

SOIL SURVEY OF BENTON COUNTY, OREGON.

By E. J. CARPENTER, of the United States Department of Agriculture, In Charge,
and E. F. TORGERSON, of the Oregon Agricultural Experiment Station.

DESCRIPTION OF THE AREA.

Benton County is situated in the middle western part of Oregon, in the second tier of counties bordering the Pacific Ocean, which lies 20 miles to the west. Portland, the principal city of the State, is 60 miles north-east of the northern boundary of the county.

The Willamette River flows along the eastern side of the county and separates it from Linn County. The county is roughly rectangular in shape, the longer dimension being north and south. It has an area of 648 square miles, or 414,720 acres.

The western half of the county is occupied largely by the foothills and higher elevations of the Coast Range. Marys Peak, situated in the west-central part of the county, rises to an elevation of 3,690 feet and is the highest point in the Coast Range north of the Umpqua River. Other peaks in this part of the county include Forest Peak in the northern, and Buck and Green Peaks in the southern end of the county.

The crest of the Coast Range, with elevations ranging from 1,000 to 3,500 feet above sea level, has a general north-south direction from near the center of the southern boundary to Marys Peak; here it swings westward out of the county, reenters at Summit, and forms the western boundary north from Summit.

The southeastern part of the county is occupied by the broad, flat valley of the Willamette River and the valleys of its tributaries, Muddy Creek, Marys River, and Long Tom River. From these valleys the foothills rise in long, rolling ridges to the more precipitous slopes of the higher elevations. North of Corvallis the main valley narrows down and at Bowers Slough it is pinched out entirely by a series of low rounded hills, of which Spring Hill is the most important. North of Spring Hill the valley broadens out again to a width of several miles before reaching the foothills, from which rises abruptly a prominent spur of the Coast Range lying between this valley and Kings Valley on the west.

The elevation of the railroad station at Corvallis is 227 feet above sea level; at Philomath, 295 feet; at Blodgett, 618 feet; and at Summit, 720 feet.

Muddy Creek has its source in the eastern slopes of the Coast Range and receives almost the entire drainage of the southeastern part of

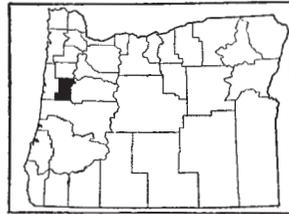


FIG. 42.—Sketch map showing location of the Benton County area, Oregon.

the county. After leaving the foothills, the creek pursues a meandering course through a flat, poorly drained country from near the southern boundary of the county northward to its confluence with Marys River, 3 miles southwest of Corvallis. During the rainy season it often overflows and covers the land along its course for a quarter of a mile or more with water, which may remain for weeks at a time.

Long Tom River has its source in the eastern slopes of the Coast Range Mountains of Lane County, and after crossing the southern boundary of Benton County, flows in a general northerly direction roughly paralleling the Willamette River for a distance of 9 miles. Long Tom River has few small drainage ways entering it in Benton County. Rather large areas of alluvial soils occur along its course.

Marys River, which is the drainage outlet for an extensive mountain region in the western and central part of the county, has cut its course through a series of low hills and mountains and flows in an easterly direction to its junction with the Willamette River just south of Corvallis. Along this river and its tributaries are numerous small intermountain valleys; some of these have been cleared and are under cultivation, but most of them are still covered with a dense virgin forest.

The Alsea River, in the southwestern part of the county, has its source in the western slopes of the Coast Range and flows in a westerly direction to the Pacific Ocean. The Alsea valley lies somewhat in the shape of a Y, with the base extending up Spencer Creek in a northeasterly direction. For the most part the valley is narrow, and the mountains rise abruptly from the valley floor.

The South Fork of the Luckiamute River enters Benton County about 5 miles east of the northwestern corner of the county, and flows in a southeasterly direction for about 5 miles, when it makes a sharp bend and flows directly north out of the county 3 miles from its point of entrance. A small but fertile valley extends south and east of the bend along Maxfield and Beaver Creeks. On the north and west the mountains border the valley floor. On the east there is a narrow belt of low foothills between the valley and the rougher country. South of the bend a low range of rounded hills forms the crest of the watershed of the Luckiamute River on the north and Marys River on the south.

The valley areas of the county consist of two physiographic divisions: (1) the alluvial flood plains, (2) the alluvial terraces and valley slopes. The alluvial flood plains, which are occupied by recent-alluvial sediments, are still largely subject to periodic overflow. In width they vary from a few rods along the smaller streams to about 4 miles along the larger rivers. The older sedimentary deposits of the terraces and valley plains and slopes now lie at elevations ranging from several feet to 50 feet or more above the present flood plains. For the most part the surface of these areas is smooth to gently undulating. Some of the smoother areas have very poor natural drainage and are in a water-logged condition during the rainy season.

In the mountainous sections the creeks and streams are generally swift and are slowly cutting their channels deeper. These streams offer opportunity for the development of small water-powers. In

addition to the streams indicated on the map, many small intermittent creeks ramify all sections of the mountain areas and provide excellent drainage.

Following the settlement of the lower part of the Willamette Valley, settlers slowly pushed their way up the Willamette River, until in the forties the first white settlers came into the area now known as Benton County. Wild grasses occupied the treeless prairies, affording pasture for sheep and cattle and offering little resistance to agricultural development. To the west arose the foothills and mountains of the Coast Range, heavily forested with fir, with only here and there open areas which from time to time had been swept by fire. Many other immigrants, attracted by the fertile soils of the valley and the ease of putting them under cultivation, located in this section in the two years following the first settlement, and in 1849 the county was organized. The first settlers were principally from the Middle Western States. At the present time 94 per cent of the population of the county is American born; of the remainder, about one-fourth is German, and the rest principally English, Canadian, Scotch, and Swedish.

The population of the county, according to the census of 1920, is 13,744. Of this number about 42 per cent is classed as urban and 58 per cent as rural. The valley proper is the most thickly populated, although the foothill section is largely developed and quite thickly settled. Large areas in the western part of the county are entirely uninhabited.

