SOIL SURVEY OF BRADFORD COUNTY, PENNSYLVANIA.

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DESCRIPTION OF THE AREA.

Bradford County is situated in the northeastern part of the State of Pennsylvania on the New York-Pennsylvania State line. It is bounded on the north by Chemung and Tioga Counties, N. Y., on the east by Susquehanna County, on the south by Wyoming, Sullivan, and Lycoming Counties, and on the west by Tioga County, Pa.

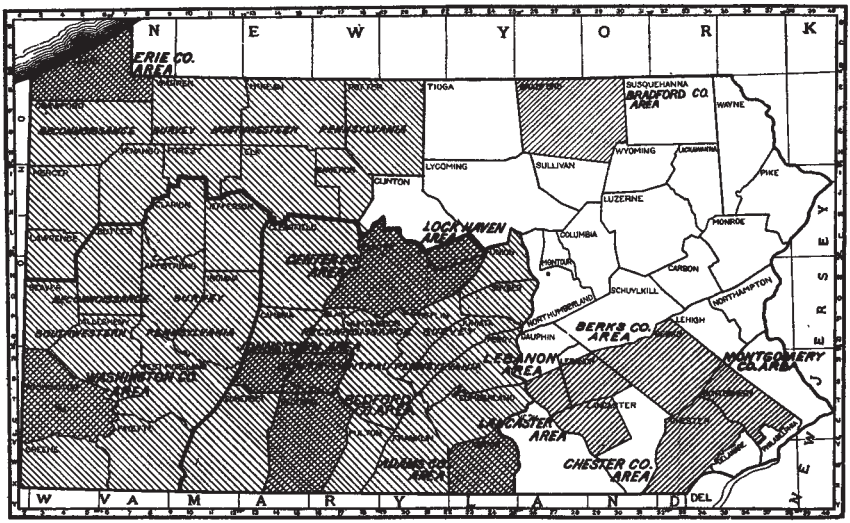

FIG. 5.—Sketch map showing areas surveyed in Pennsylvania.

Its greatest width from east to west is 40 miles and from north to south 32 miles. It is the third largest county in the State, containing 1,160 square miles, or 742,400 acres.

The area forms a part of the Allegheny Plateau that has been deeply dissected and carved by the Chemung and Susquehanna Rivers and their local tributaries into a condition of topographic relief varying from rolling and hilly to rough and mountainous. The highest point in the area is Mount Pisgah, 2,260 feet, in the western part of the county, while the lowest is 660 feet, along the Susquehanna River at the point where it leaves the county to the south-

east, giving a maximum range in elevation for the county of 1,600 feet. The general trend of drainage waters is from northwest to southeast. The predominant topographic features, however, are wholly independent of the drainage, running approximately at right angles to the main drainage line, the Susquehanna River, and parallel to the subordinate lines. The latter do not follow the main ridges, but instead incline to the direction of lowland belts, occasionally crossing the main line. Although, as stated above, the county lies wholly within the Allegheny Plateau, its surface is not that of a typical plateau, or even of a dissected plateau. Even if the stream valleys were filled to the tops of the adjacent slopes the upland surface would not be smooth. The filling of the creek and river valleys would not affect the predominant features, but would make them more prominent by eliminating the minute topographic detail that obscures to a limited extent the main features.

Three ridges enter the area, while a fourth barely touches the extreme southeastern corner. The most northerly one extends from the west, but fades out within a few miles after entering the county. It is the least prominent of the three in both height and extent. The second extends entirely across the county as a single, rather prominent ridge west of the Susquehanna and as two faint ones east of it. In Tioga County both of these ridges are prominent, the second one being the more pronounced. It becomes considerably lower and less continuous within a few miles after entering Bradford County. Except for the western 5 miles of its extent in the county it is, like the northernmost ridge, merely a broad belt of high and strongly rolling country, varying in width from 3 or 4 to 10 or 12 miles. The third ridge is the most prominent. It is really a tongue of the true Allegheny Plateau, with flat top and steep slopes, that extends into the county at its southwestern corner. It is not a prominent feature east of the Susquehanna River. Its breadth varies from a very few miles to 10 or 12 miles. The lowest slope only of the fourth ridge extends into the county in its southeastern corner. Alternating with these high belts there are four low belts—all of these distinct topographic features in the western part of the county. The two most northerly ones unite into one belt east of the eastern end of the northernmost high belt, while all of them are less clearly defined east of the Susquehanna, owing to the faintness of the ridges.

The lowland belts are of rolling topography, with rather strong relief. There seems to be no well-defined accordance of elevation among the hilltops and ridges within the belts. The hill and ridge tops are well rounded, and a few small areas are well worn down to a lowland of faint relief. The extreme of local relief within these belts will reach nearly 1,000 feet, and their prevailing character is that of a very hilly country with an upland of rounded outline.

The greater part of the northern section of the county is drained by northwardly flowing streams tributary to the Chemung in the western and to the Susquehanna north of the State line in the eastern part of the county. The central and southern parts of the county are drained directly into the Susquehanna. The main streams are Sugar, Towanda, and Sugar Run Creeks west of the river, with Wysox and Wyalusing Creeks east of it. Sugar Creek flows along the northern side of the third belt from the north, but its tributary streams on its north side head on the southern border of the second lowland belt, cutting valleys entirely through the second ridge. Towanda Creek drains the north and central parts of the third ridge and the southern part of the third lowland belt, the watershed between it and Sugar Creek lying wholly within this belt. Sugar Run Creek is a small stream lying within the southernmost lowland belt. A considerable part of the latter belt, however, is drained by the South Branch of Towanda Creek, which heads in and flows northward from it across the third ridge.

East of the Susquehanna Wysox Creek has a southwestward course across the general trend of the main topographic features. Wyalusing Creek, however, lies wholly within the third lowland belt. It is evident from the foregoing that neither the main nor the secondary drainage fits into the main features of the topograpny.

The most northern of the lowland belts occupies only a small part of the northwestern section of the county. Wells and Fassett villages lie in it. The central line of the second belt passes through Snedekerville, Middletown, Athens, and Litchfield. It is about 6 miles wide west of the Northern Central Railway, but east of that is united with the northern belt and widens to 12 miles or more. The axial line of the third belt is the Canton, Granville Center, Mountain Lake, Towanda, and Brushville line. The belt is 7 to 10 miles wide.

The fourth belt lies along the Wilmot, Sugar Run, and Springhill line. Its width is about the same as that of the others.

The high belts vary from 1,200 to 2,000 feet in elevation, while the low belts range from 800 to 1,200 feet.

The North Branch of the Susquehanna River traverses the county, entering a little east of the center and flowing nearly south to Towanda in a comparatively straight line and thence in a southeasterly direction, leaving the county below Wyalusing. It is joined by the Chemung River flowing from the northwest, the two streams, with the State line, inclosing a triangular area 5 or 6 square miles in extent, in which Sayre and Athens are situated.

In its total length of something over 45 miles in Bradford County the Susquehanna drops 113 feet, or about 2½ feet to the mile, in a uniform descent.

The low gradient of the Chemung and Susquehanna Rivers, the immense watershed drained by them, and the removal of the timber growth combine to cause frequent overflows of the bottom lands and, at less frequent periods, of the terraces above them. These rivers are bordered by alternating steep hills and flat bottoms and stream terraces, the latter, with the bottoms along the large creeks, comprising the most desirable land in the area. Across the river from Towanda is a sheer outcrop of rock, which rises in an almost perpendicular cliff to a height of 1,317 feet, or almost 600 feet above the river, and which is about three-quarters of a mile long.

The large tributaries, such as Sugar, Towanda, Wysox, Wyalusing, and Wappasening Creeks, have a much higher gradient than the Susquehanna, that of Towanda Creek, for example, being nearly 21 feet to the mile in the 26 miles from Canton to Towanda. Serious overflows take place along the bottoms of these creeks, especially near the points of junction with the river, where the current encounters relatively slack water. Occasionally the bottoms are covered for miles back from the river, as occurred in December, 1901, when the Towanda Creek bottom was inundated from hill to hill for a distance of 10 miles from its mouth. These overflows often cause heavy damage to the fields and, in the event of a flood like the one just mentioned, are occasionally accompanied by loss of life. The inundated areas, however, receive valuable depositions of fine soil material from the sediment-laden waters.

There are a number of small lakes and ponds in Bradford County, situated in depressions at high elevations, the most important being Mountain Lake, near Burlington; Lake Wesauking, northeast of Towanda; Lake of Meadows, east of Warren Center; and Lake Nepahwing, near Canton. Such lakes are typical of a glaciated country and result from the blocking of the drainage channels.

Permanent settlement of the county dates back to 1760, when Moravian missionaries entered the region. By 1774 several families had established themselves, taking up lands along the river in the eastern section of the county. Most of the early settlers in Bradford County were from New England. To-day almost the entire population is native-born. The county was organized in 1810 from parts of Lycoming and Luzerne Counties and Towanda, the county seat, was laid out in 1812. Post-offices were established at Sheshequin, Wyalusing, and Tioga Point in 1803. By 1820 the population had increased to 11,454; in 1860 it was 48,734; in 1900 the census showed 59,403 inhabitants. According to the census of 1910 there has been a decrease during the last decade, only 54,526 being returned for the county. The great majority of the inhabitants is engaged or directly interested in agriculture.

Sayre is the largest town, with a population of 6,426. It has the shops of the Lehigh Valley Railroad and is also an important division point on that road. Towanda, the county seat, has a population of 4,281. Several manufacturing enterprises are located there, among them three silk and knitting mills, a cut-glass factory, two flour mills, a toy factory, and a furniture factory. Athens, adjoining Sayre on the south, has a population of 3,796. Its principal industries are a furniture factory and tool works. The other towns on the river are all small. Canton and Troy are the leading towns in the western side of the county, having about 1,600 and 1,200 inhabitants, respectively. Burlington, East Smithfield, Leroy, Alba, and Gillett are smaller towns.

