid colors or possibly grayish-brown rather than by light-gray or mottled colors. The last especially should be avoided if possible. It may be added that it is not difficult to select upland soils in the States under discussion that are free from mottling, are well oxidized, deep, and located on well-rounded hills and gentle slopes where the processes of orchard practice are not unduly expensive. These soils are also of diverse mineral composition, and respond well in most cases where sufficient humus is supplied.

The ratio of leaf transpiration on pruned and unpruned trees to the moisture-holding tendency and moisture-furnishing capacity of the soil also adds greatly to the complexity of the problem of separating the influence of the soil factor upon varietal adaptation from the influence of other factors of environment known to bear upon varietal behavior. The physical limitations to be encountered in an endeavor to determine accurately this relationship postpones its solution to the indefinite future. So far as this investigation goes the endeavor has been to balance or to eliminate this factor of influence by the consideration of a large number of cases, but this, of course, only reduces the problem in the final analysis to one of individual judgment and leaves the actual problem for future investigation.

The discussion of the adaptedness of soils to varieties is based in part on the investigational work of the writer for several years past, as well as on the work of 1911 in Massachusetts, and 1912 in Connecticut. During the course of the field work it has been possible to observe the behavior of varieties under a wide range of soil and other conditions influencing apple production and meanwhile to gather much data from the experience of a great number of orchardists and farmers. Consistently has the attempt been made to check all such material by personal observation, likewise to study in a comparative way, as fully as circumstances would permit, the external appearance, the keeping character, the dessert and the culinary qualities of the fruit itself as affected by soil differences. The reader should keep ever in view the fact, however, that the soil is not the sole factor, but only one of several factors which together determine the adaptability of any given site to the different varieties of apples or of other tree fruits. It is perhaps needless to mention the difficulty of distinguishing the influence of the soil from various associated factors of climate, and it is fully realized that the data presented is not only very incomplete, but that much further study of the subject is needed.

CLASSIFICATION OF SOILS.

The classification of soils into groups by some arbitrary standard is not difficult, but it is no easy task for one unfamiliar with the process of such separations to make them fit the unmapped soils of a given farm. The many individual conceptions of a sandy loam may differ materially from the place in any definite classification scheme where it properly belongs. But this in no way lessens the necessity for a uniform plan for the grouping of soils, and in view of present knowledge the following plan has been adopted by the Bureau of Soils as the most logical.

The sands group[1] is classified as coarse, medium, fine, and very fine. The name implies that the subsoil as well as the surface soil consists of sand. A sand soil type usually contains as many as three of these grades and sometimes all four, but the predominating grade determines the type name—as a fine sand.

When enough of the finer particles, clay, silt, or both, are included with the sand to make the soil somewhat coherent and loamy, or, as often expressed, "to give it more body," the type is a sandy loam.

---

[1] A key to the soil terms used appear in the following table:

Soils containing less than 20 per cent silt and clay:	
Coarse sand	Over 25 per cent fine gravel and coarse sand and less than 50 per cent any other grade.
Sand	Over 25 per cent fine gravel, coarse and medium sand, and less than 50 per cent fine sand.
Fine sand	Over 50 per cent fine sand, or less than 25 per cent fine gravel, coarse and medium sand.
Very fine sand	Over 50 per cent very fine sand.
Soils containing 20 to 50 per cent silt and clay:	
Sandy loam	Over 25 per cent fine gravel, coarse and medium sand.
Fine sandy loam	Over 50 per cent fine sand, or less than 25 per cent fine gravel, coarse and medium sand.
Sandy clay	Less than 20 per cent silt.
Soils containing over 50 per cent silt and clay:	
Loam	Less than 20 per cent clay, less than 50 per cent silt.
Silt loam	Less than 20 per cent clay, over 50 per cent silt.
Clay loam	20 to 30 per cent clay, less than 50 per cent silt.
Silty clay loam	20 to 30 per cent clay, over 50 per cent silt.
Clay	Over 30 per cent clay.

If most of the sand is fine, rather than medium or coarse, the type is a fine sandy loam. When still more of the clay and silt are included, so that the proportions of sand and fine material are about equal, thus obscuring largely the grittiness of the sand, the soil is a loam.

When the clay and silt particles predominate only the fine grades of sand are usually present. If the silt grade is most abundant the soil is a silt loam. If clay is greatest in amount, the soil is a clay loam. And if the exceedingly fine clay particles constitute more than 30 per cent of the soil mass, the type is a clay, the other 70 per cent being primarily of silt and very fine sand. A soil containing as much as 50 per cent clay is very "heavy," while those containing 60 to 70 per cent, as along Lake Superior and Lake Champlain, are exceedingly stiff and hard to work.

The classification in the above table refers to surface soils. Where surface soils differ materially in color, as red and yellow, even though derived from similar geological materials, as the Wethersfield and the Middlefield soils, they are placed in different series. If two identical surface soils are underlain by subsoils, one of a sandy nature and the other clayey, they also are, or should be, placed in different series, as the light and heavy subsoils of the Gloucester series. If two soils and subsoils are identical in texture and color, but differ in the character of the geological material from which they are derived, as limestone and granite, they are placed in different series, to wit, the Dover and the Gloucester series. These distinctions all lie within a given soil province such as New England, or the Atlantic Coastal Plain, the Appalachian Mountains and valleys, etc., but on account of differences in climatic and consequent cropping characteristics the same series name is not used in two soil provinces, even though the soils are similar in color and derivation. This is illustrated in the Southern States by the Cecil and the Porters soils, the former occurring in the Piedmont Plateau and the latter in the Appalachian Mountains division.

In the Gloucester series loams and fine sandy loams are the predominating soil types in Massachusetts and Connecticut. Fine sand is next in importance, and on Cape Cod it is the most prevalent type. True clays and heavy clay loams do not occur. Even light clay loams are uncommon, heavy loams and silty loams constituting the heavy soils of the region. In the Wethersfield and Middlefield series the silt loams and the fine sandy loams are the most important types, though there is considerable loam and a little sandy clay.

SOILS FAVORABLE FOR THE BALDWIN.

If soils are thought of as grading from heavy to light, corresponding to the range from clay to sand, then soils grading from medium to semilight apparently fulfill best the requirements of the Baldwin, particularly under a system involving such average cultivation as is usually practiced in commercial plantings. Following definitely the classification standards of the Bureau of Soils with reference to the proportions of clay, silt, and sands, this grouping would include the medium to light loams, the heavy sandy loams, and also the medium sandy loams provided they were underlain by soil material not lighter than a medium loam nor heavier than a light or medium clay loam of friable structure.

From this broad generalization it will be seen that the surface soil should contain an appreciable amount of sand. The sands, moreover, should not be of one grade—that is, a high percentage of coarse sand would give a poor soil, whereas a moderate admixture of it with the finer grades of sand, together with sufficient clay and silt, would work no harm. In general, the sand content should be of the finer grades, but soils also occur, though comparatively rare, which would be too heavy for this variety were it not for a marked content of the coarse sands, the effect of which is to make the soil mass much more friable and open than would be expected with the presence of so much clay. Such conditions occur in parts of Perry County, Pa. Soil types having characters as above described dry quickly after a rain, and are not to be classed as moist soils. They will never clod if worked under moisture conditions that are at all favorable. The subsoil on the other hand must never be heavy enough to impede ready drainage of excess moisture, and it should be sufficiently clayey to retain a good moisture supply—that is, plastic, not stiff. If the subsoil be so clayey or heavy that moisture does not percolate down through it readily, or if the same result is caused by hardpan, a Baldwin of poor color with a skin more or less greasy is the usual result. The best results are secured, other circumstances being equal, from warm and "kind" yet not too sandy soils. Such soils can be so managed as to secure a sufficient but not excessive vegetative growth, the proper balance between it and the growth of fruit being readily maintained, a condition necessary to produce the best developed and highly colored fruit.