Corvallis, the county seat and largest city, has 5,752 inhabitants. The Oregon State Agricultural College and the Oregon Agricultural Experiment Station are located here. Philomath is the next town in size in the county, with a population of 591. Monroe, population 191, is located in the heart of the fruit-growing section of the county and is an important shipping point for lumber. Other towns are Alesia, Alpine, Bellfountain, Summit, Blodgett, Hoskins, Kings Valley, Wellsdale Station, and Wren. In addition there are numerous small villages and railroad points.

Benton County is very well supplied with transportation facilities, except in the southwestern part. The West Side Division of the Southern Pacific Railroad, electrified (Portland, Eugene & Eastern), has its present terminus at Corvallis. A branch of the same line extends south, passing through Monroe and connecting with the main line of the Southern Pacific Railroad at Eugene in Lane County. Another spur extends northeast, connecting Corvallis with the main line at Albany, just outside the county. The Yaquina branch of the Southern Pacific Railroad, which taps the forested area in the west-central part of the county, also has its terminus at Corvallis. The Valley & Siletz Railroad, a privately owned logging railroad, gives good transportation service for the Kings Valley section. Other logging railroads branch from the main Southern Pacific lines at Noon and Alpine Junction, tapping the most heavily forested areas of the county. The Oregon Electric (Hill System) runs a 5-mile spur from Gray, in Linn County, to Corvallis, making direct connection with Portland on the north and Eugene on the south. Water transportation is available on the Willamette River from Corvallis to Portland for six to eight months of the year.

Throughout the valley the public roads are in very good condition, being either macadamized or surfaced with gravel, as are also many of the private roads. Money has been appropriated for paving the main highways, and the work is in progress. In the hill section the main roads are usually macadamized or graveled, making them passable throughout the year. The branch roads, however, are generally in very poor condition during the winter rains.

Telephones are in general use throughout the county, and electric power is available for use in all the larger communities. Schools and churches are conveniently located in all sections of the county.

The greater part of the fresh fruit, livestock, and dairy products produced in the county is shipped to the Portland markets. Dried prunes and grains are shipped mainly by way of Portland to outside markets.

CLIMATE.

The climate of this section of Oregon is best characterized as mild. The mean annual temperature at Corvallis is 51.5° F. Extremes of heat or cold are very rare, the heat of the summer months being tempered by the daily ocean breeze, which usually sets inland about 3 o'clock in the afternoon and continues until sundown. The winter temperatures are moderated by winds warmed by ocean currents. The summer nights are always cool and comfortable, never being too hot for complete rest. The mean temperature for the winter months is 40.1° F., for the spring 50.2° F., for the summer 63.6° F., and for the fall months 52° F. The lowest recorded temperature is -14° F., and the highest, 103° F.

The mean annual precipitation is 42.30 inches, somewhat lower than along the coast. The rainfall is heaviest during the spring, fall, and winter months, when 95 per cent of the annual precipitation occurs. The months of June, July, and August are usually dry. The total rainfall at Corvallis for the driest year of which there is any record (1892) was 31.88 inches, while that for the wettest year (1896) was 57.76 inches.

On the western slopes of the Coast Range the precipitation is much heavier than that recorded at Corvallis; during the winter months snow on the higher elevations is of common occurrence, and some of the higher peaks are snowcapped until the 1st of July. In the valley snow generally melts just as it falls, though during the winter of 1919-20 a snowfall of 20 inches was recorded at Corvallis. The rains almost invariably come from the southwest, while the coldest weather is usually experienced with the wind in the northwest.

In the valley there is a comparative freedom from either damaging spring or early fall frosts. The average date of the last killing frost in the spring is April 24, and of the first in the fall, October 16, giving an average growing season of 175 days. The latest recorded killing frost in spring occurred on May 18, and the earliest in fall September 21.

Throughout the mountain section of the county the date of killing frosts in the spring and fall is extremely variable, owing to differences in elevation and conditions of air drainage. Pasturing is limited by the wet condition of the fields rather than by frost or snow.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded by the Weather Bureau station at Corvallis:

Normal monthly, seasonal, and annual temperature and precipitation at Corvallis.

[Elevation, 266 feet.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1892).	Total amount for the wettest year (1896).
	° F.	° F.	° F.	Inches.	Inches.	Inches.
December	39.1	66	-14	6.72	6.20	7.81
January	39.0	64	- 1	7.03	5.55	8.35
February	42.1	69	20	5.52	1.77	3.24
Winter	40.1	69	-14	19.27	13.52	19.40
March	45.5	77	22	4.54	3.20	3.13
April	50.2	87	24	2.75	4.65	6.98
May	54.8	87	28	2.05	.45	5.71
Spring	50.2	87	22	9.34	8.30	15.82
June	59.8	97	32	1.18	.61	.98
July	65.5	103	36	.34	.45	.00
August	65.5	101	40	.41	.T	1.16
Summer	63.6	103	32	1.93	1.06	2.14
September	59.7	93	33	1.76	1.68	.41
October	52.4	85	23	2.91	2.05	3.30
November	44.0	68	19	7.09	5.27	16.69
Fall	52.0	93	19	11.76	9.00	20.40
Year	51.5	103	-14	42.30	31.88	57.76

AGRICULTURE.

The early settlers in this region occupied the level treeless valley floors which provided grass and wild hay in abundance. Owing to a lack of agricultural implements and available markets, only sufficient land was cultivated to supply the immediate home needs, and for a number of years the leading industry was the grazing of cattle on the open range. With the gradual increase in population and the establishing of lines of communication, more attention was paid to the raising of grain and forage crops. Crop failures were almost unknown, and with the large areas of fertile soil waiting only to be plowed, the growing of these crops rapidly came to be the dominant industry, pushing the range cattle back into the hills for the summer pasture, but affording an abundant supply of hay and grain for winter feed.

According to the census of 1880, the area in wheat in 1879¹ was 31,015 acres, producing 497,068 bushels; oats, 9,063 acres, producing 256,832 bushels; and hay on 6,235 acres produced 10,793 tons. These three crops occupied practically the entire acreage reported in selected crops, with wheat occupying nearly two-thirds of it. Though yields of these crops were still good, the continued cropping year after year to grain had begun to impair the soils and yields were falling off to a marked degree. Barnyard manure was available on every farm, but very little was used.

¹ Part of Benton County was taken to form part of Lincoln County in 1893. Accordingly the acreages and yields in 1879 and 1889 represent a larger territory and are not strictly comparable with those of later census years.