Several attempts were made in the early history of the county to run steamboats on the Susquehanna River, but all proved unsuccessful, because of the swift current and shallow depth. In 1854 a canal was completed along the Chemung and Susquehanna Rivers, connecting the Erie Canal system via Elmira and Watkins with Wilkes-Barre and the canal along the lower Susquehanna. This was soon abandoned, however, owing to faulty construction, and was later converted into the roadbed of the Lehigh Valley Railroad. Trains were first run over this road as far as Towanda in 1867. Waverly was reached in 1868, and in 1891 the road was completed to Buffalo.

East of the river there is no means of transportation other than by wagon. The Northern Central branch of the Pennsylvania System traverses the western side of the county, following as natural a path as does the Lehigh, while the Delaware, Lackawanna & Western, and the Erie touch the county on the north, the latter making connections with the Lehigh Valley at Waverly, a town just across the State line in New York, west of Sayre. The Susquehanna & New York Railroad runs from Towanda along the Shrader Branch of Towanda Creek, connecting with the Northern Central at Ralston, in Lycoming County, a few miles south of Bradford County. A branch of the Erie also cuts across the extreme northwest corner of the county.

The county has, therefore, excellent communication with points outside the area, but means of communication between the eastern and western sides are lacking.

The area is plentifully supplied with roads, which are kept in fair condition. The predominant soil type, the Volusia silt loam, with its heavy, silty clay subsoil, affords excellent material for the construction of dirt roads. There are about 20 miles of State or macadam road in the area in disconnected sections, and a preliminary survey has just been made for one which will cross the county from west to east.

The county is well supplied with schools. Excellent high schools are found in all the larger towns and a higher academy in Towanda.

Philadelphia, Baltimore, and Elmira are the principal markets for the western side of the county, while the eastern side finds its markets in New York, Scranton, and Wilkes-Barre.

CLIMATE.

Bradford County enjoys a wide range of temperature, the extremes recorded at Towanda during the past 14 years being 90° F. in summer and —31° F. in winter. While the lower figure is seldom reached, a yearly range of about 100° may be expected. January and February are the coldest months and July and August the warmest. Shut off by the highlands of eastern Pennsylvania and New York from almost all marine influence, the climate of the area is drier and not so susceptible to coastal storms and fluctuations of temperature.

The data given in the following table were recorded at Towanda, on the Susquehanna, and can scarcely be regarded as representative of the whole area on account of the modifying effect of the river and also because practically two-thirds of the county lies at an elevation of 500 to 1,000 feet higher than the county seat.

From observations taken at Leroy on Towanda Creek, the average date of the first killing frost in fall is given as October 7, while the earliest date on record is September 22. The last frost in the spring averages May 6, with May 29 as the extreme. This gives an average growing season for the valleys of about 140 days. On the higher hills, however, not more than 120 to 125 days without a hard frost can be counted on.

A table showing the temperatures and precipitation at Wellsboro, Tioga County, about 25 miles west of Bradford County and 575 feet higher than Towanda, may be useful for comparison. It should not, however, be regarded as strictly representative of the Bradford County hills, as Wellsboro is in a much more mountainous section. This table shows a uniformly colder climate, except for the mean of the three winter months.

The precipitation recorded at Towanda ranges from 25.4 to 43.7 inches in 14 years, with a mean for that period of 34.6 inches. About 6 inches of this falls as snow, and the ground is covered for a good part of the winter months, especially in the more elevated country. It is reported that the summer rainfall on Armenia and Barclay Mountains is much heavier and better distributed than on the lower hills and this fact, with the prevailing cooler weather, makes conditions more favorable for certain short-season crops. A comparison of the precipitation at Wellsboro and at Towanda shows no

appreciable difference for the summer months, though the average annual precipitation is almost 5 inches greater at the latter place.

On a heavy silt soil, such as is typical of this area, the distribution of rainfall is most important, since the thin layer of moisture-retaining soil is generally too wet for early cultivation in the spring, while in the event of a dry period in July and August it becomes completely dried out at a time when many crops are at a critical stage. Such summer droughts have been frequent and disastrous to hill farms in recent years.

The prevailing fair-weather wind in the area is north or northwest, while a south or southeast wind generally brings rain.

Normal monthly, seasonal, and annual temperature and precipitation recorded at Towanda and Wellsboro, Pa.

Month.	Towanda.						Wellsboro.			
	Temperature.			Precipitation.			Temperature.			Mean precipitation.
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean.	Absolute maximum.	Absolute minimum.	
	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*	° *F.*	° *F.*	° *F.*	*Inches.*
December	28.8	65	−16	2.68	3.57	6.00	28.9	65	−28	3.20
January	24.7	70	−31	1.88	1.95	.91	24.6	66	−25	2.26
February	22.8	60	−17	1.88	.50	.45	24.6	62	−25	2.45
Winter	25.4	.....	.....	6.44	6.02	7.36	26.0	.....	.....	7.91
March	34.7	82	−19	3.01	1.28	3.92	32.3	76	−12	3.01
April	46.2	87	18	2.38	1.70	4.65	44.2	86	14	3.14
May	58.3	93	22	3.11	2.56	7.58	57.0	92	21	4.11
Spring	46.4	.....	.....	8.50	5.64	16.15	44.5	.....	.....	10.26
June	66.2	95	35	3.86	3.64	4.26	64.6	94	32	3.56
July	70.9	97	38	3.86	2.84	3.51	68.9	96	34	4.00
August	68.5	99	35	3.60	2.47	4.78	65.6	93	33	3.09
Summer	68.5	.....	.....	11.32	8.95	12.55	66.7	.....	.....	10.65
September	62.6	94	27	2.93	1.47	3.95	59.7	88	26	2.75
October	50.6	88	17	3.31	1.19	1.31	49.0	76	13	3.35
November	39.0	75	10	2.14	2.22	2.43	37.7	65	6	2.60
Fall	50.7	.....	.....	8.38	4.88	7.69	45.5	.....	.....	8.90
Year	47.8	.....	.....	34.64	25.41	43.76	46.4	.....	.....	39.76

AGRICULTURE.

The earliest settlers in the area found the Indians raising crops on the river flats, and, making use of this knowledge, established their homesteads on the fertile bottoms and terraces bordering the Sus-

quehanna and Chemung Rivers. The Indians raised corn, vegetables, and fruits, their custom being to plant corn year after year in the same hills, the natural fertility of the soil and the occasional overflows undoubtedly tending to offset the otherwise injurious effects of this practice.

The early settlers found the hills covered with excellent hemlock, white pine, beech, birch, and maple, and the bottoms with sycamore, butternut, black walnut, hickory, elm, and maple. As the country was opened up and the population increased lumbering became an important industry. Only in very recent years was the last of the valuable timber removed from Bradford County. The thriving villages of Powell and Laquin owe their origin and present existence to the lumber business and its by-products. Lumbering, however, was always secondary in importance to agriculture and is now a mere side issue.

The first crops grown were corn, beans, and fruits. Wheat and oats were soon added, followed by rye, flax, and tobacco. Wheat was formerly much more extensively grown than at present, but in late years the production has decreased to make way for more profitable crops. As late as 1880 the output reached over 200,000 bushels annually, while in 1899 only 177,430 bushels were produced, with an average yield of only 15 bushels to the acre. Since then the production has still further declined, the census of 1910 giving the production as 72,168 bushels.

In the early days communities were comparatively isolated, owing to the poor transportation facilities, and, therefore, more or less independent. Grist mills were numerous, local distilleries used the surplus grain, charcoal burners and ash pits used the supply of wood furnished by clearing the land, and numerous tanneries came into existence, only a few of which remain.

Tobacco seems to have reached its maximum production in 1900, when 1,693,820 pounds were grown, as compared with 173,142 pounds in 1879. In 1910 the production had decreased to 328,753 pounds, owing to low prices, but is now increasing, and the high price of 14 cents reached last season will still further stimulate planting. There are many tobacco sheds along the rivers and large creeks, some of which have been transformed into barns. These will undoubtedly again be used for their original purpose. One disadvantage of the tobacco crop, aside from the labor involved, is that the tobacco land, usually the richest on the farm, receives the great bulk of the available manure, while the hill fields, partly because of their comparative inaccessibility and partly because of their lack of adaptability for tobacco, receive practically no fertilization.

The production of barley and wheat has declined within the last 20 years, while buckwheat, rye, and potatoes show a marked increase.

This is but natural, as without careful management the Volusia soils, which predominate in the area, become acid and wet. Buckwheat does better than almost any other crop under such conditions and many farmers have turned to it instead of draining, liming, and building up their land. The production of buckwheat in 1909 was 498,758 bushels, or an average yield of 18 bushels per acre. Buckwheat ranks next to oats in acreage, hay taking the lead over all other crops.

The production of corn has decreased from 721,662 bushels in 1899 to 386,453 bushels in 1909, with an average of about 26 bushels to the acre. Corn can be successfully grown on the high-hill soils (Volusia and Lackawanna series), and taken as a whole the area falls far below its possibilities in point of acreage devoted to this crop. Sugar beets and mangel-wurzels have been tried occasionally and it has been demonstrated that these crops can be successfully grown.

Dairying has for years been one of the leading industries of the county, the abundance of hill land, better suited to pasturage than to crops, and the excellent transportation facilities to outside points making an ideal combination to foster this branch of agriculture. The growth of the dairy herds has been consistent and steady. The census of 1900 placed the value of dairy products at $1,419,285 for the year 1899. Sales of live stock, sheep, and beef animals amounted to $676,070. It is probable the 1910 figures will show a still further increase. Interest among the farmers in the improvement, feeding, and care of dairy herds is awakening and larger returns from this industry are anticipated.