On heavy loams where Baldwin matures slowly, and is dark and dull at harvest time, the fruit sometimes possesses unusually good keeping qualities, and in some cases the color develops satisfactorily by midwinter. For storage such fruit is excellent.

Another unfavorable soil condition was noted in several instances in both Connecticut and Massachusetts. It is well illustrated in an orchard where the cause of the unsatisfactory color of fruit is due doubtless to the condition of the surface soil rather than to the subsoil which is a well-drained yellow to light-brown friable loam or light clay loam. The surface soil is dark-brown to grayish-brown heavy loam more retentive of moisture than the subsoil. Such a soil is better for Gravenstein or Fall Pippin.

The Bernardston soils are not quite so good as the Gloucester for the Baldwin and similar red varieties of apples because the fruit matures later and, under the climatic conditions which obtain where these soils are found, tends to a deficiency in color. On the basis of comparisons with similar soils in Connecticut this deficiency seems to be even more marked with peaches. The Rhode Island Greening is well grown, however, on these soils.

The apparent ideal to be sought is a heavy, fine sandy loam, or light mellow loam, underlain by a deep subsoil of plastic light clay loam or heavy silty loam. It is fully realized that many will not possess this ideal, but the soil that most closely resembles it should be chosen. If corn be grown on such soil the lower leaves will cure down in an average season before cutting time, giving evidence of moderately early maturity. This is one of the safe criteria by which to be guided in choosing soil for this variety in the New England section. Typical Gloucester loam conforms ideally to the above conditions and characteristic growth of the Baldwin on this soil at both low and high altitudes—50 to 1,000 feet—is shown in Plate X to XIV, inclusive.

Mention was not made in the above description of the color of the soil. The desirability of a surface soil of dark brown, the color being due to the presence of decaying organic matter, is unquestionable and generally recognized, and if the soil be not that color the successful orchardist will so make it by the incorporation of organic matter through the growth of leguminous crops or otherwise. It is often cheaper to buy soil with a good organic content or humus supply than it is to be compelled to put it there after purchase. Hence, this is purely an economic feature. The warning should be stated, however, that a soil should not be purchased or planted to apples of any variety because it is dark colored and rich in humus. Both soil and subsoil should be selected because of their textural and structural adaptation regardless of the organic content. Then if such soils happen to be well supplied with vegetable matter so much the better; if not, it may be supplied.

To modify, by the addition of humus, the physical condition of a sand until it resembles a sandy loam as far down as tree roots ordinarily extend, is unquestionably an expensive process, and as orchards are grown for profit the soils on which they are to be planted should be so selected for the different varieties as to furnish the most favorable conditions possible before going to the additional expense of trying to change their character artificially.

While soils so deficient in humus as to be leachy in the case of sands, and stiff, intractable, and cloddy in the case of clays, clay loams, and loams, should have their humus content increased until these unfavorable conditions for crop growth of any kind be overcome as far as practicable, it is impossible to ignore the effects of the inherent physical character of the soil itself as related to adaptation to crops, and, in some cases at least, varieties of the same crop. It is easily possible, furthermore, on soils of medium texture, especially, so to accentuate the vegetative habit of the Baldwin that the color of the fruit becomes impaired. In current orchard practice this is a common occurrence which growers seek to overcome by withholding ammonia-carrying fertilizers, by checking tillage, and by avoiding humus-forming cover crops. It lowers cost of production to let nature help as much as possible.

In both States nearness to salt water is sometimes suggested as a cause for deficient color of red apples, especially the Baldwin; and while sufficient evidence is not at hand to refute the statement completely, it is apparent in many cases that the difficulty is chiefly one of impervious subsoil. Low elevation is also a factor in some instances. In the Connecticut Valley, for example, 35 miles from the Sound shore, Baldwins do not color satisfactorily, even though the soil is favorable. At the highest altitudes in northern Berkshire and Franklin Counties, Mass., and farther north in Vermont, Baldwin shows a tendency to become slightly constricted and ridgy at the calyx end. It was not as plump in the season of 1912, at least, as at altitudes of 1,000 feet. The minimum elevation where this effect was noticeable in 1912 was around 1,200 feet, while at 1,600 feet, along the Vermont line, the tendency was more pronounced. It may be added, too, that the variety becomes more susceptible to winter injury at about this same point, thus suggesting proximity to those climatic conditions where Baldwin should be replaced by the Fameuse and McIntosh or others of the Fameuse group. As one drives in this locality from characteristic Baldwin territory through the transition zone to higher altitudes, where this variety no longer develops to its best, it is most interesting to note corresponding changes in the natural forest growth, and in the varieties of farm crops. With increasing elevation these changes are first noticed on exposed and wind-swept areas, where apple trees lean away from the direction of the prevailing winds. A given variety of flint corn becomes more dwarfed than at lower elevations. The hemlock, which prevails at 1,000 feet, gives way to spruce in protected situations, while the high ground, which is more exposed, is occupied with a much larger percentage of the hardwoods—beech, maple, black, and yellow birch.

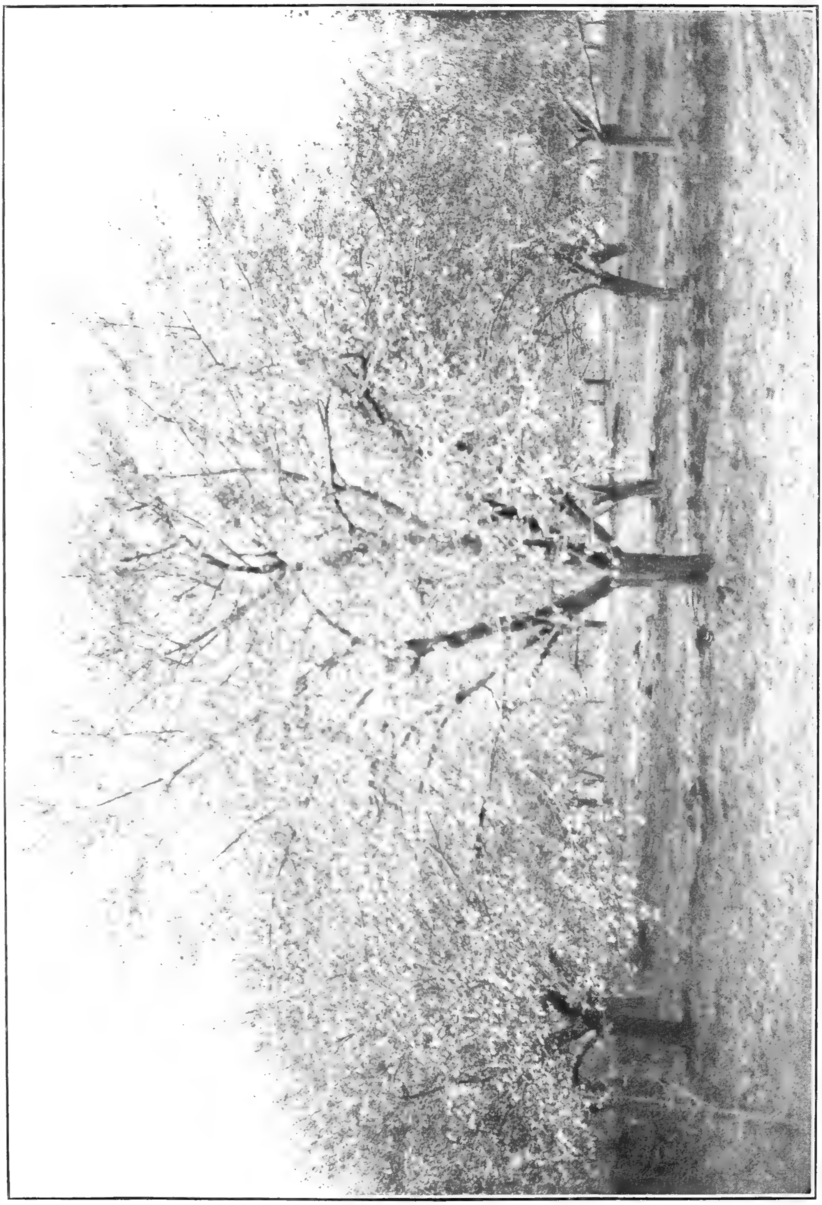
While the hills of Massachusetts and Connecticut include a great deal of ideal Baldwin soil, or soil that resembles the ideal closely enough for practical purposes, they also include a great deal of soil that is not so well adapted to the Baldwin. The greatly superior color of the fruit from some orchards on mellow, friable loams, when compared with that from others on a more retentive kind of soil and subsoil—certain clay loams of the same series or moist loams of a different series—elevation, slope, methods of culture, and fertilization being virtually the same, gives striking evidence of the importance of the soil factor. On just this basis the fruit from some orchards sells for a higher price than that from others. This illustrates the economic advisability of selecting the orchard site with soils adapted to the variety to be planted.