In 1889 the acreage in wheat had decreased to 18,415 acres, producing 394,533 bushels; oats occupied 12,929 acres and produced 391,842 bushels; while hay produced 14,695 tons on 8,979 acres. Barley, hops, and potatoes were also being grown to some extent, there being 661 acres in potatoes with a production of 53,238 bushels. Among the fruits, apples were of first importance, with 48,128 trees yielding 46,029 bushels. In the same year 2,160 peach trees were reported.

In 1899 the agriculture of the county was beginning to be somewhat more diversified, though the acreage in wheat was more than 35 per cent of the total area in improved land in the county. Oats had increased in acreage from 1889, as had also the hay crops, among which clover is reported as occupying 94 acres. Corn occupied 376 acres and grains were cut green for hay on 3,656 acres. There were 94,208 apple trees, and 6,544 peach trees; and the total value of all orchard products amounted to \$18,583.

In 1909 the agriculture of the county had been established on a permanently paying basis. Wheat occupied 12,080 acres, or about 13 per cent of the total area of improved land. Oats occupied 18,532 acres, an increase of about 2,000 acres over 1889. The most important change, however, was in the expansion of the dairy industry and the consequent increase in the acreage of clover and of grains cut green for hay. Clover alone or mixed with timothy was grown on 945 acres, and grains cut green for hay occupied 14,912 acres, yielding 23,422 tons. Animals sold and slaughtered were valued at \$514,386, as compared with \$152,247 in 1899; dairy products, excluding home use, were valued at \$148,841, as compared with \$33,958 in 1889; and poultry and eggs produced were valued at \$126,233, as compared with \$24,640 in 1889. Orchard products continued to become more important, though a slight decrease is noted in the number of apple and peach trees. Prunes and plums were beginning to assume some importance in the agriculture of the county, there being 49,635 trees, yielding 40,815 bushels. Pears and cherries were harvested with 7,001 and 3,909 trees, respectively.

During the next decade the dairy industry continued to gain in prominence, and with it there was further increase in the production of clover and corn, which were grown in 1919 on 2,502 acres and 1,053 acres, respectively. Beans also assumed prominence, being raised on 729 acres. Wheat occupied 20,717 acres, or 20 per cent of the total area of improved land. Oats occupied 14,602 acres; grains cut for hay, 12,380 acres; silage crops, 1,449 acres. The value of the principal agricultural products in 1919 was reported by the census as follows: Cereals, \$1,251,826; other grains and seeds, \$79,732; hay and forage, \$764,885; vegetables, \$380,524; fruit and nuts, \$308,661; all other crops, \$71,973; dairy products, excluding home use, \$427,716; poultry and eggs, \$314,039; wool and mohair, \$90,570. There were 76,569 plum and prune trees, 73,092 apple trees, 17,928 pear trees, 50 acres in strawberries, and 125 acres in raspberries and blackberries, including the loganberry.

At the present time the agriculture of the county consists of general farming, dairying, fruit raising, and to a relatively small extent trucking. Wheat, oats, clover, vetch, and corn are the principal crops grown, though in recent years potatoes and beans have

received more attention than formerly and are found to be well adapted to use in rotations.

Wheat and oats are the leading cash crops of the county, wheat being most important. Both are grown on nearly every farm. The wheat is sold to local flour mills or is shipped to Portland. The soft wheats are the only ones grown, and the acreage of winter wheat, as reported by the State Tax Commission for the year 1919, was nearly double that of spring wheat.

Oats are grown either alone or with vetch. In the latter case the crop is cut for hay and fed to dairy or beef cattle during the winter months. When grown for grain it is utilized to some extent on the farms for stock feed, but markets are always available for the surplus.

Clover, vetch, and corn are grown almost entirely in connection with the dairy industry. The first crop of clover is usually cut for hay and the second left for seed or pasture. Clover seed is becoming very important as a cash crop. Vetch is sometimes grown for seed as a cash crop, but generally it is sown with oats and harvested as hay. Corn is grown mainly for silage and fed on the farms. A great deal has been done toward improving varieties by seed selection, and in late years some grain has regularly been harvested and sold locally for seed.

The production of potatoes and, especially, of beans has increased from year to year, and at present both crops are of considerable importance. Potatoes are sold in the local markets, but any surplus finds a ready sale in Portland. Beans are a cash crop. Owing to their adaptation they are being grown to a greater extent each year on the more poorly drained soils.

On the majority of farms the sale of dairy products now constitutes the chief source of income. As reported by the census, there were 5,131 dairy cows, including heifers 2 years old and over, in Benton County in January, 1920. The products marketed consist principally of cream or whole milk; in most cases only the cream is marketed, the skim milk being fed to hogs, which are pastured on clover sod or grain-stubble fields. Jersey cattle are most numerous in the county, though several good herds of Holsteins also are maintained. There is an increasing tendency to keep only purebred stock of cattle, sheep, and hogs, some of the best bred stock to be found in the Willamette Valley being in Benton County.

The Willamette Valley is particularly well adapted to sheep and goats, and under the stimulus of the high prices during the last few years for mutton, wool, and mohair, there has been a large increase in the flocks of the county. During the summer they are pastured in the hills, but after harvest they are returned to the valley and pastured on clover or grain-stubble fields.

Barley and rye are grown to a small extent in the county and utilized largely on the farms as stock feed.

Orchard fruits and small fruits are grown on nearly every farm for home use, but in only a few instances are the small fruits produced for market. Prunes and apples are the principal fruits grown on a commercial scale; several orchards in the county are devoted entirely to their production. The yield of apples is somewhat lower than in specialized fruit-growing sections of the West, but a good quality of fruit is produced in sufficient quantities to prove profitable. The

large Italian Prune is grown almost exclusively, and an excellent quality of fruit is produced. The English walnut is also gaining some prominence, several small plantings being found in which prunes or cherries are used as fillers between the trees. According to the 1920 census, there were 1,329 walnut trees of bearing age in the county, producing 6,910 pounds of nuts. Peaches and pears are also grown to a small extent both for home use and for sale. Two canneries, one at Corvallis and the other at Philomath, provide readily accessible markets for surplus orchard and garden products.