The principal crops of the area are corn, oats, buckwheat, potatoes, and hay. The usual crop rotation is corn and potatoes, followed by buckwheat, oats, and hay. In late years side oats have been extensively grown and under favorable conditions seem to give larger yields than other varieties. Potatoes also are being given a larger acreage, the crop of 1909 being 705,214 bushels, with an average yield of 96 bushels per acre. Onions and beans are but little grown. The vegetables and small fruits grown in the area in 1899 were valued at approximately $100,000.

The production of fruit in Bradford County has been held back by scale and other pests unknown years ago. Nearly all the orchards in the county show signs of neglect, while many, especially peach orchards, have been abandoned to the scale. However, in the vicinity of New Albany and in other localities commercial orchards are coming into bearing, and with the cooperation of the State Agricultural College and increased knowledge of the control and prevention of pests increased crops of fruit may be looked for. A peach orchard of considerable size is found near East Smithfield on Volusia silt loam, and a still larger one near Liberty Corners on the same soil.

The Volusia silt loam, light phase, and the Lackawanna soils, however, are better adapted to both apples and peaches than the Volusia silt loam.

Some alfalfa was grown in the area in 1899, and since then many farmers have been experimenting with this valuable crop. As a result it has gained a firm place in the agriculture of the county and its production is steadily increasing. Despite the skepticism of many farmers, it has been demonstrated that alfalfa can be successfully grown not only on the creek and river soils, where it seems to thrive best, but also on the upland soils, both Volusia and Lackawanna. Probably the best method is to take a piece of corn land, inoculate with 200 or 300 pounds per acre of soil from a field of alfalfa or sweet clover, applying from 1½ to 2½ tons of lime per acre, and then harrow frequently until about the last of August or first of September, when the alfalfa should be sowed alone. After the first cutting the following summer 200 to 300 pounds of acid phosphate per acre will insure a larger subsequent crop.

Another method that has proved successful on hill soils is to prepare the land thoroughly all summer and in the fall to sow about a half bushel of wheat per acre, sowing the alfalfa early in the spring. The wheat is taken off when ripe and a good stand of alfalfa is secured. Alfalfa and timothy may be sown in the spring with oats. The timothy seems to make a better growth than when sowed with clover or alone, and fills in the spaces between the alfalfa plants. After the oats are cut the timothy and alfalfa ripen, the timothy being headed when the alfalfa is in blossom. After the first cutting practically no more timothy is obtained.

The first method is the one most likely to insure success, as, with a nurse crop, weeds are liable to get the start of the alfalfa. It is important to have the land in excellent condition, with a mellow, loose, and clean seed bed, before sowing. If the stand is very weedy, in the spring, it is advisable to go over the field several times with a spring-tooth harrow and, after loosening the soil well, to sow more alfalfa. From 1½ to 6 tons of alfalfa per acre have been secured on hill soils by the above methods.

In 1910 the county had 623,303 acres in farms, of which 73 per cent, or 458,637 acres, were improved. This shows a slight decrease in the area in farms but an increase in the area improved as compared with 1900. The farm lands in 1900 were valued at $11,596,340, in 1910 at $9,517,226, buildings at $7,387,180 and $8,543,573, and implements and machinery at $1,464,000 and $1,770,795, respectively. The expenditures for labor were about the same in 1900 and 1910, while for fertilizers an increase of approximately 25 per cent is shown, the amount in 1910 being a little over $60,000. The income

on many farms is considerably augmented by the sale of maple sirup, there being considerable sugar bush throughout the county. Poultry and eggs are also sold in large quantities and represent a steadily increasing source of profit. In 1899 the county raised poultry worth $155,885 as against $188,467 for 1909.

The average size of the farms in the county is 99.3 acres, and 80.8 per cent of the farms are worked by the owners. Share tenants represent about 18.7 per cent.

By far the larger part of the area is occupied by the Volusia soils. Much of this land, with proper management, makes very fair farming land. On many farms in these soils dairying could be profitably superseded by sheep raising, with potatoes as the cash crop. The Volusia soils are well adapted to potatoes, the yields being fair to good, and the quality excellent. Mangel-wurzel beets and rutabaga turnips also do well. A good rotation recommended for a farm on Volusia soils, especially the silt loam, is potatoes the first year, with rutabagas and possibly cabbage or rape for sheep feed, followed by oats, with which should be sowed timothy and clover, and hay the third year. If the mowing is of exceptional quality it may well be left down another year. Alsike clover will be found to surpass red clover if the land is inclined to be wet and sour.

If cows are kept part of the first year's rotation should include mangel-wurzels or silage corn, or both; and oats and peas may be included in the second year, to be cut and fed green through the summer.

Another good rotation is potatoes and corn one year, buckwheat one year, oats and seeding one year, and hay one or two years. One advantage of buckwheat is that it provides a place in the rotation for the plowing under of a green manuring crop such as rye and vetch, mammoth clover, or rye alone. Such a practice, together with liming, manuring, and deep plowing, will result in marked improvement of practically all the soils in the county.

There are many thousands of acres of permanent pasture in the county, the majority of which are run year after year with no attention or attempt at improvement. A method adopted by a successful business man who has lately taken up farming near Towanda may offer some good suggestions, even to men who have long lived on farms. A 30-year permanent hillside pasture was plowed in the fall to a depth of 10 inches. After being well harrowed it was seeded with 1½ bushels of rye and 1 bushel of vetch to the acre. In the spring this crop was plowed under and a crop of buckwheat sowed. This in turn was plowed under and the field then seeded with a mixture of grasses and clovers, including timothy, bluegrass, orchard grass, red and white clover, and meadow fescue. While not every

farmer can follow such an expensive and elaborate system, he can at least harrow his permanent pastures every year or two, thus distributing the droppings, disturbing the mosses, and making a lodging place for fresh seed, which should be broadcasted, and thus insure a good continuous pasture. A mixture of seed which is not expensive and which will give good results is 2 pounds of timothy, 1 pound of red clover, 1 pound of alsike clover, and 1 pound of Kentucky bluegrass or orchard grass, or both.

Most of the farmers in the county are well supplied with machinery, suited to their varied styles of farming. There are a number of reversible sulky plows in use, although some authorities are not favorably inclined toward these implements on Volusia and Lackawanna soils. On the soils having stony subsoils the plows are often set at too shallow a depth. Deep plowing is one of the requisites for improvement of these soils.

The three striking needs of the majority of hill farms in Bradford County are drainage, liming, and the incorporation of organic matter. The Lackawanna soils, with the exception of the silty clay loam, are not in such urgent need of drainage as the majority of Volusia soils, but they will be much improved by following the same treatment. Soils with a dense, compact subsoil, such as the Volusia silt loam and Lackawanna silty clay loam, have a sharp line of demarcation between soil and subsoil, especially where plowing at the same depth is practiced year after year. Surface moisture or seepage from higher levels follows the line of this compact subsoil, emerging at various spots in the fields as spring holes or swampy places. Tile drains constitute the most efficient means of removing surplus water and are to be recommended in all cases of this kind. In many cases an open ditch, wide and deep, run along the top of a field nearly on the contour line of the hill will remove the surplus water from above and effect a marked improvement in the field below. Dynamiting the subsoil has proved very efficient in some cases. Sticks or half sticks of specially prepared dynamite are set at 20 or 30 foot squares and when exploded loosen and crack the subsoil, allowing the escape of surplus water. Deep plowing acts in much the same way and is probably preferable where practicable. This practice provides an increased reservoir for water, disposing of the surplus in wet weather and holding it for use by the crop in times of drought.

Much of the land in Bradford County is acid, as is evidenced by the poor stands of clover and wheat secured, and by the abundance of sorrel, and there is little land in the county that would not be benefited by applications of lime. From 1 ton to 2½ tons to the acre will be required, depending upon the condition of the soils in any particular case.

But few farms produce sufficient manure for their requirements. Some fields are manured heavily, often at the expense of others. Usually applications are made to the sod land to be used for the production of corn. An inexpensive means of supplying organic matter is to plow under green crops, as has been previously suggested. Rye, vetch, buckwheat, and crimson clover are all excellently adapted to this purpose. Whenever possible a leguminous crop should be included in those turned under to increase the supply of available nitrogen in the soil.

Agriculture in Bradford County presents difficulties and problems, most of which are peculiar to Volusia soils, and which can be overcome by a study of the individual soil types and by following the suggestions and practices found effective on similar soils in other areas.

SOILS.

Bradford County forms part of a large area in northern Pennsylvania, northeastern Ohio, and southern New York, which is underlain by Devonian and Carboniferous sandstones and shales and which has been but comparatively thinly glaciated. This area is approximately 15,000 square miles in extent and represents a high hill country which has suffered considerable preglacial erosion, and over which the Volusia soils constitute the predominating upland series.

The soils of Bradford County divide themselves naturally into two main groups, upland or hill soils and bottom or river and stream soils. The first group, which occupies the larger proportion of the county, is separated into two soil series, the Volusia and the Lackawanna, the main basis for separation being the character of soil-forming material and degree of glaciation. Of these series the Volusia is by far the larger.

The alluvial soils have been separated into three groups, based on position and character of material, the Genesee, Chenango, and Barbour series. Altogether 17 types of soils, including Muck, Meadow, Rough stony land, and Steep broken land, were encountered and mapped in the area, as shown on the accompanying soil map.

The Volusia soils are predominantly an ashy gray or yellowish brown at the surface, with yellowish gray to brown subsoils, and range in texture from a gravelly loam to a silt loam, the latter type being the most extensive member of the series.

The Volusia soils of Bradford County are derived from the weathering of a thin mantle of glacial till, the material being principally of local origin from the underlying rocks, consisting of shales

and sandstones of the Chemung period of Devonian age. These usually occur at somewhat lower elevations than the rocks giving rise to the Lackawanna soils. The mineralogical character of these rocks thus exerts a direct and important influence upon the soils and their principal phases.