SOILS FAVORABLE FOR THE RHODE ISLAND GREENING.

As the best prices for the Rhode Island Greening are usually obtained in New York City the majority of commercial growers have aimed to meet the preference of that market. The demand there for a "green" Greening has usually been stronger than for one carrying a high blush; and while individual buyers may be found, it is said, who do not discriminate against the latter, many of them do. Not infrequently the "green" Greening brings a premium of 25 cents or more a barrel over the "blush" Greening. Of even more importance sometimes is the fact that a "green" Greening will move on a slow market when a "blush" Greening fails to do so. There is also a trade objection to the "blush" Greening from the fact that the consumer is rarely able to distinguish it from Monmouth, a red-cheeked green apple, which does not serve at all well the purpose for which the Greening is usually bought. In view of these trade conditions the writer has especially sought those soil characteristics which best contribute to the production of a "green" Greening, and in previous writings or in meetings addressed, the soil adaptations for the Rhode Island Greening have been described with the green type of apple as the standard sought. Bearing this ideal in mind, the soils adapted to this variety are distinct from the Baldwin standard. A surface soil of heavy silty loam or light silty clay loam underlain by silty clay loam excels for the "green" Rhode Island Greening. Such soil will retain sufficient moisture to be classed as a moist soil, yet it is not so heavy as ever to be ill-drained if surface drainage is adequate. The soil should be moderately rich in organic matter, decidedly more so than for the Baldwin. In contrast to the Baldwin soil in the growth of corn, it should keep the lower leaves of the plant green until harvesting time, or at least until late in the season. Such soil conditions maintain a long seasonal

EXCELLENT 6-YEAR RHODE ISLAND GREENING INTERPLANTED WITH PEACH ON VIRGIN WETHERSFIELD LOAM AT WALLINGFORD, CONN.

[Greening tends to blush a little earlier than on the Gloucester loam. Compare Pl. XV.]



NORTHERN SPY ON WETHERSFIELD LIGHT SILTY LOAM AT GOOD LOCAL ELEVATION IN CONNECTICUT VALLEY, MASS.

[Few of this variety are being planted, although individual trees show excellent results.]

growth under uniform conditions of moisture and thus produce the firm yet crisp texture and the remarkable juiciness for which this variety is noted.

A dealer in cider apples who has bought the fruit from two orchards on the same farm in northeastern Massachusetts for many years testifies that the apples from the orchard with subsoil of heavy loam to clay loam yield from 5 to 7 per cent more juice than apples from the orchard on sandy soil and subsoil. On the State farm at Bridgewater, Rhode Island Greening is very successfully grown on a rich, heavy loam from 10 to 16 inches deep. The fruit is large and is said to keep well until January in common storage. On the sandy soils in the same region it is usually described as a fall apple. If a high blush is desired, however, to meet other market requirement, a soil somewhat warmer than that described should be selected—a deep, light, mellow loam or productive fine sandy loam being favorable. To secure a "finish" of this character, soils approaching more nearly to the Baldwin standard are best adapted.

Plate XV shows Rhode Island Greening on heavy Gloucester loam. Fruit is large and green. Plate XVI shows a tree yielding heavily at six years of age on Wethersfield loam—a soil somewhat lighter than the Gloucester loam in the preceding plate.

In northwestern Massachusetts on the heavy phase of Gloucester loam Rhode Island Greening bears heavily. The fruit is firm in texture, of excellent quality, and keeps well until late winter. The blush is usually well developed. The variety is highly profitable in this locality, but the call for red apples among the buyers who come there is so strong that no Rhode Island Greenings are included in the younger plantings.

The loam and silt loam of the Bernardston series of the Western Highlands are also especially well adapted to the Rhode Island Greening, giving greener fruit than the Gloucester loam.

In eastern Massachusetts the variety drops from the trees earlier than in the western part, but this is undoubtedly due largely to the difference in elevation. This tendency would doubtless be retarded somewhat by planting on heavier soils.

In southern Connecticut and somewhat farther north in the Connecticut Valley, Rhode Island Greening is generally found less satisfactory than in Massachusetts. In many cases the fruit is not a deep, dark green even at harvest time, but rather a pale green, with sometimes a suggestion of yellow. As the fruit ripens it rapidly becomes more yellow and the apple is much less desirable than that grown in western Massachusetts or at good altitudes in Litchfield County, Conn. The flavor is not well developed, the texture is not as fine, and the keeping quality is poorer, most of the fruit being consumed before New Years. In fact, the variety as grown in southern Connecticut, even on soils adapted to it, is not as well developed as that from the northern half of the Connecticut Valley in Massachusetts, notwithstanding the low elevation there. Even in Litchfield County, in orchards well cared for, Rhode Island Greening has not in some cases given yields sufficiently large to make it as profitable as Baldwin. These various limitations indicate that Rhode Island Greening is more restricted in its range of adaptation than the Baldwin, and that it does not adapt itself to climatic conditions as far south as the Baldwin, even though suitable soils occur there. In fact, its southern boundary may be roughly estimated at 0.25° north of the forty-first parallel. South of that it becomes a fall apple and keeps very poorly.

SOILS FAVORABLE FOR THE HUBBARDSTON.

Compared with the Baldwin soil requirements, the heaviest soils desirable for the Hubbardston lap over for a little upon the lightest soils desirable for the Baldwin, while at the other extreme the Hubbardston will utilize to advantage a more sandy soil than most other varieties of New England. This does not mean that it will succeed on poor light sands, for on such soils the apple will not attain sufficient size to be of value, nor is the tree vigorous enough; but the soil should always be very mellow. A rich, fine sandy loam to a depth of at least a foot is preferable, and the subsoil well may be of the same texture. The Hubbardston does remarkably well on a rich fine sandy loam in the Connecticut Valley in Massachusetts where fertilized highly enough for tobacco, onions, or garden crops. The fruit is of good size, well colored, and with good keeping qualities. Baldwin grown alongside is poorly colored and inferior in both flavor and keeping quality, yet on the same soil where the humus content is lower, and the soil less rich, the fruit is much better in all these respects. This warrants the conclusion that on this soil humus and nitrogen-carrying fertilizers may easily be supplied in too great amounts for the Baldwin, and that Hubbardston can use more of them to advantage than Baldwin. This indicates relative soil conditions for these varieties, and, to some extent, fundamental soil selection also. A subsoil containing enough clay to make the fine sandy material somewhat coherent, or sticky, is not objectionable for Hubbardston, but there should never be enough clay present to render the subsoil heavy. If the soil is too heavy or too clayey the fruit is liable to have a greasy skin and a deficient color, the fruit tends to be small and the flavor is insufficiently developed. This last tendency was very noticeable in 1912 in an orchard which receives good treatment but is underlain with hardpan at depths ranging from 18 to 24 inches. In 1912 the color was good, but the owner stated it also to be deficient in normal seasons. The light phase of the Gloucester loam gives much better results with Hubbardston than the heavier subsoil phase but this variety is not commercially popular in the eastern half of Massachusetts where so much of the lighter phase occurs. Neither does it do well on the Gloucester soils of Northwest Massachusetts where the elevation is 1,000 feet or more.