The "red hill soils" of the Aiken, Olympic, and Sites series are recognized by the farmers of Benton County as being well adapted to the production of prunes, apples, and walnuts. In the valley, wheat and red clover are grown on the higher, better-drained Willamette soils (Pl. XXIV, fig. 1). Alsike clover and oats are grown on the wetter areas of Amity and Dayton soils. Beans are also known to be adapted to the Amity and Dayton soils. Corn, peaches, and potatoes are usually planted on the river-bottom soils when available, the potatoes and peaches generally occupying the sandy types of either the Newberg or Chehalis series, while corn is planted on the heavy as well as light textured types of these series (Pl. XXIV, fig. 2).

In preparing land for crops it is usually plowed or disked in the fall to a depth of 4 to 6 inches, and harrowed and seeded as soon as moisture conditions permit. Small grains are harvested with the binder, while hay crops are cut with a mower, raked almost immediately and put up in cocks, and when sufficiently dry taken to the barn. Grain crops are shocked, and at the time of threshing the grain is put into sacks and hauled to storage houses, where it is held until ready to market.

Clover which is to be threshed is left standing until perfectly ripe. It is then cut, raked into windrows, and as soon as dry threshed with a clover huller.

A general air of prosperity is given the valley by well-built and well-kept farm buildings and home sites. The dairy farms especially are well improved with good barns, silos, and outbuildings, and the houses through the valley are better than those usually found in farming communities. Owing to a scarcity of farm labor, tractors are now in general use throughout the valley, a small, light tractor being the prevailing type. Light farm work or hauling is done with horses or trucks, medium-weight horses being in general favor.

The orchards throughout the county are generally given sufficient cultivation to keep down weeds and preserve a mulch over the surface. Occasionally a crop of rye or vetch is planted early in the fall between the trees, and turned under the next spring as green manure. The commercial orchards are well cared for, but small home orchards are generally unpruned and unsprayed, and the fruit shows the effects of this neglect.

A 3-year rotation of wheat, clover, and oats is commonly practiced. Clover is generally seeded in February or March in fall-sown grain. The second year two crops of clover are harvested, the first for hay and the second for seed. The sod is then plowed in the fall, and the third year the land is planted to spring oats or wheat. Where a cultivated crop is included it usually follows the clover crop. Corn, beans, or potatoes are used, but the acreage in these crops is insufficient to make this four-year rotation of general applicability at the present time.

Very little commercial fertilizer is used in Benton County. According to the census, 189 farms, or one-seventh of the whole number, reported the use of fertilizer in 1919, at a total cost of \$7,924. The soils of this section are generally acid, and ground limestone is applied where available, but owing to its excessive cost very little is used. Gypsum² is used to some extent on young clover, and all the available barnyard manure is utilized. Recent experiments by the Oregon Agricultural Experiment Station have shown marked results on many soils of the valley, following the application of soluble phosphates.

The majority of the laborers employed in the valley are American born and efficient. However, owing to the high wages paid for labor in the cities and on construction work, where conditions for labor are somewhat better, laborers are very scarce in this area and there is sometimes lack of sufficient help to harvest the crops properly. The monthly wage of farm labor at the time of this survey (1920) ranged from \$85 to \$100, with board, while the wages for day labor were \$5 to \$7 a day. The cost of labor on 677 farms in 1919, according to the census, was \$317,882. In many cases the area in crops has been cut down, so that the farm operator can do all his work, with the exception of gathering the crops.

As reported by the census of 1920, 53 per cent of the area of the county is included in 1,320 farms. The average size of these farms is 176.8 acres, of which 44.2 per cent, or 78.2 acres, is classed as improved land. The size of individual farms ranges from 40 to several hundred acres, the larger ones being devoted principally to stock raising.

The census shows that 78.2 per cent of the farms are operated by owners, 19.8 per cent by tenants, and 2 per cent by managers. About 65 per cent of the tenants rent on the share basis, giving the farm owner one-third of the crop. Cash rents range from \$5 to \$8 an acre, depending on location, type of soil, and improvements.

The price of land in Benton County varies according to location, improvements, and type of soil. Some land in producing orchards sells for \$500 to \$700 an acre, while general farm land ranges from \$50 to \$180 an acre, with an average price of \$90. Some of the river-bottom land, well adapted to specialized crops, sells for \$350 to \$400 an acre.

SOILS.

Benton County is situated in the humid part of the Pacific coast soil region in middle western Oregon. It lies on the west side of the Willamette River. About 20 per cent of its area is included in the Willamette Valley proper, an additional 55 per cent in the drainage area of the Willamette River, and the remaining 25 per cent lies on the western slopes of the Coast Range.

The transported soils occupying the main valley are of mixed origin, having been deposited by the flood waters of the Willamette River, which has its source in the Cascade Mountains to the east but has some tributaries rising in the Coast Range to the west. The residual soils occupying the hilly and mountainous districts are generally

² The hill soils are low in sulphur and respond to its application. Experiments strongly indicate that the results obtained with gypsum can frequently be obtained more cheaply by applying sulphur.

covered with a dense growth of fir and smaller vegetation, and have in most cases suffered very little translocation by the heavy rainfall characteristic of this region. Instances of erosion are rare, but slides along the steeper slopes are of common occurrence.

In general, the minor streams have deposited their sediments in narrow, tortuous valleys from which the residual soils rise abruptly on both sides. In a number of embayments in the lower foothills the old alluvium has been spread out over a considerable area, through which the streams have cut their courses, leaving the older materials as terraces several feet above the present flood plains.

The soils of Benton County are classed in four groups, as follows: (1) Residual soils, (2) old valley-filling soils, (3) recent-alluvial soils, and (4) miscellaneous materials, including Rough mountainous land and Riverwash.

The residual soils, with which may be placed Rough mountainous land, are by far the most extensive group, occupying about 73 per cent of the area of the county. The old valley-filling soils cover about 11 per cent, and the recent-alluvial soils about 16 per cent. The Rough mountainous land alone covers nearly three-eighths of the area of the county.

According to the system of soil classification developed by the Bureau of Soils, the soils of the first three groups are classed in soil series and soil types. Each series includes types that are similar in essential characteristics, such as color, structure, derivation of soil material, and mode of formation or accumulation. The types in the several series differ in texture, or in their content of sand, silt, and clay particles in the surface soil. The type is the unit of mapping. Subordinate variations within the type are recognized as phases.