The Lackawanna soils are typically Indian-red in color, though varying from a light pinkish red to dark reddish brown, the underlying subsoils being usually a more pronounced shade of red. Two types are represented, the most important being the silt loam, which is shown in two phases in addition to the typical soil, and the other, which occurs in smaller areas, the silty clay loam. The soils of this series occupy the high hill country throughout the southern and southwestern parts of the county, and while glacial ice passed over these sections the material left behind it was so thin as to make evidences of its presence difficult to find in some places.

The Lackawanna soils are derived from the underlying Catskill shales and sandstones, from which they obtain their red color. Shale seems to be more generally present throughout Lackawanna territory, thus explaining the almost uniform occurrence of the silt loam.

The Catskill rocks overlie the Chemung formations and as a whole seem softer and more easily influenced by erosion and weathering. They are found at higher elevations than the Chemung, and while there is a rather distinct boundary between the country occupied by the Volusia and the Lackawanna series, isolated patches of Lackawanna material are often found on knolls and hilltops above the surrounding Volusia types. The two soils series derived from these two groups of rocks, the Chemung and Catskill, cover the greater part of the county. They are designated by the farmers as "clay" and "red shell" lands, respectively.

Along the rivers and streams are found three series of soils, not so extensive as the two upland series, but nevertheless important groups, many of the finest farms in the county being located on them. They are the Genesee, Chenango, and Barbour series. The Genesee soils have been formed by comparatively recent stream deposition, and usually occur as first bottoms. They are found principally along the Chemung and Susquehanna Rivers and some of their tributaries. They are subject to overflow and are still in process of formation through the deposition of new material from time to time by the streams. Two types of this series have been mapped, the very fine sandy loam and the silt loam, of which the silt loam is by far the more extensive. A small amount of clay loam related to this series was recognized, but the areas were too small and unimportant to warrant their separation as an individual type and they were mapped with the silt loam.

The Chenango series is derived from material presumably washed from Volusia upland soils and deposited as flood-plain material along the larger streams, which, owing to the subsequent deepening of their channels, is now left above the level of overflow and known as river terraces. The Chenango soils of this area occur mainly along the Susquehanna and Chemung Rivers and Wyalusing Creek, and were probably deposited during or soon after the glacial period. The soils of this series usually occur as first or second terraces above the overflow bottoms, but one type, the high-terrace phase of the Chenango silt loam, is found at relatively high elevations—100 or 200 feet above the flood plain. This more elevated occurrence of the type is probably due to local impounding of the river waters by ice. Three types have been mapped—the gravelly sandy loam, stony gravelly loam, and silt loam. They are uniformly light in color, a yellow to yellowish-brown being most typical, as might be expected from their origin.

The third series occurring along streams is the Barbour, which partakes somewhat of the characteristics of both the Genesee and Chenango. This series consists of alluvial material along small streams flowing through the Lackawanna country, its soils being formed of the wash from Lackawanna soils. They are prevailingly red soils.

The Barbour series occurs in such narrow strips that it was found impossible to separate the first and second terraces. It consists of bottoms periodically overflowed, together with gently sloping terraces, some of which are occasionally covered by sheet flow from side streams, the whole usually of narrow extent. Two types have been mapped—the Barbour silt loam and gravelly loam. The small stream bottoms are by no means uniform and present constantly changing phases within the same type, making the establishment of a definite boundary difficult. The silt loam is more often subject to overflow, while the gravelly loam occurs more often as true terrace, similar to the Chenango.

The types mapped as the Rodman gravelly loam and Tunkhannock gravelly loam are heterogeneous mixtures of materials of different textures, sand and gravel predominating. The areas form true glacial kames. They are of small extent and importance and occur principally in the southern and southwestern parts of the area, nearest the terminal moraine and chiefly adjacent to preglacial stream valleys.

Muck, Meadow, Steep broken land, and Rough stony land are groupings of soils of different material which occur scattered over the area and which do not fall within any of the above classes. They are discussed in detail in the following chapters.

The following table gives the names and extent of the various soils mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Volusia silt loam	417,472		Meadow	8,512	1.2
Light phase	29,760	62.3	Volusia gravelly loam	7,360	1.0
Stony phase	11,520		Genesee silt loam	6,912	.9
Thin phase	3,584		Rodman gravelly loam	6,144	.8
Lackawanna silt loam	93,312		Lackawanna silty clay loam	4,736	.6
Thin phase	16,640	15.5	Barbour silt loam	4,416	.6
Stony phase	5,248		Barbour gravelly loam	3,648	.5
Rough stony land	45,376	6.1	Genesee very fine sandy loam	2,944	.4
Chenango stony gravelly loam	26,496	3.6	Tunkhannock gravelly loam	2,688	.4
Steep broken land	25,344	3.4	Chenango gravelly sandy loam	2,368	.3
Chenango silt loam	9,408		Muck	640	.1
High-terrace phase	5,440	2.3			
Light phase	2,432		Total	742,400	

VOLUSIA SILT LOAM.

The Volusia silt loam to a depth of 6 to 8 inches consists of a gray to yellowish-brown silt loam, usually underlain to a depth of 36 inches by a yellowish-brown to yellow silt loam to silty clay loam. Both soil and subsoil frequently carry a large content of sharp, angular shale and sandstone fragments, which occasionally are found on the surface. The subsoil, especially the lower portion, is seldom free from stones and is often mottled with grayish blue and yellowish brown.

This type has phases or variations ranging from a silt loam with a very high silt content and very low in clay to the other extreme, this latter condition being especially true of the subsoil, which is commonly spoken of by the farmers as "hardpan." This variation in the texture is due to the character of the original soil-forming materials, mostly shales and sandstones of the Chemung formation of Devonian age. Where the parent rock was an argillaceous shale, the resulting soil is high in silt and clay. An arenaceous shale or fine-grained sandstone, on the other hand, gives rise to a soil containing more sand and less clay.

The topography varies from nearly level or gently undulating to rolling and hilly, broken by high plateaus with steep sides.

The Volusia silt loam owes its origin to the glaciation of the underlying country rock, with the addition of some foreign material. As a rule, this glacial débris is 3 feet or more in depth, although bedrock is often found outcropping or at scarcely more than plow depth. Such areas have been indicated by hachures on the accompanying map and constitute what is called the thin phase of the type. The soil in the immediate neighborhood of these outcrops and where the

bedrock approaches the surface is usually full of chips and larger fragments of shale. Such areas often occur as knolls and small hillocks and if of sufficient extent would have been mapped as Volusia shale loam, but these extremely shaly areas are incidental to the outcrops just mentioned and occupy such small areas that they must be included in the main type.

The Volusia silt loam is locally called "clay" land, the term being used mainly to distinguish it from the Lackawanna silt loam, which is called "red shell land."

Retarded underdrainage is one of the most serious problems on the Volusia soils. On account of the dense, compact structure of the subsoils the downward movement of water is interrupted, and in wet periods the surface soil is more or less saturated. Lateral movement or seepage along the slopes offers the only outlet for moisture. The result is a wet, spongy condition of the top soil, with numerous springs and swales on the hillsides and swamps and mucky areas in the depressions. On account of this condition spring planting is often delayed. One of the first steps necessary on these soils is adequate underdrainage. In dry weather the crops suffer from lack of moisture. Deeper plowing and the turning under of organic matter, either in the form of manure or of such crops as rye, buckwheat, or clover would do much to improve the tilth. The increase in depth of plowing should be accomplished gradually—an inch or two a year to allow oxidation and aeration of the turned-up subsoil. The water-holding capacity of the soil will also be increased by this deeper breaking.

While these two steps are of great value in increasing the productiveness of the type, artificial drainage must be resorted to in order to secure the best results. Open ditches are sometimes of value, and a combination of tile drains and open ditches may in many places prove advisable. The use of dynamite to loosen the deep subsoil and provide small drainage channels to increase the water reservoir is said to be very effective and beneficial, but has not been tried in the county or on this soil.

Another characteristic of the Volusia silt loam is its acid condition. While the type as a whole in Bradford County is not as bad in this respect as in many other districts where this type predominates, the prevalence of sorrel in many localities, the adaptability of redtop, alsike clover, and other acid-resistant plants, the decreasing yields of red clover, and the chemical reaction to litmus paper all point to the fact that this soil is more acid than it should be to secure the best results with most crops. The use of lime is thus strongly indicated, and the farmers are gradually making more use of this material. Applications ranging from 500 to 1,000 pounds produce marked improvement in the soil, but in many cases these should be

doubled. Heavy applications are often necessary to secure a stand of alfalfa. Lime should not be applied directly before planting to potatoes, the best time being a few weeks before sowing a grain crop with which grass is sown. Care should be taken that several rains intervene between spreading the lime and sowing the seed. Lime can be purchased in Bradford County at $3.50 to $4.50 a ton, delivered.

The incorporation of organic matter can not be too strongly recommended for the improvement of the Volusia silt loam. This practice is of benefit in supplying plant food, in increasing the water-holding capacity of the soil, in improving its tilth, and in various other ways. Green crops are a good substitute where manure can not be had. Any heavy, quick-growing crop is beneficial for this purpose, but the legumes are preferable, as they add larger quantities of nitrogen to the soil. Rye and vetch, mixed, and crimson clover are two very good green manuring crops. Some of the heaviest users of lime and most consistent growers of green manure crops are farmers on the river flats, but the Volusia silt loam, owing to its peculiar texture and structure, is especially in need of such treatments.

The crop adaptations of the Volusia silt loam are well recognized by farmers, although this knowledge is not always used. This soil is best adapted to the production of potatoes, buckwheat, oats, and grass. The quality of potatoes is excellent and very good yields can be secured where good cultural methods are used. The average yield is from 100 to 125 bushels per acre, but yields of 150 to 250 bushels are sometimes obtained. The desirability of making potatoes the main money crop has not been recognized by many farmers, the majority of whom plant but a small patch and pay little attention to the crop. A county in southern New York, the predominating soil of which is Volusia silt loam, ranks third in output of potatoes in the United States.