In one Essex County orchard, Hubbardston is excellent as grown on a surface soil ranging from heavy fine sandy loam to light loam with subsoil of fine sandy loam (Gloucester fine sandy loam). There is good local elevation, though the orchard is slightly less than 100 feet above sea level. The productivity of the land has been well maintained, so in this respect it may be compared with the Connecticut Valley soils mentioned. Stable manure has been the principal fertilizer, and the orchard is fenced and used as a poultry yard. The number of hens is not sufficient to prevent some growth of grass. Until a few years ago, wood ashes were applied in small amounts. The trees show a thrifty growth, and the fruit keeps well. The color of the fruit is said to be superior to that from trees on a heavier soil in another part of the same orchard.

In most places in Connecticut, and especially in the southern part, the Hubbardston is not held in high esteem, and it seems not as well grown as farther north in Massachusetts.

Sutton (Beauty) is adapted, so far as we have been able to observe, to about the same range of soils as the Hubbardston. In the town of Sutton where it originated, and in the surrounding section, it seems especially promising on the Gloucester fine sandy loam. Sufficient plantings have not been found, however, for adequate comparison on a commercial scale.

SOILS FAVORABLE FOR THE NORTHERN SPY.

This variety is one of the most exacting in soil requirements. To obtain good quality of fruit—i. e., fine texture, juiciness, and high flavor—the soil must be moderately heavy, and for the first two qualities alone the "green" Rhode Island Greening soil would be admirable. The fact that the Northern Spy is a red apple, however, makes it imperative that the color be well developed, and the skin free from the greasy tendency. This necessitates a fine adjustment of soil conditions, for the heaviest of the soils adapted to the Rhode Island Greening produce a Northern Spy with greasy skin and usually of inferior color. The habit of tree growth of this variety, moreover, is such as to require careful attention. Its tendency to grow upright seems to be accentuated by too clayey soils, if well enriched, and such soils tend to promote growth faster than the tree is able to mature well. On the other hand, the Spy from sandy soils, while possessing good color and a clear skin, is often unsatisfactory in texture and flavor, especially if the fruit be held for very long in open storage. The commercial keeping quality, too, is said to be inferior to that of the Spy grown on heavier soils in the same district. Hence the soil requirements of this variety are decidedly exacting, and are best supplied apparently by a medium loam underlain by a heavy loam or light clay loam; that is, a soil as heavy as can be selected without incurring the danger of inferior drainage, for a poorly-drained soil should in no case be used. It is surely best not to plant Northern Spy on a soil lighter than a very heavy fine sandy loam, underlain by a light clay loam, or possibly a heavy loam. Good elevation and good air drainage are also very essential with this variety.

In the southeastern counties of Massachusetts, Northern Spy has not been very satisfactory, but rarely has it received suitable care. In southern Connecticut, even when grown on soils very well suited to it, the Northern Spy is held in much less esteem than in the northwestern part of the State, where the conditions much more nearly resemble those in western Massachusetts, a district in which the variety is excellent when grown on the right kind of soil with sufficient altitude. In the northeastern part of Hartford County, at elevations approximating 300 feet, Northern Spy does not keep well much after New Years. Plate XVII shows excellent growth of this variety under favorable conditions.

SOILS FAVORABLE FOR THE WAGENER.

In northeastern Pennsylvania, where the climatic conditions are not greatly dissimilar to those of southern New England, Wagener is one of the most profitable sorts for filler purposes. It gave remarkable results, too, in northeastern Massachusetts in 1911 at a very low altitude, and in the western part of the State, at an altitude of nearly 1,200 feet, it is also doing very well, indeed. The tree is weak in growth, hence a soil that is deep, strong, mellow, and loamy should be selected. Stiff subsoils are especially objectionable with this variety, and thin soils and light sandy soils should be avoided. The Wagener thus fits in nicely with Northern Spy in soil requirements, and its habit of early bearing makes an effective offset to the tardiness of the Northern Spy in this respect.

SOILS FAVORABLE FOR THE M'INTOSH.

The McIntosh is an apple of high quality that is now very popular. As McIntosh trees of sufficient age for safe comparisons are rarely available in Massachusetts or Connecticut over any considerable range of soil conditions, no positive statement is made concerning the soil preferences of this variety. The indications are, however, that the heavier of the Baldwin soils as described are desirable for the McIntosh. (See Pl. XVIII.) From the experience in Connecticut so far available this variety seems to yield somewhat heavier crops at the highest altitudes in the northern part of the State than in the southern part; there is less trouble from dropping and the fruit has better keeping quality. Even in the northern counties at elevations as low as 300 feet there is much loss from dropping, the tree does not yield satisfactorily, and the fruit is not as crisp as at higher altitudes.

SOILS FAVORABLE FOR THE TOMPKINS KING.

The Tompkins King is fully as exacting as Northern Spy in soil adaptation. The tree, with its straggling tendency of growth, does not develop satisfactorily on sandy soils, but succeeds best on a moist yet well-drained soil, i. e., the light Rhode Island Greening soil, a soil capable of maintaining such supply of moisture that the tree receives no check at the approach of drought. But the fruit grown on soils so heavy often lacks clearness of skin, and the appearance of the apple is marred by the greenish look extending far up the sides from the blossom end, and the lack of the well-developed color which makes this fruit at its best very attractive. A layer of hardpan within a few feet of the surface may produce similar effects. Hence the problem is to balance these two opposite tendencies as well as possible, and soil of the following description seems best to do this: Light, mellow loam, the sand content thereof being medium rather than fine, thus constituting an open textured loam rather than a fine loam. A subsoil of the same texture or only slightly heavier is favorable, and one heavier than a very light, plastic clay loam or inclining toward stiffness in structure should be avoided. For this variety the productivity of the soil should be at least moderately well maintained.

SOILS FAVORABLE FOR THE FALL PIPPIN.

Soils adapted to the Fall Pippin are somewhat wider in range than those described for Northern Spy and Tompkins King. In fact, this variety may be very successfully grown on the soils described for both the Tompkins King and the Northern Spy. It is preferable, however, that the surface soil be a fine loam rather than the open-textured loam described for the Tompkins King.

Another soil combination which has given very good results in Connecticut is a strong loam 10 to 12 inches deep, underlain by sandy loam which offsets in a measure the retentiveness of the surface soil.

SOILS FAVORABLE FOR THE ROME BEAUTY.

The commercial worth of Rome Beauty for New England is yet to be determined. In middle latitudes it bears the same relation to the Grimes in soil requirements that Baldwin does to the Rhode

Island Greening in their respective regions. There is, however, something of an overlapping of regions. That is, the Baldwin extends farther south in adaptation than the Rhode Island Greening, and the Rome Beauty extends as far north as the Grimes. But this intraregional overlapping of Rome Beauty and Baldwin is largely a matter of dovetailing due to variations in elevation. Thus in southern Pennsylvania, as the Baldwin in its southern extension seeks its soil at higher elevations to offset the climatic changes, so does Rome Beauty in its northern extension seek the same soil at a lower elevation for the same reason.

With increasing distance south, the Baldwin very soon becomes a fall variety, and where this tendency is sufficiently pronounced to lessen materially its desirability it may well be replaced by the Rome Beauty, which is adapted to the same kind of soil.

Rome Beauty is grown with fairly good success in the lower Hudson Valley and at low elevations in western New York, but there is question if it will become a leading commercial sort in either region.

SOILS FAVORABLE FOR THE BEN DAVIS AND GANO.