The soils of this area occur under humid to subhumid conditions, though they are normally subject to a rather long period of drought during the summer months. Most of the areas of residual soil are in forest, and many of them are heavily forested, though some of the lower hills adjacent to the larger valleys are treeless or support only a scattering or scrubby growth of trees and brush. The valley soils were developed in part under forest and in part under prairie conditions.

The soils of the county are well leached of soluble minerals and are rather low in lime, and some of the lower lying soils with poor drainage are decidedly acid in reaction.

A characteristic feature of the soils of this region, which appears to be associated with climatic conditions of heavy annual rainfall and summer drought, is the occurrence of small spherical concretions, which appear to be due to cementation of soil particles by iron. These are of brown or reddish-brown color, dull bluish gray internally, and usually of the size of buckshot. As a rule they are rather soft and frequently can be crushed in the fingers, but they do not disintegrate readily under cultivation. Where occurring in large quantities they modify the soil by giving it a more open structure and coarser texture, acting much the same as gravel fragments of similar size in the gravelly soil types.

They are generally most abundant in the surface soils, but locally they occur also in the subsoil. In this county they are conspicuous in the residual and are abundant in places in the old valley-filling soils,

particularly in those with flat surface and poor drainage. In the recent alluvial soils they are less abundant but may appear where washed in from adjacent slopes.

The residual soils have been formed by the weathering in place of consolidated rock materials, which in this area consist mainly of two kinds, igneous and sedimentary.

The igneous rocks are mainly of low quartz content, or basic in character, and consist largely of basalt, though considerably coarser grained material, probably either diorite or dolerite, is found in this area. The soils on most of the higher foothills and mountains bordering the Willamette Valley are derived from such materials, though occasional areas of sedimentary rock are found. The coarser grained rocks are characterized by rather shallow weathering giving rise to areas of shallow soils. The Cascade soils in this county are derived largely from rock of this character. Where deeply weathered the igneous rocks have formed the red soils of the Aiken series or the brown or reddish-brown soils of the Olympic series.

The sedimentary rocks consist principally of a medium textured grayish-brown sandstone. The residual soils on the lower foothills bordering the Willamette Valley are generally of sandstone or shale origin, while the soils of the western one-third of the county, comprising a strip 8 to 12 miles wide along the western boundary, are very largely of sandstone origin. These formations give rise to the soils of the Sites, Melbourne, and Carlton series.

The types of the Aiken series have surface soils of red to pronounced reddish brown or dull red color, and a red subsoil. The red color is usually most pronounced under moist field conditions. In general these soils are deeply weathered, bedrock, which is for the most part basalt, lying at depths varying from 3 to 15 feet or more. They occupy higher elevations of gently undulating to rolling topography and occasional steep hillsides. The Aiken silty clay loam occurs in Benton County.

The Olympic series includes types with brown, dark-brown, reddish or rusty-brown soils, and a brown, rusty-brown, or somewhat yellowish brown subsoil, in most areas somewhat lighter in color than the surface soil. The basalt or other rocks of low quartz content from which this series is derived is commonly deeply weathered, though generally weathering has not extended to so great depth as in the Aiken series. The soils of this series occupy the lower foothills bordering the valley (Pl. XXV, fig. 1) and steep mountain slopes, generally in those areas where through natural causes the oxidation of iron has been retarded. Three types are mapped in the county, the silty clay loam, clay loam, and clay, the last two with shallow phases.

The Cascade series includes types with dark-brown to light-brown soils, and a yellowish-brown subsoil, in most places underlain by a yellow deep subsoil layer, slightly lighter in texture than the overlying material and somewhat mottled with light yellowish brown. The soils of this series are derived from igneous rocks, either basalt or some of the closely associated coarser grained basic rocks, such as diorite or dolerite. In this county the soils are characterized by comparatively shallow weathering and the yellow substratum is not very well developed. They occur principally along the lower foothills closely associated with the Olympic types. The Cascade clay loam, with a shallow phase, has been mapped.

The types in the Sites series are characterized by yellowish-red to dark-red or reddish-brown soils and a red subsoil. This series is similar to the Aiken series but is derived from sandstones and other sedimentary rocks. The subsoil is normally heavier and more compact than the surface soil and rests upon the underlying sandstone or shale at depths varying from 4 to 10 feet or more. The Sites clay, with a friable phase, has been recognized in this county.

The soils of the Melbourne series, which is similar to the Sites series in origin and occurrence, are brown, reddish brown, or in places light brown or yellowish brown in color. The subsoil is yellow or yellowish brown to brownish yellow, and locally mottled with gray or with brown and red iron stains. Fragments of the sandstone or shale rock, from which the soils are derived, occur in the lower subsoil, and bedrock is generally encountered at depths varying from 3 to 8 feet. The series generally is developed in the lower foothills, and the topography varies from broken to gently rolling. Slides are more common in these soils than in those derived from igneous rocks. The sandstones from which the soils of the Melbourne series are in part derived are of massive structure in places, and where the rocks are deeply weathered it is frequently difficult to distinguish them in the field from the weathered igneous rocks giving rise to the Aiken, Olympic, and Cascade soils. Consequently soil boundaries in these areas are in places somewhat arbitrary or approximate, and as mapped the Melbourne soils may include some material of the other series mentioned, particularly the Cascade, which most closely resembles the Melbourne in color. Two types were mapped, the Melbourne silty clay loam and the Melbourne clay loam, the latter with a friable phase.

The surface soils of the types included in the Carlton series are light brown to light grayish brown, faintly mottled with gray. The subsoil is normally somewhat heavier textured than the surface soil, compact, and mottled with gray or in places with iron stains. The soil is derived from the weathering in place of sandstone and shale rocks and is characteristically deep, the bedrock being reached at depths of 20 feet or more. The series is developed principally along the base of the lower foothills and has a gently sloping topography not unlike the terrace soils with which it is closely associated. Both surface soil and subsoil are leached of lime carbonate and other readily soluble salts. The series is represented in the present survey by the Carlton silty clay loam.

The old valley-filling soils are derived from the older water-laid, mainly stream-laid, deposits, but in part colluvial wash. The soils have been more or less modified in structure and profile through weathering and leaching, with the consequent development in most areas of compact or heavy-textured subsoils.