Oats are universally grown and occupy the largest acreage of any crop in the county except hay. The average yield is from 30 to 40 bushels per acre. Many farmers rarely obtain 40 bushels, while others call anything below that figure a poor crop. Buckwheat is widely grown. The yields are not high, ranging from 15 to 25 bushels, with 30 to 40 as an occasional maximum. The yield of corn varies greatly on different farms, the average per acre for the county in 1909 being about 26 bushels. Yields of 75 to 100 bushels are not uncommon, although most farmers are satisfied with 40 to 60. The writer has seen corn crops on the Volusia silt loam cut with a reaper with not an ear in the entire field. Most of the corn grown is for silage and averages from 8 to 12 tons per acre, although higher yields are often obtained. Grass is extensively grown, but the yields are not high, averaging from three-fourths of a ton to 1¼ tons per acre. Timothy,

redtop, red clover, and alsike clover are the most popular of the grasses.

As a whole, the Volusia silt loam in Bradford County is above the average of the type, owing in a large measure to the prevalence of dairying. Most farms have dairy herds of 10 to 30 cows, and sometimes a flock of sheep as well.

The original timber growth on this type consisted of white pine, hemlock, chestnut, hard maple, beech, and birch. Very little of the original timber growth is left, the pine and hemlock especially having practically all been removed. Many groves of sugar maple are found scattered over the type, and the sale of sirup and sugar adds to the income of many farmers. The woodlots now run mainly to chestnut and various hardwoods. The rougher and less desirable lands, especially those in which considerable areas of the thin phase occur, could be profitably reforested.

The price of land ranges from $50 to $20 an acre, and even as low as $7 in the more remote and poorer-farmed localities, and large areas of the type can be bought for $20 to $30.

Volusia silt loam, light phase.—The Volusia silt loam, light phase, consists of a grayish to yellowish-brown loam to silty loam, 6 to 9 inches deep, underlain to a depth of 36 inches by a yellow to yellowish-brown fine sandy to silty loam. Angular fragments of shale and sandstone varying in size from small chips to fragments weighing several pounds are present in considerable quantities in the soil and subsoil, the rounded stones being more noticeable in this type than in the typical soil. Borings below 18 to 24 inches are frequently impossible on account of the large quantity of stones in the lower subsoil.

As a whole, the Volusia silt loam, light phase, is fairly well drained, owing to the rather open structure of the soil and the high stone content of the deep subsoil, yet many local areas are encountered where the mottled color of the subsoil and inferior crop yields indicate that underdrainage could be used to advantage.

The mantle of glacial till from which the light phase of the Volusia silt loam has weathered is usually deeper than that giving rise to the typical soil, much fewer rock outcrops being found, and bedrock being seldom encountered within the 3-foot section. The glacial material was very largely derived from local rock, probably moved but short distances and deposited as ground moraine by the retreating ice sheet. There is a considerably higher percentage of sandstone fragments present in the light phase than in the typical soil, and it is to the influence of the sandstone upon the glacial till that the textural difference between the two is due. Where the parent rock is largely sandstone or arenaceous shale, the sand content of the resulting soil is always higher than where the parent rocks are finer, more argillaceous

shales. This fact is well illustrated by the comparatively large areas of loam near East Smithfield, where the predominating rock is sandstone.

The topography of the Volusia silt loam, light phase, is rolling to slightly hilly, being as a rule less rough than that of the silt loam. It is often found on comparatively gentle slopes between the silt loam hills and stream bottoms and valleys. In such locations it has doubtless been washed down from the higher-lying ground.

The largest area of this light phase of the type is found in the township of Smithfield, though important areas also occur in Springfield, Ulster, North Towanda, and Asylum Townships, west of the Susquehanna, and in Herrick and Pike Townships in the eastern part of the county.

The original timber growth of the Volusia silt loam, light phase, was similar to that of the typical soil, but with a preponderance of white pine and chestnut. In many localities it is yet called pine and chestnut land. The first growth has practically all been removed, and the present wood lots contain mostly chestnut, maple, birch, and beech.

The Volusia silt loam, light phase, in Bradford County does not differ strikingly from the better areas of the typical soil and the poorer drained areas much resemble the average of the latter. The light phase, however, is generally an easier soil to work, is somewhat warmer and earlier, and is better adapted to corn, potatoes, and wheat. Most of the wheat grown on the uplands is grown on the light phase and the lighter-textured areas of the typical soil. The former is especially well adapted to potatoes, but it is not utilized for this crop as much as it should be. Potatoes average from 100 to 150 bushels per acre; yields of 200 to 250 bushels are by no means uncommon on this soil in other areas. This difference in yield is largely accounted for by differences in preparation of the soil, selection of seed, and cultivation.

Corn averages from 35 to 40 bushels to the acre, with a maximum of 50 to 60 bushels. Oats average about 40 bushels, although higher yields may be easily secured. Buckwheat does well on this type in many areas. The ordinary yield in Bradford County is 20 to 25 bushels to the acre. The average yield of wheat is around 20 bushels and of hay from 1 to 1½ tons per acre.

The prevailing type of agriculture on the Volusia silt loam, light phase, is general farming. Usually a few cows are kept. Potatoes should be more extensively grown as a money crop and enough cows or other stock kept to consume the other crops produced on the farm. A system of farming which includes hay and grain for cash sale without an adequate return of fertilizing elements to the land is bound

to result in depletion of the soil. Apples do well on this type, though few orchards exist.

The price of farms of Volusia silt loam, light phase, ranges from $30 to $50 an acre. Location with reference to towns and shipping points and the condition of the buildings are very important factors in determining values.

Volusia silt loam, thin phase.—Areas of Volusia silt loam where the covering of soil over the rocks is shallow, and where for this reason there is a marked difference in agricultural value, have been indicated in the map by means of a distinctive ruling over the color used for the typical soil. This differentiation has been made, of course, only in case where such areas are of considerable extent and where the difference in soil depth is most pronounced.

Such areas are used for the same crops as the typical soil, but owing mainly to unsatisfactory moisture conditions the yields taken year by year are lower. The profits from their cultivation are also less, for the reason that more labor is required in their production.

The inferiority of this thin land is recognized by the farmers and is reflected in the prices asked for farms made up in whole or in part of this phase as compared with the prices of the typical soil.

Volusia silt loam, stony phase.—Certain areas of the Volusia silt loam in which the content of stones is excessive or where rock outcrops are numerous and many large bowlders lie upon the surface have been separated in mapping the type and shown by means of ruling in the map. Such areas are better suited to use as pasture than for the production of cultivated crops. They represent a departure from the true type in agricultural value of sufficient importance to warrant a separation, but only the more prominent areas could be differentiated and even in this case the boundaries are more or less arbitrary, because of the gradual merging of the typical and the more stony conditions.

The following table gives the results of mechanical analyses of typical samples of the soil and subsoil of the Volusia silt loam and of its light phase:

Mechanical analyses of Volusia silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
24190	Soil	3.1	3.8	1.9	2.1	5.1	71.1	13.3
24191	Subsoil	3.0	4.2	1.9	2.4	9.2	62.9	16.1
Light phase:								
25782	Soil	1.7	2.9	1.8	5.2	12.0	60.0	16.2
25783	Subsoil	2.8	3.6	2.0	5.0	11.0	60.8	14.8

VOLUSIA GRAVELLY LOAM.

The Volusia gravelly loam consists of 6 inches of yellowish-brown rather silty loam, underlain by a yellowish-brown to yellow loam to silty loam, extending to a depth of 36 inches. Both soil and subsoil contain varying quantities of shale and sandstone chips, rounded gravel, and stones. Often the subsoil is so stony as to make deep boring impossible.

This type occurs in the form of small moraines scattered over the Volusia country, usually bordering upland valleys and preglacial drainage basins. The topography is rolling to hilly. The drainage, owing to the comparatively light texture and high stone and gravel content, is better than on any of the other Volusia soils. It is consequently better adapted to corn than the other soils of this series, being earlier and drier in the spring, though more dependent on an even distribution of rainfall throughout the growing season, for it does not withstand drought well.

Owing to its occurrence in comparatively small bodies, this type is of less importance than the other members of the series. In years of average to heavy precipitation throughout the growing season it gives good yields of the general farm crops.

The original timber growth consisted of beech and hard maple, with some white pine and hemlock, little of which now remains.

LACKAWANNA SILT LOAM.

The surface soil of the Lackawanna silt loam consists of 6 to 8 inches of a rather heavy Indian-red silt loam. The subsoil is a heavy silt loam, somewhat lighter in color and usually more compact than the surface soil, extending without marked change to a depth of 36 inches. Both soil and subsoil contain varying quantities of shale and sandstone chips and angular fragments. Like the Volusia soils, this type is characterized by a high stone content.

This soil occurs in the southern and southwestern parts of Bradford County, where it forms part of a large body of Lackawanna soils in northern and northeastern Pennsylvania. The boundary between the Volusia and Lackawanna soils is comparatively sharp, although small detached bodies of each are sometimes found surrounded by the other. Usually the Lackawanna is surrounded by the Volusia.

The Lackawanna silt loam is derived from the glaciation of the underlying red Catskill shales and sandstones, which give to the soil its distinctive color. The type is locally called "red shell" land, owing to the occurrence of small red chips and fragments of shale and argillaceous sandstone. The underlying rock is uniformly finer grained than the more arenaceous shales and sandstones of the

Chemung formation and the soils are correspondingly finer textured and smoother than those of the Volusia series. The Catskill rocks are the next younger formation to the Chemung, which explains why many hills and knolls in the Volusia country adjacent to Lackawanna soils are capped by this material.

The topography of the type is rolling to hilly, the hills being more rounded than those of the Volusia country. Huge blocks of the country rock are numerous in many localities and are usually piled in fence corners or made into walls. In some of the more remote townships these outcrops and bowlders are so numerous that grain is necessarily cradled and all farm operations are made more difficult and less effective.