The reference to the Ben Davis and Gano here should not be construed as a recommendation for planting in this region, for it is believed they should not be planted in Massachusetts or in Connecticut, but they are mentioned simply because of the value they may have in this discussion of fruit soils. These varieties are adapted primarily to the middle latitudes of this country rather than to the northern ones, and it is believed that the latter can not, for this reason, compete successfully in their production. The influence of the soil factor on these varieties is somewhat less marked than with varieties of higher quality, though the best color is not developed on soils excessively clayey or ill-drained. The Ben Davis has a tendency to bear annually better than most other varieties, but there are other sorts of good quality that are sufficiently productive to make the planting of the Ben Davis and Gano ill-advised for this section of the country.

SOILS FAVORABLE FOR THE GRAVENSTEIN.

The Gravenstein has given growers in Massachusetts much trouble, but its general excellence, the high price the fruit brings, and the strong demand for it in some markets makes the Gravenstein a tempting sort to plant. Its susceptibility to winter injury, however, is often a serious matter. There is good evidence to show that Gravenstein should not be forced in growth, at least until it is 15 years old or older. In western Middlesex County, on rich moist ground or with heavy fertilization with nitrogenous manures, its growth is rarely matured early enough in the season to avoid more or less winter injury. It often continues to grow until freezing weather and thus is very susceptible to injury. On a medium soil, neither too moist nor too rich, its growth may well be held in control, early annual maturity may be forced, and the color of the fruit from such soils is satisfactory. (See Pl. XIX.) The subsoil should never be so clayey as to prevent ready downward percolation of any excess of free soil water. Annual applications of the mineral fertilizers, such as basic slag and potash, seem desirable on such soils, and a moderate amount of humus should be furnished, but nitrogenous fertilizers should be used sparingly. If the growth is too vigorous at any time it is well to seed to grass at once.

Fruit of good color is especially desirable with this variety, the color adding materially to the selling price. This has led to its being planted on thin or light sandy soils in some cases, but on such land the Gravenstein is generally unsatisfactory.

In Massachusetts and Connecticut the Gravenstein is a variety for the specialist only, but for such it is very profitable when grown near a market, especially if within driving distance. Gravenstein is a good illustration of a variety that is difficult to grow well but which brings high profits if it reaches market in good condition. This has doubtless led to its planting under conditions that have not always been favorable. Market demands may make it profitable and desirable to grow a variety even though soil conditions are not ideal and the variety does not grow its best.

To secure the best color the fruit must be left on the tree in most seasons until the loss from dropping becomes serious. By mulching heavily with poor hay or straw these drops, many of which will be well colored, may be gathered clean and practically free from bruise. They will not keep long, but at that season the market is usually eager for them at good prices. Most of the Gravensteins in Massachusetts are grown within driving distance of some of the larger markets, especially between the radii of 10 and 25 miles from Boston, where the drops sell to good advantage and the variety is considered highly profitable. Many of the smaller cities in Massachusetts are not well supplied with this variety, however, and in some cases there is good opportunity for the specialist to plant Gravenstein for local markets, as the large markets always take any surplus of the best grade at high prices when well packed.

SOILS FAVORABLE FOR THE ROXBURY (ROXBURY RUSSET).

The Roxbury is now seldom planted, but there are some commercial orchards of it in Massachusetts, and many of the old orchards contain a few trees. It is most extensively grown in the Oldtown district of Newbury, near Newburyport. The Roxbury is a gross feeder, the growers believing that it will use to advantage heavy applications of stable manure.

In one of the most successful orchards the surface soil consists of a heavy loam from 10 to 15 inches deep, which has been highly fertilized with stable manure and kept well supplied with humus for at least 50 years, the very antithesis of the soil conditions desired for the Baldwin (see Plates IV and XX). The subsoil is lighter, a fine sandy loam or a gravelly sandy loam. The soil of another excellent orchard consists of a light silty and fine sandy loam underlain by fine sandy loam.

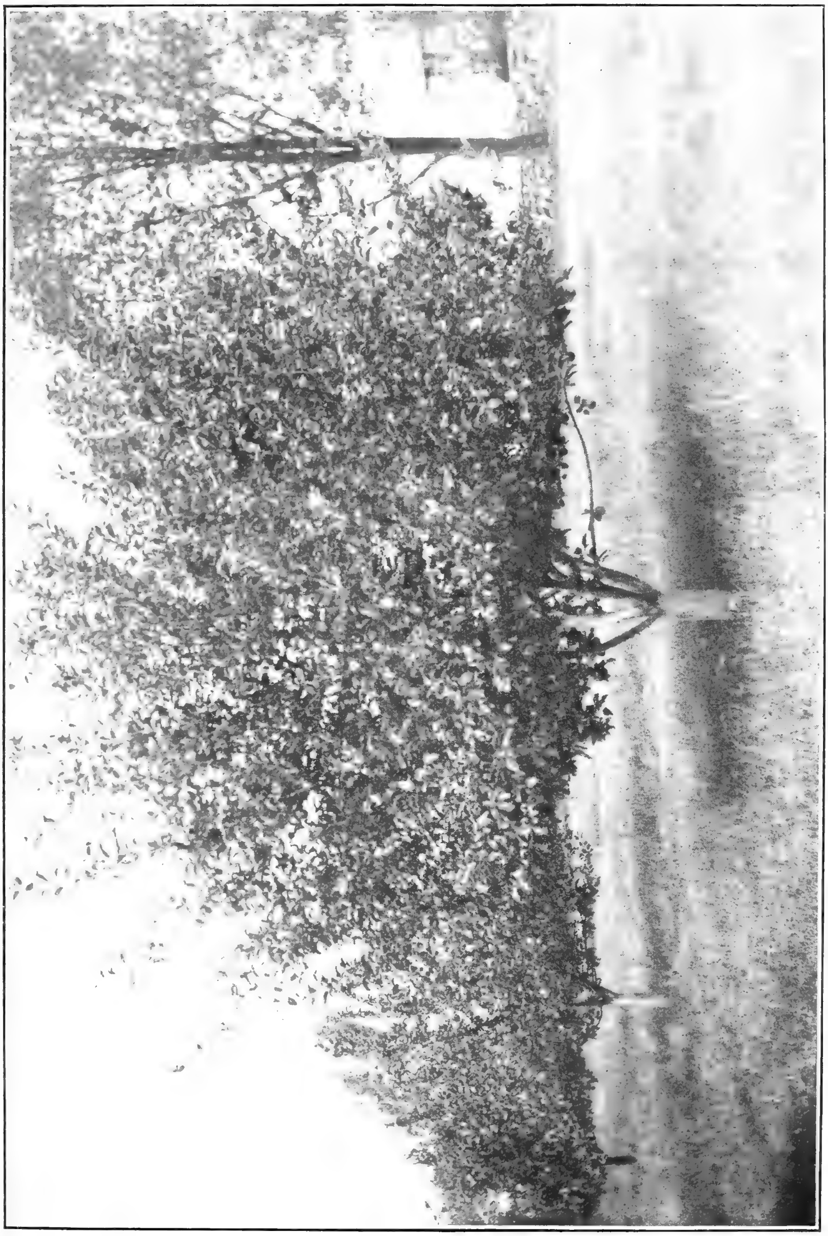
A deep, rich, loamy soil with the upper subsoil of at least medium porosity seems to be essential, though a heavier subsoil at a depth of 4 to 6 feet is apparently not objectionable. The first orchard mentioned is underlain by a retentive subsoil of clay loam to clay, at a depth of about 6 feet. The Roxbury thrives on a much richer soil than the Baldwin, which does not color well on the best russet soils. The "green" Rhode Island greening soil, on the other hand, is somewhat too clayey for the Roxbury.

Grown on the soil conditions described, the Roxbury tree is prolific in Massachusetts, the fruit attains large size and good quality, its keeping characteristics are excellent, and it brings a good price, especially for export trade. Young trees of this sort are now so rarely planted that there would seem to be a good opportunity for it in a limited way to supply the small yet definite demand.

MISCELLANEOUS NOTES ON SOIL-VARIETAL ADAPTATION.