These soils occupy valley slopes and stream terraces varying in elevation from a few feet to 50 feet or more above the level of normal stream flow and in most instances are undergoing degradation. The terraces are flat or gently sloping, and have about the same elevation, indicating that they are all of practically the same geological age. The materials forming these soils are derived from a variety of rocks. The soils of this group in Benton County occur under conditions of moderately heavy rainfall, but in general receive less rainfall than the residual soils. The Willamette, Dayton, Amity, Salem, and Grande Ronde series compose the group in Benton County.

The Willamette series includes types with brown surface soils and a lighter brown subsoil slightly heavier or more compact than the surface. These soils are generally without mottling or are only faintly mottled within 3 feet of the surface. They are derived from old water-laid deposits having their source in a variety of rocks. They usually occupy gently sloping or slightly undulating valley plains and terraces where conditions of natural drainage are best developed. The series is represented in this survey by the Willamette silt loam.

The Dayton series differs from the other old-alluvial soils in the survey. The surface soils are grayish brown to light gray or dull gray, the upper subsoil a drab, plastic clay, the lower subsoil light brown, and more friable, and mottled with yellowish gray and brown. The surface is nearly level to flat or basinlike, and both surface and internal drainage are poor. (Pl. XXV, fig. 2.) The series is represented by the Dayton silty clay loam.

The Amity series is intermediate between the Willamette and Dayton series with respect to color of surface soils, character of subsoil, drainage, and occurrence. It includes types with grayish-brown to brown surface soils, sometimes faintly mottled, underlain by a mottled brown, yellow, and gray subsoil. It is intimately associated with the Willamette and Dayton series, and is distinguished from the former by the grayer color of its surface soils and the pronounced mottling in the subsoil, and from the latter by a browner color and by the absence of the characteristic heavy upper subsoil of the Dayton series. It is derived from old water-laid deposits which have been considerably altered since deposition by weathering. The Amity silty clay loam has been mapped in this county.

The Salem series includes types with rich-brown to reddish-brown surface soils, a subsoil of similar or lighter brown color, containing gravel and cobblestones and a rather compact but permeable gravel substratum. In this county the gravel in the substratum is composed largely of basaltic rock, with which is mixed a little sedimentary rock. This series differs from the Willamette mainly in the occurrence of gravel in the subsoil and substratum. It is derived from the weathering of old unconsolidated sedimentary deposits. The topography is gently sloping, giving good drainage. The Salem clay loam is found in Benton County.

The surface soils of the types included in the Grande Ronde series are light brown to yellowish brown and underlain by a dull-yellow to yellowish-brown subsoil of heavy texture, mottled with gray and stained with iron in the lower part. These soils occupy alluvial fans and the lower slopes of the hills composed of sedimentary rocks and consist largely of the weathered outwash from these hills, together with other unconsolidated water-laid deposits. The surface is smooth and gently sloping to nearly flat and in most places underdrainage is restricted. The Grande Ronde silty clay loam has been mapped in the county.

The group of recent-alluvial soils includes stream-laid deposits still in the process of accumulation or deposited so recently that they have undergone little if any modification in profile since accumulation. The areas lie only a few feet above the normal flow of the stream, and are subject to periodic overflow. Along the minor streams they have

a smooth surface, in contrast to those along the Willamette River, where, owing to varying currents in time of flood, the surface is more irregular. Unlike the old valley-filling soils, these soils have permeable or only moderately compact subsoils, and include most of the lighter textured types of the county.

The largest areas of the recent-alluvial soils are in the southeastern part of the county along the Willamette River. Areas of varying size occur along nearly all the streams of the county; especially in the western part, where the streams have cut their way through the soft sandstones. The soils of this group have been classified in the Chehalis, Newberg, Camas, Wapato, Whiteson, and Cove series.

The surface soils of the types included in the Chehalis series are brown and the subsoil similar in color, friable in texture. Types of this series occupy first bottoms and are subject to occasional overflow (Pl. XXV, fig. 1), differing in this respect from the Willamette soils, which they resemble in color. Except during occasional overflows, the drainage is good. Two types have been mapped in the county, the Chehalis fine sandy loam, and the Chehalis silty clay loam, the latter including a heavy phase.

The Newberg series includes types with brown to rather dark brown surface soils and a slightly lighter brown and lighter textured subsoil. The subsoil layer is encountered at depths varying from 1 to 3 feet and continues to a depth of several feet. The types of this series closely resemble the Chehalis soils in color, but differ from them in having a lower position, a more irregular surface, and a lighter and more porous subsoil. In Benton County the two series are intimately associated and are separated with considerable difficulty. The series is represented by three types, the fine sandy loam, which includes a gravelly phase, the loam, and the silty clay loam.

The Camas series includes types with brown to rather dark brown surface soils and a similarly colored subsoil containing gravel and cobblestones in the upper part and underlain at shallow depths by a gravel substratum. This series corresponds to the Salem series of the old valley-filling group, but differs from it in that the material is of more recent deposition, and is composed entirely or mainly of materials derived from basaltic or other basic igneous rocks, while the Salem material is derived from both igneous and sedimentary rocks. The drainage is good, except during periods of high water, when the soils may be covered for several days at a time. Only one type of this series, the clay loam, occurs in Benton County.

The Wapato soils have a rather wide range in color and in character of surface soil and subsoil material. They are poorly drained and contain mottling in the subsoil and in places in the surface material. Where typically developed the surface soils are dark grayish brown or dark brown, mottled locally with gray and rusty brown, and the subsoil is brown to dark brown or drab, mottled with rusty brown, gray, drab, or yellow. The soils are formed of recent-alluvial material derived from many different rocks. Many areas are developed in places where, because of natural obstructions, the water is backed up and held on the surface for long periods of time. One type of this series is mapped, the Wapato silty clay loam.

Included in the Whiteson series are types consisting of light brownish gray or light-gray to rather dark gray surface soils, underlain by a subsurface layer of drab plastic clay, 8 to 10 inches thick, beneath



FIG. 1.—TYPICAL WILLAMETTE VALLEY FARM SCENE, SHOWING CLOVER HAY ON WILLAMETTE SILT LOAM.



FIG. 2.—CORN ON SOILS OF THE CHEHALIS SERIES.



FIG. 1.—TOPOGRAPHY OF THE CHEHALIS AND OLYMPIC SERIES.

Alluvial valley in foreground occupied by soils of the Chehalis series. Hills in the distance occupied mainly by soils of the Olympic series.