The Lackawanna silt loam country was even more feebly glaciated than that where the Volusia soils occur. Lying as it does on the high hills between the Volusia soils and the terminal moraine, it was covered probably by a comparatively thin sheet of ice, which dropped but little extraneous material. Sometimes evidences of glaciation are quite difficult to find, consisting mostly of a stirring and mixing of the local rock material with a partial rounding of exposed rock ledges and a blocking of old drainage channels. Foreign material is more abundant at lower elevations than on the hillsides.

Many areas of the Lackawanna silt loam would be improved by drainage, though the type as a whole is not so markedly deficient in this respect as the Volusia silt loam.

This type is a good general farming soil. It is earlier and warmer than the Volusia silt loam and is a better corn and wheat soil than the latter. Under ordinary management it produces average yields of the other general crops. It is well suited to apples, and alfalfa can be successfully grown on it. It supports many dairy farms, and is used also for sheep raising.

In the more remote hill country, where much of the soil is thin and stony, poor yields are common, but many good farms on this type show that with good management excellent results can be secured. The farms giving the best results are situated on the gentle lower slopes of some of the high hills, on the north side of Barclay Mountain along Towanda Creek, the east slope of Armenian Mountain, along the Canton-Troy road, and upon other areas in the smaller valleys. Such areas apparently have a deeper, mellower soil, and undoubtedly represent a thicker mantle of glacial till and some party colluvial soil material. Their position on comparatively gentle slopes between the steep hillsides and stream bottoms has enabled them to resist erosion. They constitute the highest development of the type. Yields of 20 tons of silage and from 50 to 75 bushels of corn are obtained on some farms, but the average for the type is doubtless nearer 50 bushels. Oats range in yield from 20 to 40 bushels, with a

possible maximum of 60 to 65 bushels. Wheat does not often yield over 30 bushels per acre, and the ordinary return is from 20 to 25 bushels. Yields of 15 to 30 bushels of buckwheat per acre are usual and new seedings cut from about 1 ton to 2 tons of hay per acre, with 1 to 1½ tons the second year. Clover does better than on the Volusia soils. Lime has proved very beneficial and large yields can hardly be expected without its use.

Land values vary greatly. Unimproved areas can be bought for $8 to $10 an acre, while some farms near Troy and Canton are held at $100 an acre or even more. The ordinary range in price is from $25 to $40 an acre.

The original timber growth on the Lackawanna silt loam consisted of white pine, hemlock, maple, beech, and birch. Most of the pine and hemlock has been cut off. Small areas of the original hardwoods are standing, but the bulk of the present timber is second growth maple, birch, beech, hickory, and poplar. Many of the rougher, stonier areas should be reforested as they are better adapted to this use than to any other, although some of them could profitably be utilized as sheep pastures.

Lackawanna silt loam, thin phase.—There are many areas included in the Lackawanna silt loam where the depth of soil over the parent rock is shallow. The more prominent of such areas have been shown upon the map in a general way by means of a distinctive ruling. Areas of this character have a lower agricultural value than the typical soil, principally on account of their inability to retain sufficient moisture to carry crops through periods of drought. The nearness of rock ledges also interferes with plowing in some instances and altogether the land is much less desirable than the typical areas.

The crops grown are those prevailing on the main part of the type, but agricultural development has made less progress and the farms are in a less prosperous condition.

The phase is better adapted to pastures than to the production of cultivated crops, and may be used to advantage in dairying and sheep raising, especially where farmed in conjunction with better areas of the type.

Lackawanna silt loam, stony phase.—A stony phase of the Lackawanna silt loam has been differentiated in the map by means of hachures. This phase includes areas in which the stone content is unusually high or in which rock outcrops and bowlders are very numerous. Such areas are much inferior to the typical soil for agriculture. The use of farm machinery is impracticable and all the operations incident to the cultivation of crops are more arduous than elsewhere on the type. The land is better adapted to use as pasture than for tilled crops.

LACKAWANNA SILTY CLAY LOAM.

The Lackawanna silty clay loam, to a depth of 6 to 8 inches, consists of an Indian-red to reddish-brown heavy silt loam to silty clay loam, underlain by a silty clay loam to silty clay of about the same color, extending to a depth of 36 inches. In the deep subsoil a mottled bluish-gray clay is often encountered. Both soil and subsoil have a fairly high stone content, though this is not so conspicuous a feature as in the silt loam type of the same series.

The type is derived from the weathering of glacial till, composed of products from the underlying Catskill shales and sandstones, with argillaceous shale predominating. It is of comparatively small extent in Bradford County, being confined to small areas in Wilmot, New Albany, and Overton Townships.

The topography of the Lackawanna silty clay loam is gently rolling to hilly, the type occurring on comparatively gentle slopes between the steep silt loam hills and the drainage channels. Owing to its position and compact, fine-textured soil and subsoil, the type is poorly drained and locally considered inferior land. Tile drainage would remedy this defect and even open ditches would prove of marked benefit. Its natural poor drainage also tends to make the soil more acid than the silt loam and heavy applications of lime are necessary. Under present conditions the yields are considerably below the average for the silt loam member of the series. Land values range from $15 to $20 an acre.

TUNKHANNOCK GRAVELLY LOAM.

The Tunkhannock gravelly loam is of minor importance and occurs only in small patches scattered throughout the area. It is essentially the same in point of origin, topography, drainage, and texture as the Rodman gravelly loam, differing simply in the character of the original material.

The Tunkhannock gravelly loam is derived from material gathered by the ice from Catskill shales and sandstones and has a reddish color. It occurs among Lackawanna soils, the most typical areas being found east of Laddsburg. A long and narrow strip occurs in Wilmot Township bordering one of the tributaries of Sugar Run Creek.

RODMAN GRAVELLY LOAM.

The Rodman gravelly loam consists of 6 to 8 inches of yellowish-brown gravelly loam to gravelly sandy loam, containing rounded gravels and stones of varying sizes, underlain by interstratified gravel, sand, and silt, containing many stones, some of large size.

This type is locally called gravel and is found chiefly in the southwestern part of the county, in the vicinity of Canton, along Towanda

Creek and between Canton and Troy, near Alba, although small areas are occasionally encountered elsewhere.

The topography is broken, with basinlike depressions between the rounded knolls and small hills. The material forming the type consists of glacial till, assorted by water from the melting ice sheet, and deposited in holes and cavities in the ice. It differs from the Volusia gravelly loam in that the latter was deposited directly by the ice sheet as moraine and consists of unassorted material only slightly modified by water, while the former is derived from kame deposits. The material often shows cross bedding, but rarely true stratification, varies greatly in texture from a silty loam to pure sand and gravel and includes numerous rounded and subangular stones of all sizes, the widely differing materials being often deposited in the same beds and pockets.

The occurrence of the larger proportion of this type in the southwestern part of Bradford County is assumed to indicate that this part of the area was nearest the terminal moraine, where conditions were most favorable for its formation. While small kames are sometimes found at high elevations, they usually occur bordering or even in glacial drainage ways, as the water pouring from the ice found new passageways or deepened old ones.

The comparatively narrow strips in which the Rodman gravelly loam occurs and its isolated or disconnected distribution make it of minor importance. When the rainfall is plentiful, or even excessive, for the heavier soils, crops on this type do well. The drainage is excessive, owing to the porous, open structure of the type, particularly of the subsoil. This feature is not without its advantages, as in an unusually wet season tillage operations are possible much sooner after a heavy rain than on heaver, more compact soils. It is a much better soil when supplied with sufficient moisture than its appearance and topography would indicate. Average yields of the ordinary crops are obtained in favorable seasons, but practically nothing in dry ones.

Farms on which this type occurs are valued at $45 to $65 an acre, largely because of their location. They also often contain some bottom land, which enhances their value. The type is never sold by itself.

CHENANGO GRAVELLY SANDY LOAM.

The soil of the Chenango gravelly sandy loam consists of 8 inches or more of a light-brown to slightly yellowish brown sandy loam, ranging in texture from fine to medium and carrying small rounded gravel. The subsoil is a yellowish-brown to yellow sandy loam to sand of varying depth, grading into a substratum of stratified sand and gravel. This often lies within the 3-foot profile. Both soil and subsoil differ from the Chenango stony gravelly loam in having a

higher content of sand and gravel and in being practically free from angular rock fragments.

The type is level to slightly rolling and often separated from the more elevated stony gravelly loam by slight depressions. Both types consist of weathered outwash material derived originally from the adjacent hills, deposited in the river basin in preglacial times and now occupying second-terrace positions at elevations of 10 to 50 feet above the present level of the river. The gravelly sandy loam is usually found in the larger bends of the Susquehanna, near Wysox, in the vicinity of Milan, and a few other places. The type is of small extent and of no great importance.

The loose and open texture of the soil and the frequent occurrence of stratified sands and gravels in the subsoil tend to excessive drainage, and crops suffer in dry years. In years of average to heavy rainfall good yields of the ordinary farm crops are secured, but because of its excessive drainage the type is much more uncertain than the other terrace soils.

The price depends upon the surrounding types, location, and improvements and ranges from $45 to $150 an acre.

CHENANGO STONY GRAVELLY LOAM.

The Chenango stony gravelly loam to a depth of 6 to 8 inches consists of a light-brown to brownish-yellow loam, carrying rounded gravel and subangular to angular rock fragments in varying quantities. Beneath this and extending to a depth of 36 inches is a brownish-yellow to yellow loam, also containing much fragmental rock, frequently in such quantities at 20 inches or so as to make boring impossible. Strata of sand and fine gravel are sometimes encountered. While the content of stone and gravel is noticeably high in some areas, it is not great enough to make cultivation difficult.

This type consists of outwash material from the neighboring Volusia hills, deposited as terraces in drainage basins. It also includes material more recently deposited as alluvial fans at the confluences of tributary streams with the rivers or larger creeks and as narrow bottoms and terraces along smaller drainage ways. The latter areas are usually of small extent and more stony than the rest of the type. Some of the fans at stream junctions are also extremely stony.