In the eastern part of Massachusetts with its near-by markets summer and fall varieties of apples such as Williams (Williams Favorite), Red Astrachan, Maiden Blush, Oldenburg (Duchess of Oldenburg), Wealthy, etc., are grown with much success on Gloucester loam and Gloucester fine sandy loam. The predominating reason for growing these and other early season varieties in eastern Massachusetts is, however, except in the case of Wealthy and to some extent Oldenburg, the local or near-by market demand, rather than the character of the soil, which also happens to be favorable. This is shown by the fact that, with the exception of Wealthy, which has been much used as a filler in recent plantings, these varieties are little grown in western Massachusetts, even though they give good results there on the same or similar soils.

It may be added that Red Astrachan under ordinary or average conditions maintains a stronger growth for a longer term of years on the Gloucester series than on the average Wethersfield soils. This is strongly indicated by the productiveness of old trees or of trees more than 25 years old. It seems probable that the arrest of growth



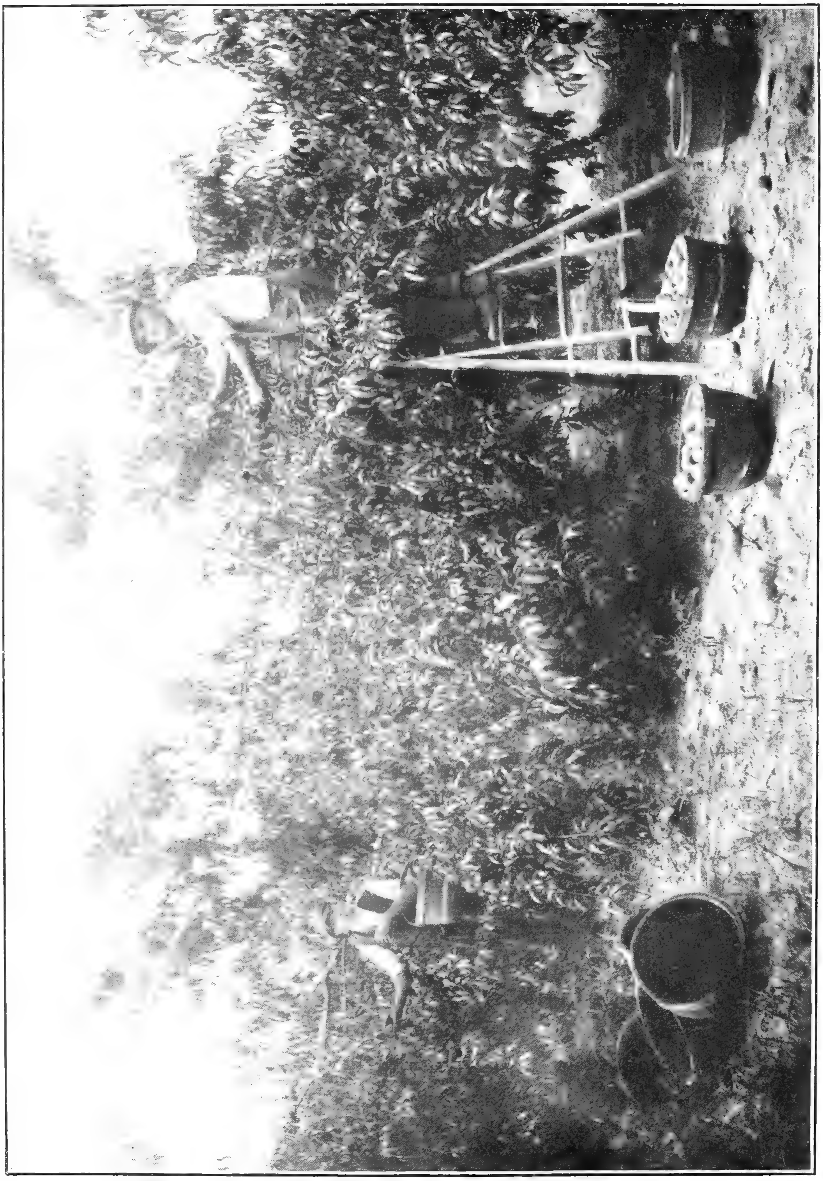
McINTOSH, 7 YEARS PLANTED, BEARING THIRD CROP. GLOUCESTER LOAM, FITCHBURG, MASS.

GRAVENSTEIN, 45 YEARS OLD, ON WETHERSFIELD LIGHT SILT LOAM.

[Top cut back and thinned. Note severe thinnings of fruit on the ground. Heavy yield and good quality.]

INDIVIDUAL TREE IN PLATE V.

[Roxbury Russett, 96 years old. Long lived and prolific on strong loam. Newbury (Oldtown), Mass.



SIX-YEAR CARMAN PEACH ON VIRGIN WETHERSFIELD LOAM. WALLINGFORD, CONN.

during a droughty period affects these sorts more severely than the stronger growing varieties such as Baldwin, and under equal conditions the Gloucester loam certainly maintains a more uniform moisture supply than the Wethersfield loam, though not necessarily more than deep areas of the less extensive Wethersfield silt loam. Undoubtedly other of the weaker-growing, or short-lived, sorts will also do better under the same treatment on the average Gloucester soils than on the Wethersfield; but strong-growing varieties such as Wealthy and McIntosh are very promising on the loam, silt loam, and heavy phases of the sandy loam in the Wethersfield series, except at low elevations in southern Connecticut, and on them Baldwin has long since proved its worth for commercial purposes.

THE ADAPTEDNESS OF SOILS TO VARIETIES OF PEACHES.

If a line be drawn connecting the northernmost of the commercial peach orchards in Connecticut it will correspond in a general way to the most southern of the average isothermal lines (U. S. Weather Bureau) of the six winter months which includes any material part of the State. During the spring months of March, April, and May the fluctuations of the extremes of temperature are also a little less marked within this belt where, at good local elevations, the minimum temperature does not reach the point of frost as frequently as elsewhere in the State, and winter temperatures are likewise a little less severe. This effects a relative steadiness of temperature during critical periods which lessens the danger from frost. The line referred to would extend just north of the southwest corner flange of the State, where it projects into New York, northeasterly about 10 miles north of South Norwalk, thence to Beacon Falls and Farmington, across the Connecticut Valley north of Hartford to Vernon, south to East Glastonbury and Haddam, and thence to the southeast corner of the State. Within the area lying between this line and the Sound most of the commercial peach orchards of Connecticut are located, though comparatively little development has taken place east of Haddam where it may be said the weather records seem a little less favorable, and in the southwestern extension of the State orchards are scattering.

On the Gloucester soils of the Western Highlands is located, however, one of the largest commercial orchards, and there are many smaller ones in both the highland districts. The importance of good local elevation can hardly be overestimated. Even in an average season the rotting of fruit is much worse in orchards where the free and rapid circulation of the air is in any way impeded, and in a season such as 1912 when the weather was hot and humid during part of the picking period, the tendency is much increased. The soils in the areas where development has chiefly taken place are distributed among four main series, the Wethersfield, the Middlefield, the Gloucester, and the Talcott, named in the order of their importance. There are various types of soil in each of these series as determined by texture, and a wide range in what may be termed general soil or field conditions. The Wethersfield and the Middlefield series are underlain by shale or sandstone at varying distances from the surface, and under equivalent treatments are not quite so strong for general farm crops as the Gloucester soils.

The fact that peach growing has not been developed more extensively in the highlands is doubtless due primarily to climatic conditions, as the opinion prevails, founded in part at least on experience, that the crop is a little less certain there than within the isothermal line mentioned. Aside from the prolongation of the isotherms northward in the Central Lowland their usual direction is northeast and southwest, and if the three southern New England States be considered as a unit the isothermal lines roughly parallel the seashore. The close relationship existing between the temperature lines covering the southern Berkshire hills in the Seymour district, the Woodstock district, in the northeast part of the State, and that locality in southeast Worcester and western Norfolk Counties, Massachusetts, where peach growing is commercial, is very striking. As successful orchards are maintained on the Gloucester soils in all these districts, it would seem that the somewhat prevailing opinion that the Wethersfield soils are superior to the Gloucester soils for peach production is based on the average texture of the series, and that the real difference is largely one of soil type rather than of soil series.