FIG. 2.—TOPOGRAPHY OF THE DAYTON SILTY CLAY LOAM, LOCALLY KNOWN AS "WHITE LAND."

which is a subsoil of drab clay mottled with yellow. In color and profile this series resembles the Dayton series of the old valley-filling group, but differs in that it is of recent-alluvial origin and subject to overflow. The series is generally developed in depressions or at the head of local drainage ways, where both surface and internal drainage are very poor. One type of this series, the Whiteson silty clay loam, is mapped in the county.

The surface soils of the types grouped in the Cove series are very dark brown or dark gray to black, and rest on a dark-colored or black subsoil normally of heavy texture, and locally mottled with brown and yellow iron stains. As developed in Benton County, there appears 3 to 5 feet below the surface, a grayish material, lighter in texture than the overlying material and somewhat mottled with yellow. The soils are subject to occasional overflow, and are poorly to moderately well drained. The Cove clay is the only type of the series mapped in this survey.

The miscellaneous types comprise Rough mountainous land and Riverwash. The Rough mountainous land includes those soils which, on account of their rough mountainous topography and relative inaccessibility, it was deemed inadvisable to map in detail. The soils in these areas are for the most part residual in origin and derived from igneous or sedimentary rocks. The areas are mainly nonagricultural, though small tracts are included that may be found adapted to cultivation when the country is more completely developed. Riverwash consists of coarse porous materials occupying flood-swept areas adjacent to stream channels, and is entirely nonagricultural.

The following table gives the names and the actual and relative extent of the various soils mapped in Benton County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Rough mountainous land.....	153,344	37.0	Olympic silty clay loam.....	7,040	1.9
Aiken silty clay loam.....	38,720	9.3	Sites clay.....	2,496	1.5
Melbourne clay loam.....	26,752	8.0	Friable phase.....	3,648	1.3
Friable phase.....	6,016		Carlton silty clay loam.....	5,632	
Chehalis silty clay loam.....	21,056	7.4	Newberg loam.....	4,800	1.1
Heavy phase.....	9,536		Cascade clay loam.....	3,072	.8
Olympic clay loam.....	21,824	5.6	Shallow phase.....	320	
Shallow phase.....	1,472		Grande Ronde silty clay loam.....	2,688	.6
Melbourne silty clay loam.....	20,800	5.0	Cove clay.....	2,112	.5
Amity silty clay loam.....	18,112	4.4	Newberg silty clay loam.....	1,792	.4
Wapato silty clay loam.....	16,896	4.1	Chehalis fine sandy loam.....	1,344	.3
Willamette silt loam.....	14,976	3.6	Salem clay loam.....	512	.1
Newberg fine sandy loam.....	7,616	2.3	Riverwash.....	512	.1
Gravelly phase.....	2,240		Camas clay loam.....	448	.1
Olympic clay.....	1,280	2.3	Whiteson silty clay loam.....	256	.1
Shallow phase.....	8,256				
Dayton silty clay loam.....	9,152	2.2	Total.....	414,720	.....

AIKEN SILTY CLAY LOAM.

The surface soil of the Aiken silty clay loam in its typical development consists of 10 to 12 inches of red to brownish-red silty clay loam. As mapped, however, some material of somewhat heavier texture is included. The subsoil is red in color, generally of about the same texture or slightly heavier than the soil, and compact. In the virgin state the surface soil has a high content of organic matter, and locally contains numerous round, partly cemented brown or rusty-brown iron concretions. In places the soil contains angular fragments of basalt

and the bedrock is found at shallow depths though it rarely outcrops. The soil is friable and easily worked, and even when wet a granular structure largely counteracts the heavy texture. For the most part this soil is deeply weathered, bedrock being reached ordinarily at from 4 to 6 feet from the surface.

The Aiken silty clay loam is prominently developed on the eastern slopes of the Coast Range south of Marys River, where it occupies nearly one-half the total area of residual soils in that section. Another large area is in the north-central part of the county along Soap Creek, and still other important areas lie along Woods Creek and in the vicinity of Wren and Blodgett.

The type occupies gently rolling hilltops and some areas that are nearly level. A few slopes are too steep for cultivation. The drainage is everywhere well developed.

The Aiken silty clay loam is a residual soil derived from the weathering in place of basalt and to some extent from coarser grained basic igneous rocks. Some small areas of the brown or reddish-brown soils of the Olympic series are included. Such areas usually occur in the lower depressions or as gradations between the Olympic and Aiken types.

Only a very small percentage of this type is under cultivation; the rest supports a valuable growth of fir or spruce timber. Several varieties of ferns are prominent in the undergrowth and are very troublesome when the land is first brought under cultivation. The principal crops on this type are wheat, oats, prunes, and apples.

This soil is naturally fertile and well supplied with organic matter, but most of the land under cultivation has been cropped continuously to wheat and oats, until the yields obtained are about half what they were formerly. Wheat yields 12 to 18 bushels per acre and oats 15 to 20 bushels per acre. On some of the better farms, where dairying is practiced, oats, vetch, and clover are grown in a rotation with wheat and cut for hay, which is fed to stock during the winter season and the manure returned to the soil. The turning under of cover crops is practiced only in some of the producing orchards in the southern part of the county, a crop of rye or vetch and rye being plowed in every third or fourth year. The prune trees set on these soils are vigorous and productive. Apples yield from 200 to 350 boxes per acre, and prunes from three-fourths to 1½ tons of dried fruit, with an average of 1 ton per acre. The growing of walnuts offers considerable promise, and several small plantings are making an excellent growth.

Producing prune orchards are valued at \$500 to \$900 an acre, depending on the age of the trees, the general condition of the orchard, and nearness to market. Apple orchards are held at about the same price. Improved land of this type not in orchard can be bought at \$50 to \$90 an acre and unimproved land at \$15 to \$25 an acre.

The Aiken silty clay loam is adapted to the production of prunes, apples, and walnuts, and where conditions are favorable these crops have proved very successful. This soil could be greatly improved in many cases by turning under some cover crop such as vetch or rye, and by enlarging the rotation to include some intertilled crops, such as corn or potatoes, which would aid in the control of ferns and weeds. Soluble phosphates have been tried on the soils of this series by the Oregon Agricultural Experiment Station and have given favorable results.

OLYMPIC CLAY LOAM.