Some of the narrow strips found along the smaller streams and mapped as Chenango stony gravelly loam are very similar in composition to the small deltas at the stream mouths, but are often in part true bottom soils, as they are subject to overflow. This usually occurs in channels and restricted areas rather than over their entire area. The parts subject to overflow are so small in area and so interspersed with the typical soil as to make separation impracticable.

The most important bodies of the Chenango stony gravelly loam occur along the Chemung and Susquehanna Rivers, sometimes adjacent to them, but often separated from the streams by the Genesee or first-bottom soils. Typical areas are found between the two rivers at Sayre and Athens, on the wide flats on the eastern bank of the Susquehanna, between Milan and Ulster, and in most of the areas inclosed by the large bends of the Susquehanna River.

The topography of the Chenango stony gravelly loam is level to gently rolling. The greater proportion of the type is fairly level, although sometimes broken by ridges.

Drainage is well established, being frequently excessive, especially where beds of sand or gravel occur in the 3-foot section. Some areas are overflowed at long intervals, especially along the larger tributaries of the rivers, but as a whole the type lies well above high-water mark.

Crops often suffer in dry seasons from lack of moisture, because of the free movement of water through the soil and the open character of the subsoil. In seasons of abundant rainfall good yields of the ordinary crops are secured. Uncertainty of yield is the greatest disadvantage of the type. It is not particularly adapted to corn, but in favorable years very fair yields are obtained. Potatoes yield from 100 to 150 bushels per acre, buckwheat 20 to 25 bushels, rye 20 to 25 bushels, and hay 1 to 1½ tons, with somewhat higher yields from fresh seeding in favorable years. Particularly stony areas are sometimes used for permanent pasture, but ordinarily the permanent pastures are confined to the Volusia hills, the majority of farms along the rivers containing both hill and valley soils.

The price of this type varies considerably, being influenced largely by location and surrounding types. From $40 to $60 an acre is the ordinary range in price.

CHENANGO SILT LOAM.

The Chenango silt loam, to a depth of 8 inches, consists of a brown to yellowish-brown silt loam, mellow and open in structure and easily worked, underlain by a silt loam to very fine sandy loam, ranging in color from light yellowish-brown to yellow. The subsoil is occasionaly quite compact in the upper section.

The topography is generally level, except where broken by a few slightly rolling areas. Over areas where the subsoil is compact drainage is poor and tiling would prove beneficial. Deep plowing and thorough cultivation, however, are usually effective in remedying this defect. As the type is comparatively loose and free from stones, it is easily maintained in a good condition of tilth.

The Chenango silt loam occurs as second terraces along the larger streams and consists of material deposited by the slower moving

currents of glacial streams. The type usually lies above overflow, but occasional areas are sometimes inundated from lateral streams and at rare intervals may be covered by overflow from the main streams along which it occurs.

Typical areas of the Chenango silt loam are found near the junction of the Chemung and Susquehanna Rivers, in the vicinity of Wysox, and in small patches scattered along the larger streams.

The type is a very good agricultural soil and is highly esteemed by farmers for its fertility and freedom from overflow. Acreage yields of 40 to 60 bushels of corn are secured, from 35 to 50 bushels of oats, from 20 to 35 bushels of wheat, and from 1½ to 2½ tons of hay.

The type varies in price according to location, surrounding soils, and improvements. From $65 to $75 per acre is probably a fair price.

Chenango silt loam, light phase.—A few small areas of Chenango silt loam have a somewhat lighter texture than the main type, both in the surface soil and the subsoil. These have been mapped as the light phase. To a depth of 7 or 8 inches the surface soil of such areas varies from a light silt loam to a yellowish-brown very fine sandy loam. This is underlain by a lighter yellow fine to very fine sandy loam, which occasionally rests upon gravel at a depth of 30 inches. The variation in the surface soil is not sufficient to justify the classification of this phase as a separate type.

The topography of this phase is practically the same as that of the main type. The principal areas are located chiefly between Towanda and Milan, along the Susquehanna, and on Wysox and Wyalusing Creeks. The phase often occurs as deltas where small lateral streams emerge from the hills.

In price, crops grown, and general use the phase departs but little from the typical soil. It should be better adapted to potatoes and truck crops, but the small size of the individual areas and the limited extent of the phase as a whole do not favor crop specialization.

Chenango silt loam, high terrace phase.—The high terrace phase of the Chenango silt loam, while greatly resembling the main type in color, texture, and crop adaptation, differs markedly in location and topography. The surface soil, to a depth of 6 to 8 inches, consists of a brown to light-brown silt loam, very high in silt and fine sand. The subsoil is a light yellowish-brown to yellow silt loam to fine sandy loam. Like the surface soil, it is loose, open, and readily takes up drainage water. While some areas approach in texture a very fine sandy loam, the type as a whole is a true silt loam. Stones are found throughout the soil profile, but not in large quantities. Some of the rock fragments are rounded, showing water action, while others are angular, the highest areas showing fragments of

shale of varying sizes. These do not occur in any great quantities, and are mostly built into fences.

This phase occupies high terraces, mainly along the Susquehanna River. It occurs sometimes at elevations of from 100 to 200 feet above the river. It consists of wash from the adjoining hills deposited at a period when the bed of the river was at a much higher level than at present. Its original topography was the same as that of the typical silt loam, being level to gently sloping. Subsequent erosion has greatly broken up and dissected these old terraces, so that now they often present a surface ranging from rolling to steeply inclined slopes.

The most typical and largest development of this phase is found on the north side of the Susquehanna River at Standing Stone, and on the west side of the river near Milan. Other smaller areas are found scattered along the larger streams.

This soil has good natural drainage, owing to its position, topography, and the loose, open structure of the soil and subsoil. It produces good crops of tobacco and alfalfa, but is generaly used for the ordinary farm crops, giving about the same yields as are obtained on the typical soil lying on lower terraces.

GENESEE SILT LOAM.

The surface soil of the Genesee silt loam consists of 10 inches of a dark-brown to grayish-brown silt loam. The subsoil, to a depth of 36 inches, is a lighter brown to yellowish-brown silt loam, usually quite compact in the upper portion of the section, but often considerably lighter in texture and more open in structure in the lower depths.

This type is found mainly along the Chemung and Susequehanna Rivers, with occasional areas along the larger creeks. No large areas are found, as it occurs usually in the form of strips or bands parallel to the streams, with the second terraces, or Chenango soils, between it and the Volusia hill soils. The largest areas are encountered near the mouth of Towanda Creek, at the junction of the Chemung and Susquehanna Rivers, and numerous smaller areas are found along the larger streams.

The Genesee silt loam occurs as first bottom or overflow land. It is still in process of formation, as each overflow deposits more or less new material. These overflows are sporadic in occurrence, a period of several years sometimes intervening. While they are doubtless beneficial in adding new material, they are not without serious disadvantages in the way of damage to crops.

The stream bottoms being comparatively narrow, overflow waters often possess sufficient velocity to cause considerable damage to fields through gullying and washing. This feature, however, is more pro-

nounced in the Genesee very fine sandy loam, which more often occurs directly bordering the river. Weed seeds of all varieties are often introduced on the bottom lands at times of flood, causing the farmers considerable trouble.

The Genesee silt loam, owing to its level topography and fairly compact subsoil, is often poorly drained, though not to such an extent as one might suppose from the location in relation to the streams, as during a large part of the year the streams run through narrow channels considerably below the level of adjoining fields.

This type originally supported a growth of elm, maple, and sycamore, with some butternut and black walnut. Owing to frequent overflow, some of it was not timbered and these areas constituted the "Indian meadows." Only a few scattered elms and maples are now found on the type.

Excellent yields of corn, from 40 to 75 bushels per acre, are obtained. Wheat yields range from 25 to 40 bushels and some farmers, it is reported, have secured 50 bushels per acre. It is an excellent oat soil, producing from 40 to 60 bushels per acre under favorable conditions. It is also a good soil for grass, both for pasture and mowing. Kentucky bluegrass, timothy, and white clover do especially well on it. Yields of from 2 to 3 tons of hay per acre are sometimes secured, with an average in the neighborhood of 2 tons. Sugar beets and tobacco do well, but a lighter-textured soil is generally preferred for the latter crop. It is also adapted to such truck crops as cabbage, peas for canning, and beans. The trucking industry has not been extensively developed.

The Genesee silt loam is one of the highest-priced soils in the area. Its level topography, high fertility, the ease with which it lends itself to cultivation, and its generally favorable location with respect to shipping points all tend to make it a valuable type. Although crops are sometimes injured by overflow, the damage from this source is relatively small, as the freshets usually occur in the late fall and early spring. As high as $200 an acre has been paid for this type, and the price ordinarily ranges from $60 to $125 an acre. The particularly favorable location of some farms is the main factor determining the higher prices.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Genesee silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
23690	Soil	0.2	0.4	0.7	2.7	12.4	66.9	16.6
23691	Subsoil	.0	.0	1.0	4.6	14.7	59.0	20.5

GENESEE VERY FINE SANDY LOAM.

The Genesee very fine sandy loam to a depth of 10 to 12 inches consists of a grayish-brown, very fine sandy loam, rather high in silt, underlain to a depth of 36 inches by a brown to yellowish-brown, very fine sandy loam. Sandy layers and also small rounded gravel are often encountered in the lower subsoil, but the coarse material is never in large quantities. Some small areas of the type show a darker color than the average, owing to a higher organic matter content. When dry the soil is usually light colored.

This type occurs as narrow strips and small bodies near the rivers and their larger tributaries. It is also found on most of the islands in the rivers, where, especially, some areas of coarser texture are occasionally encountered. The lack of uniformity is due to the more frequent overflows and the higher velocity of currents covering these exposed areas.