It is doubtless true, however, that under good treatment a given type—as the loam—of the Gloucester series is a little stronger than the loam of the Wethersfield or the Middlefield series, and hence a given variety of peach as grown on it tends to ripen a little later than on the corresponding soil type of either of the two latter series. For this reason these different series as represented by the different soil types require different treatments to maintain a normal balance between the vegetative and the fruiting habits of the tree. This is a matter requiring skill in observation, and knowledge as acquired through experience of the way the soils respond to different treatments; and the subject merits further study. It may be said, however, that certain soil conditions seem fundamental. For example, soils should be so deep and friable that any excess of free moisture not only disappears readily below the root zone of the trees but returns to that zone as capillary soil solution for the trees' use as occasion may make desirable. Anything interfering with such free movement of the soil moisture, which by the absorption of soluble matter within the soil becomes the soil solution which the trees use, is a detrimental soil condition. Underlying ledges, large stones, the several kinds of hardpan, and subsoils that are too impervious because of excessively fine texture (too clayey) or stiff structure, are of this class and should be scrupulously avoided.

Again, the textural and structural relationship between soil and subsoil may be of considerable importance. With surface soil of strong loam, for example, a subsoil of light sandy loam or even of compact sand is preferable to a loam or a clay loam, as it offsets in a measure the more retentive tendency of the surface material; and while such a soil section is probably less desirable than a strong sandy loam underlain by a friable loam, or approximate material, it has given good results, nevertheless, in several instances. It is a matter of common experience, however, in various peach districts, that where both soil and subsoil consist either of sand or of heavy material the best results are not secured. In a given case where a small part of a large orchard is a sand or a very light sandy loam it is very difficult to secure a growth as strong as desired largely on account of the difficulty of keeping up the supply of humus. But the subsoils that are in a general way satisfactory in both texture and structure are extremely variable, and to the countless combinations of these characteristics not all varieties respond equally well. For a description of some of the individual types of soil upon which peach growing has been most extensively developed the reader is referred to page 23.

In general, slightly moist soils seem less objectionable for the white varieties at present grown in southern New England than for the yellow sorts, a high finish on the latter being more difficult to secure on soils which tend to be moist. This is evidenced in some orchards on Wethersfield soils where underlain by a somewhat impervious layer at a depth of 15 to 24 inches. This layer consists of a mass of shale fragments embedded in heavy silt loam or silty clay loam, the shale being so dense as to prevent the use of a soil auger, and it in turn is usually underlain by bed rock. This soil is sufficiently impervious to delay cultivation for a few days in the spring after adjoining areas without the hardpan are ready, and all varieties ripen appreciably later. These soils are not so impervious, however, as to cause any hydration, the soil being a clear red and of open friable structure throughout. It is thus apparent that the excess moisture, while disappearing slowly, eventually does so sufficiently to prevent any hydration and to afford thorough aeration and oxidation later in the season. Several of the white varieties are grown satisfactorily, but the yellow sorts rarely have as good finish and the quality, in some cases, at least, is inferior to that secured on other soils.

The unfavorable weather conditions which prevailed during the peach-harvesting season of 1912, especially in the Carman-Champion period, furnished in conjunction with subsoil variation an unusually sensitive index to the behavior of these varieties and also to some other sorts.

The tendency of the Champion peach, when humid weather prevails, to rot before quite ripe enough to pick, is generally recognized as a very serious difficulty with this otherwise excellent variety. The connection between the direct effect of the weather in bringing this about and any impervious condition in the subsoil, as determined by hardpan, underlying rock, a too high content of clay, or a subsoil structure too stiff is quite marked, and was of much commercial importance in Connecticut in 1912. So exacting were the weather conditions that it was very difficult, and in some cases impossible, especially in the large orchards to prevent more or less loss no matter how favorable the soil and local elevation, but the fruit went down much more rapidly where the subsoils were shallow or lacked sufficient porosity from some one or more of the causes above enumerated. This was somewhat noticeable when comparing the fruit from different orchards, but as such comparisons are usually based upon the average of the soil and subsoil conditions which often include a considerable range, they are much less indicative than similar contrasts afforded by an orchard or orchards under the same management, where it is certain that the same or comparable treatments have been given, or where information is available as to the exact variation in the treatment for a considerable term of years.

The influence of variation in soil depth was well illustrated in the season of 1912, on a ridge of about 500 feet elevation in a large commercial orchard, which is divided by a north and south road. On the east side of this road Carman and Champion were both later, as in other years, than on the west side, the elevation being virtually the same. On the west side the soil is friable and of fairly good depth. As the underlying rock dips to the east, it is much less broken than on the west side and consequently subsoil drainage is far less complete. The friable soil—Wethersfield silty loam—does not vary materially to an approximate depth of 2 feet, but because of the difference in subsoil drainage that west of the road may be worked from a week to 10 days earlier in the spring than that east of the road, and there is a similar difference in the ripening date of a given variety of peach. On August 31, for example, the Champions still needed to ripen for several days, and stray Carman trees were only just ready to pick, though the Carman season was supposed to have ended in that locality a week before. In this case all conditions except the subsoils are so nearly identical that the difference seems due solely to the greater retentiveness of the one, the extra moisture thereby retained so lowering the specific heat of the subsoil as materially to defer the ripening of fruit or other products. If there be excessive humidity just before picking time, however, this additional moisture may cause the fruit to go down more quickly than that from subsoils less retentive of moisture.

Judging from the experience of a very large number of growers in Connecticut and in other States, combined with field observations, it seems evident that the Champion peach is especially sensitive to any condition of subsoil which hinders the ready movement of moisture within a probable depth of as much as 4 feet from the surface. This would include not only those conditions which tend toward hardpan, but also the subsoils whose clay and silt content is sufficient to render them compact or close, particularly the clays and the clay loams.

While the surface soil should not be heavy enough to form clods, its character is of much less importance than that of the subsoil.

Notwithstanding the fact that a fairly strong soil is desirable for the best tree growth and size of fruit, it is very easy so to overdo these tendencies that the fruit neither matures well nor ships well. If the picking season happens to be wet the rotting tendency of Champion is increased and such a season is almost fatal to this variety when grown on rich strong ground. So it seems that Champion is best planted on soils of only medium productivity, but they should be sufficiently loamy and deep for the variety to be held well within control. There should be not too much humus, yet just enough. The soil and subsoil should be held so closely in hand that a little fertilization will increase the size of the fruit if necessary, and conversely that the fruit may be held in check if the shipping quality is not satisfactory. The best results, averaging seasons, have come from light porous soils such as medium to heavy friable sandy loams underlain by material not heavier than a friable loam, and preferably by a heavy sandy loam. Too great porosity of the entire soil section may entail, however, more risk from droughty periods than would appear from rot on a soil section a little heavier, hence soils may be too sandy and loose even for the Champion.

Carman and Mountain Rose are not quite so dependent as the Champion on soils that drain out hastily, and while they succeed best on soils of a little greater moisture-holding capacity than the Champion, they nevertheless give the best results on deep and well-drained soils. They do very well indeed on the Wethersfield loam which seems for them a typical soil condition. They are also grown with success on heavy sandy loams and on the light silty loams of the Wethersfield series and the Middlefield series where the subsoil is not more compact than a friable loam or light silty loam. (See Pl. XXI.)

The Elberta and the Belle (*Belle of Georgia*) thrive on well-drained soils that are somewhat stronger than the varieties previously mentioned. The wood is said to be less brittle than that of some other varieties, and hence suffers less from breaking down. Loams, silty loams, and silt loams with subsoils of similar material seem not too heavy, nor to supply any excess of moisture provided the entire soil section is well drained. These varieties do not ripen as early locally on such soil types as on those more sandy, but in most cases earliness is of little importance with these varieties as compared with a better development of fruit. While the Elberta and the Belle, in common with other varieties, are best grown on deep soils, they are somewhat less sensitive to shallow soil conditions than are such varieties as Champion or Carman, though no variety grows so well on shallow soils, and in general they will stand stronger fertilization and greater amounts of organic matter in the soil than will Champion or Carman.

Late Crawford also seems to thrive best on a fairly strong soil such as a light porous loam, one that is a little less retentive of moisture than the heaviest of the Elberta soils mentioned.

Some of the early varieties, such as Greensboro, are less sensitive to shallow soil conditions than others, this probably being due, in part at least, to the inferior quality of these early sorts as compared with later varieties.

SUMMARY.

The surface features of Massachusetts and Connecticut are locally complex, but they may be grouped as follows to show general relationships: The Western Highland, the Berkshire Valley, the Connecticut Valley, the Eastern Highland, and farther east in Massachusetts the Eastern Plateau, the Framingham-Boston Lowland, and the coastal district, which includes Cape Cod.

The climate is rigorous, but the seasons are of sufficient length for the securing of good farm crops. The climatic conditions are very favorable for apples in both States. Peaches are successfully grown in several localities, but the chief development is along the high slopes adjoining the lower Connecticut Valley Basin.

The upland soils have been derived from glacial drift, except possibly on a few of the steep and narrow preglacial ridges early denuded of all glacial débris. The soils are thus composite in character. Large and important areas of sedimentary soils occupy the Connecticut Valley and alluvial soils also occur along many of the minor streams.

There is a wide range of soils in Massachusetts and Connecticut, which vary greatly in productivity. Poor soils occur, but there is a large total acreage of good soils which are in part well farmed and in part so poorly managed that they bear the reputation of being low in productive quality, or even worn out. The latter soils need first to be located and classified, and then to have their farming possibilities demonstrated by experimental crop growing.

A general soil classification follows:

The Gloucester series is by far the most extensive. It includes the yellow and brown upland soils. The gray and blue-gray upland soils constitute the Bernardston series. The Wethersfield series includes the glaciated upland areas of Triassic red standstone and shale, the surface soils of the sandy types being gray or pinkish gray, and the heavier types red or salmon in color. The subsoils are red or salmon. The Middlefield series includes the glaciated upland areas of Triassic yellow and gray sandstone and shale, the surface soils being yellow, brown or gray, and their subsoils brown to yellow. The glacial outwash soils found along the lower courses of streams as they issue from the uplands into the major valleys constitute the Merrimac series. The Dover series consists of glaciated limestone soils in the Berkshire Valley. The Whitman series occurs in depressed or basin-shaped areas, and also bordering streams. The surface soils range from brownish gray to almost black, while the subsoils are lighter gray, or mottled gray and yellow. The Essex series consists of dark-brown glacial soil underlain by a light-brown to yellow subsoil usually lighter in texture than the surface soil.

The agricultural methods pursued in the market gardening sections, and in other districts of special crop development, are intensive, but in the general farming districts extensive methods prevail.

Even in this long settled region there is need for improvement in the agricultural and horticultural practice. Growers of special crops—onions, tobacco, market-garden produce, apples, peaches, cranberries, etc.—are generally prosperous. Other farmers who prosper are those who retail the milk produced on their own farms, poultrymen who have placed their business on a firm footing notwithstanding frequent individual failures, and dairymen who have produced some money crop or product, such as apples, potatoes, garden produce, poultry, etc. Few farmers prosper, on the other hand, unless an income is secured from some special money crop or product.

In the hilly districts some farms have properly been abandoned because they did not furnish, under current agricultural conditions, a sustaining basis for a prosperous family. Other farms that have always possessed the possibility of a good livelihood if efficiently managed have been abandoned on account of family circumstances. The first class of lands should be managed by the owners of the second class—that is, as adjuncts to farms now existing as economic units—or they could be so combined in some cases as to form new economic units of land holdings. There are good opportunities in both States for such land development, but they must be developed on the basis of economic adaptedness of the different soil conditions to crops and other farm products.

There is little land tenantry in either State. Most farms are occupied by their owners, but those owned by city residents are often occupied by managers and superintendents.

Labor conditions do not differ from those in other northeastern States. The cost of labor has steadily increased, thus necessitating more efficient farm management—a goal not infrequently attained.

The principal products sold are horticultural crops from field and greenhouse, milk and cream, poultry and eggs, veal and pork, tobacco and onions.

In districts intensively farmed the adaptedness of soils to crops is pretty well understood and the cropping system is generally well arranged. In the districts where extensive methods of farming prevail, adaptedness of the soil to crops is less generally recognized.

Trunk-line and branch railways, with many trolley lines, furnish good transportation facilities for most of the region, though some districts are still far from such advantages.

The area of Massachusetts is 8,039 square miles, and in 1910 her population was 3,366,416, or 418.7 per square mile. The area of Connecticut is 4,820 square miles, and in 1910 her population was 1,113,736, or 210.5 per square mile. Such a mass of population furnishes excellent markets for large quantities of farm-food products.

Soil development along various lines is possible. Among these, orcharding is important.

The different varieties of apples and peaches do not succeed equally well on all soils, some varieties giving the best results on soils or under soil conditions that may be more or less definitely defined. In some cases, however, a soil not suitable in all respects may be modified, as by increasing or decreasing the humus content, tile draining, etc., to meet the requirements to such a degree that moderately good results may be secured. The kinds of soil upon which various varieties of apples have given, and may reasonably be expected to give, good results are described.

Under cultivation mellow loams and fine sandy loams overlying subsoils not lighter than a medium loam nor heavier than a light or medium clay loam of friable structure excel for the Baldwin. Under the same soil conditions Rome Beauty thrives farther south, where the climate is a little warmer. Heavy silty loam or light silty clay loam with similar subsoil brings a good "green" Rhode Island Greening, but lighter soils such as fine sandy loams and warm mellow loams excel if a high blush is desired.

Soils favoring the Hubbardston are rich fine sandy loams, or heavy loamy fine sands with subsoils of fine sandy loam or mellow loam.

For the Northern Spy and the Wagener, a mellow medium loam underlain by heavy loam or friable light clay loam is desirable, but the supply of humus and the application of ammonia-carrying fertilizers should be much greater for the Wagener than for the Northern Spy.

The heavier of the soils described for the Baldwin seem promising for the McIntosh.

For Tompkins King and Gravenstein, an open-textured loam, rather than a fine loam, with subsoil of the same or only slightly heavier texture, is preferred. While similar soils are excellent for Ben Davis and Gano, it is believed that these varieties should be grown outside of New England.

Both the Tompkins King and the Northern Spy soils give good results with the Fall Pippin.

A deep rich loamy soil with subsoil of at least medium porosity, preferably a sandy loam, is excellent for Roxbury.

Soil adaptedness under Connecticut conditions to some of the commercial varieties of peaches follows:

Champion succeeds best on soils of only medium productivity, but they should be deep and well drained. Medium to heavy friable sandy loams underlain by material not heavier than a friable loam and preferably a heavy sandy loam are very desirable.

Carman and Mountain Rose succeed best on soils somewhat less pervious than the Champion, but still deep and well drained. This soil condition seems typically supplied by the loams of the Wethersfield and the Middlefield series.

The Elberta and the Belle prefer stronger soils than the Carman and the Mountain Rose. Loams, silty loams, and silt loams, with subsoils of similar material seem best to meet these requirements under Connecticut conditions.

For Late Crawford, a fairly strong soil, such as a light porous loam somewhat less retentive of moisture than the heaviest of the Elberta soils is desirable.

Some of the early varieties, such as Greensboro, are less sensitive to shallow soil conditions than the varieties mentioned above.

ADDITIONAL COPIES

OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
25 CENTS PER COPY