The topography is nearly level, like that of the Genesee silt loam, but the drainage is somewhat better, owing to the coarser texture and more open structure of the soil. It is in all ways closely related to its companion type, the silt loam, the lighter texture and better drainage being the chief points of difference. Yields compare favorably with those on the silt loam, and its occurrence in small areas causes the type to be cropped and worked with the silt loam. Corn yields from 30 to 50 bushels, oats from 30 to 50 bushels, and hay from 1½ to 2½ tons per acre.

The very fine sandy loam is preferred to the silt loam as a tobacco soil. While the yields are about the same, the leaf grown on the lighter type is thinner and of better quality. Yields of 2,000 pounds to the acre are secured by the best farmers.

The land is in need of liming. Acreage applications of 1,500 pounds of lime will be sufficient in most cases. A green crop, rye or vetch, planted in the fall and plowed under in the spring, should be sown at intervals. This practice will prove beneficial in maintaining a proper physical condition of the soil. The best farmers already employ these means of increasing the yields of tobacco and other crops.

No definite price can be given for this type, as it is always farmed and sold in conjunction with other bottom and terrace soils. Farms consisting largely of these "flats" sell for $60 to $150 an acre, depending largely on location and improvements.

BARBOUR SILT LOAM.

The surface soil of the Barbour silt loam consists of 8 inches of an Indian-red silt loam, practically free from stones or gravel. The subsoil, to 36 inches, is a somewhat lighter red to pinkish-red silt

loam, often compact and sometimes approaching a silty clay loam in texture. The deep subsoil in many places contains strata of sandy material or even nearly pure sand. Occasionally some gravel may be encountered, but not to any extent.

The type occurs as bottoms along the streams flowing through sections of the county where the upland soils belong to the Lackawanna series, and the type consists of reworked water-deposited materials derived from the feebly glaciated soils of the surrounding hills and uplands, from which soils it derives the characteristic red color. It occurs as bottoms periodically overflowed and gently sloping terraces, some of which are sometimes covered by sheet flow from side streams. The type is limited in extent, usually occurring along the smaller streams.

The topography of the Barbour silt loam is level to gently sloping. In spots in the immediate vicinity of streams the drainage is poor, but the greater part of the type is adequately drained. The best development is found along the upper reaches of Towanda Creek, in the vicinity of Canton, and along Sugar Creek, near Troy. It often alternates with Genesee soils, the areas frequently grading into each other almost imperceptibly. While the Barbour soils are nowhere of great extent, they comprise the best parts of the farms on which they occur.

Good yields are obtained on this type, corn ranging from 50 to 75 bushels per acre, oats from 40 to 50, wheat from 25 to 35, buckwheat from 25 to 35, potatoes 125 to 150, and tobacco about 2,000 pounds to the acre. These yields are obtained on the better farms, where lime and heavy applications of manure are used. Many of the fields were formerly used for tobacco, but on account of the low prices and the scarcity of dependable labor its production has largely been abandoned. The practice of making liberal applications of barnyard manure, together with careful methods of tillage in connection with this crop, has left the soil well supplied with organic matter and in good physical condition; consequently excellent yields of ordinary farm crops are now secured.

The prices of land of this type varies considerably and is largely dependent upon location and improvements. Some tracts are held at close to $200 an acre, but most of the type has a value between $60 to $125 an acre.

BARBOUR GRAVELLY LOAM.

The surface soil of the Barbour gravelly loam to a depth of 6 to 8 inches consists of an Indian-red gravelly loam containing considerable gravel and stones of varying sizes, the gravel being usually small and well rounded. The subsoil is similar in color to the surface soil and varies from a gravelly loam to a gravel. Numerous stones

encountered in the lower portion make boring difficult and at times impossible.

This type is closely associated with the Barbour silt loam, but usually occupies a somewhat higher position, often occurring as fan-shaped deltas at the mouths of small lateral streams and as terraces along the banks of drainage ways having narrow strips of the silt loam nearer the streams. The town of Canton is built on such a delta and Troy partly so.

The type is of small extent and little importance. Portions of it are subject to occasional overflow. It is always held and farmed in conjunction with other types. The Barbour soils usually comprise but a few fields on each farm and are often confined to narrow strips along the streams. Where of small extent and poorly drained they usually form pastures.

The topography of the Barbour gravelly loam is usually gently sloping, which, together with its loose, open structure, gives good drainage. It approximates the silt loam in yields. It is well adapted to alfalfa and also produces good crops of potatoes of excellent quality.

MUCK.

The soil mapped as Muck is composed of organic matter in varying stages of decomposition, mixed with some mineral material. The typical color is very dark brown to black, the areas where the color is brown being in a less decomposed state and resembling peat. Under the layer of Muck, usually within the 3-foot section, is found a bluish clay or sandy clay, which tends to hold and accumulate water, making artificial drainage necessary.

Muck is generally found in glaciated areas. The many depressions and obstructed drainage channels develop a rank growth of swamp grasses, shrubs, and other water-loving plants, the remains of which accumulate year by year until the depression is filled with organic matter, sometimes to a great depth. Such areas usually remain in a swampy, saturated condition until artificially drained.

The areas of Muck in Bradford County are all small, and but few have been improved and put under cultivation. The largest single area is found at Snedekerville and comprises less than 100 acres. Other small areas are found scattered over the county, none of them large. For the most part they support a growth of hemlock, spruce, elm, and various shrubs and grasses.

Muck is a special-purpose soil, adapted to the production of celery, onions, spinach, and peppermint. Heavy fertilization is necessary to make these crops successful.

Celery is grown on Muck areas by only one farmer in Bradford County. About 10,000 plants per acre are secured on this tract.

Onions produce from 750 to 1,000 bushels per acre and potatoes from 150 to 200 bushels. These are practically the only crops grown on Muck areas in the county.

Muck land cleared and drained and near a shipping point is worth about $200 an acre. Undeveloped tracts can be bought at much lower prices.

MEADOW.

The term Meadow is used to designate areas too wet for cultivation but which are not true Swamp. Areas of this kind border minor streams and lie around the heads of drainage channels. A few areas are wet continuously and are true Swamp, but these are of very limited extent.

Meadow often joins or incloses Muck areas. Land sloping gently up from a depression, slough, or small stream in the Volusia silt loam particularly will be so saturated for a considerable distance as to be classed with the material in the bottom itself, and occasional areas on a hill side will be so classified from their accumulation of seepage waters. These have been mapped as Meadow wherever of sufficient size to be shown.

ROUGH STONY LAND.

Rough stony land consists of areas too broken and stony to permit of use for agriculture. Most of the land so mapped in Bradford County is situated on the top of Barclay and Robwood Mountains. Until recently it supported a thick growth of timber, but this has been removed, leaving a desolate rolling country covered with briers, stumps, and rocks. The land is so rocky that walking is difficult. A few fields have been cleared for pastures, and two or three farmers are attempting to cultivate other small cleared areas.

Much of the rock is Pocono sandstone, with which the mountain is capped, and Pottsville conglomerate, which includes the beds of low-grade bituminous coal mined at Barclay and Carbon Run.

STEEP BROKEN LAND.

Steep broken land consists of hillsides formerly covered with timber and too steep to be of any agricultural value. They can only be used for forestry or as pastures for sheep.

Usually the slopes contain numerous outcrops of rock and the soil covering is very thin. Many areas of this sort are found along the rivers. The sides of Barclay and Armenian Mountains are so steep and rugged as to fall in this class, and various other steep-sided hills throughout the county have so been mapped. Sometimes a bare outcrop of rock will be found in an area of Steep broken land, often a sheer precipice, as occurs opposite Towanda. In the aggregate these

are of such small extent and isolated occurrence that they were included in the Steep broken areas without other designation.

SUMMARY.

Bradford County is situated in the northeastern part of Pennsylvania, on the New York State line, and has an area of 1,160 square miles, or 742,400 acres.

The topography is rolling to hilly, the southern part of the area being quite rough and broken. The elevations range from 2,260 feet to less than 660 feet.

The county is drained by the Susquehanna and Chemung Rivers and their tributary streams.

Weather records at Towanda show a yearly range in temperature of over 100°, from a maximum of 90° F. in summer to a minimum of —30° F. in winter. The average growing season has a duration of 140 days in the valleys and from 120 to 125 days on the hill slopes. The mean rainfall is 34.64 inches. This is evenly distributed through the several seasons.

Dairying and general farming are the prevailing forms of agriculture, milk shipping stations and creameries being numerous throughout the county.

Over 70 per cent of the farms are operated by the owners, about 15 per cent by share tenants, and the balance by tenants paying a cash rental or making other arrangements for working the farms. Labor is fairly plentiful. Farm wages average about $25 per month, with board.

The soils of the county fall naturally into two divisions—upland soils or "hill land" and stream bottoms and terrace soils, known locally as "river flats."

Seventeen soil types were mapped in the area, representing seven series, and the miscellaneous materials mapped as Muck, Meadow, Rough stony land, and Steep broken land. Of these series the most important is the Volusia, of which two types—one of them with three phases—were separated and mapped. These are the silt loam and gravelly loam. The Volusia soils predominate in the uplands, the Lackawanna series being confined to the southern section of the county.

The Volusia silt loam is greater in extent than all other types of the area combined. It is best adapted to potatoes, buckwheat, oats, and grass. The former should be made the money crop. Sheep may advantageously be substituted for dairy cows on many of the rougher areas. General farming and dairying are the prevailing forms of agriculture on this type.

Two types were mapped in the Lackawanna series—the silt loam, with two phases, and the silty clay loam. The silt loam is the most

important. It is a good general farming soil and better adapted to corn, wheat, and apples than the Volusia silt loam.

The Genesee silt loam and very fine sandy loam form the overflow land in the river bottoms. The Chenango soils, the silt loam, stony gravelly loam, and gravelly sandy loam, occupy the upper benches or terraces. The lighter phases of the silt loam member of these series and the Genesee very fine sandy loam are frequently used for tobacco. The Chenango stony gravelly loam is an excellent alfalfa soil. This crop, with careful culture, can also be grown on other types in the area.

The Barbour soils are excellent general farming soils, but of small extent in the area.

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