The surface soil of Olympic clay loam has a depth of 10 to 12 inches and consists typically of brown to dark reddish brown friable clay loam, relatively high in silt in places, and carrying appreciable quantities of organic matter and rusty-brown iron concretions or pellets. The subsoil is a brown compact silty clay loam, clay loam, or clay, underlain at depths varying from 2 to 6 feet by massive basalt. Angular fragments or rounded weathered bowlders of the parent rock occur locally throughout the soil profile. Rock outcrops are numerous on the steeper and more broken slopes.

The Olympic clay loam is of residual origin, being derived from the weathering of basalt and associated igneous rocks. In general it is not so deeply weathered as the Aiken soil and contains more rock fragments. It is closely associated with the Aiken silty clay loam, but normally occupies positions of slightly lower elevation, or those in which natural drainage is not so well developed.

This type occurs throughout the hill and mountain section of the central part of the county, as well as on occasional intrusions of igneous rocks in the region of sandstone formation in the western part of the survey. The largest areas lie south and west of Philomath and east of Wren. Other areas are east of Kings Valley and in the vicinity of Wellsdale Station. The drainage of the type is generally good, except where the land is subject to seepage from higher areas.

Owing to the rugged topography and the difficulty of clearing this soil of its heavy growth of fir and oak, only about 6 per cent is in cultivation. The rank undergrowth of ferns throughout the forested part of the type is very troublesome when the land is put under cultivation. Wheat and oats are the principal crops and yield practically the same as on the Aiken silty clay loam. Sheep and cattle are grazed on the unforested areas during the spring and fall when moisture conditions permit. Improved land of this type sells for \$50 to \$90 an acre and unimproved land for \$10 to \$25 an acre.

Tree fruits do well on this soil, as indicated by the yields from small home orchards. Along the streams where moisture conditions are good all kinds of small fruits yield abundantly, and suggest the possibility of using this soil more extensively in their production. The suggestions made for the improvement of the Aiken silty clay loam are equally applicable to this type.

Olympic clay loam, shallow phase.—The soil material of the Olympic clay loam, shallow phase, is brown to dark brown in color, and rests upon the underlying bedrock at depths of 6 to 18 inches. Included with the phase are some small areas occupying slight depressions, where the soil is of greater depth, but such areas are of little agricultural importance. Rock outcrop is common over the phase and scattering rock fragments are everywhere present. Drainage is excessive, and the vegetation, which consists almost entirely of grass, with here and there patches of scrub oak, suffers for want of moisture during the summer season.

Three bodies of the phase lie north and east of Wren School, and others are east and south of Kings Valley. The phase has little value except for the scant pasture afforded during 3 or 4 months of the year. It is held at \$15 to \$40 an acre.

OLYMPIC SILTY CLAY LOAM.

The surface soil of the Olympic silty clay loam consists typically of 10 to 12 inches of brown to dark-brown friable silty clay loam. As mapped, however, the material is somewhat variable in texture and may include some silt loam, clay loam, or clay material. The subsoil is compact in structure, and typically somewhat lighter in color and slightly heavier in texture than the surface soil. The soil contains an abundance of iron concretions and small granular rock fragments which make it easy to work under a wide range of moisture conditions. Bedrock is usually encountered at depths of 2 to 4 feet, and on the steeper slopes outcrops occur over small areas. Rock fragments are abundant in this soil, being more numerous in this than in any other residual type. Places where they are especially abundant have been indicated on the soil map by gravel symbols.

Several large areas of this type occur east and south of Kings Valley and north of Alsea. Other areas are at Marys Peak, Blodgett, and south and west of Alsea. The surface of the type is generally quite steep with places here and there that are too steep or broken for cultivation. Drainage is good to excessive.

The soil is of residual origin, being derived from the weathering of igneous rocks largely basaltic in character. The type includes small areas of soils of similar origin occupying slight depressions and also more deeply weathered areas in which the texture is slightly heavier.

The Olympic silty clay loam has little agricultural importance at present, only about 3 per cent of its area being under cultivation. Several areas of moderate size are without forest growth, but are unfit for cultivation owing to the shallow soil and consequent droughty nature. The forest growth on the better areas consists principally of fir and oak. Wheat and oats, the chief crops, yield moderately well in favorable seasons, wheat producing on an average from 10 to 15 bushels per acre and oats 15 to 20 bushels per acre.

Where the soil is deep and moisture conditions are favorable, the type is adapted to the production of prunes and apples, or small fruits such as strawberries or blackberries. The type is low in organic matter and could be greatly improved both in moisture-holding capacity and fertility by turning under rye or vetch. The steeper areas are suited only to grazing, and those in forest should be utilized for forestry.

OLYMPIC CLAY.

The surface soil of the Olympic clay is a brown to dark-brown, heavy, plastic clay, extending to a depth of 8 to 10 inches. In local areas lying in the drainage ways or in small depressions the soil is much darker than typical, ranging from dark brown to grayish black in color. Such areas if large enough would be classed in a distinct series. The subsoil comprises two layers. The upper one is a grayish-brown or drab-colored clay containing numerous rusty-brown or black iron concretions or pellets and partly decayed fragments of the parent rock; the lower, encountered at depths of 16 to 24 inches, is a grayish-yellow or yellowish-drab clay loam containing enough partly decayed rock fragments to give it a gravelly texture. This lower, yellow layer is not typical. The type is generally shallow, the bedrock being reached at depths of 2 to 4 feet, though rarely outcropping.

The Olympic clay is of small extent, being developed in small areas north and northeast of Philomath, in the vicinity of Wren, and 1 mile northwest of Witham School. The topography is gently sloping or rolling, and the drainage is well developed.

The Olympic clay is a residual soil derived from the weathering of the coarser grained basic igneous rocks.

The type has little agricultural value, not over 80 acres being in cultivation. Scrub oak is found where moisture conditions are favorable, but most of the type supports only a scant growth of grass while there is sufficient moisture. Wheat and oats, the only crops grown on the type, give fair yields in favorable seasons. After the soil has dried out sufficiently in the spring, sheep and cattle are grazed on it for one to two months, and again in the fall for a short time after the first fall rains have started a growth of grass. Owing to its heavy texture and general droughty condition, the type is better suited to grazing than to the production of cultivated crops. This type is sold only with other soils.

Olympic clay, shallow phase.—The Olympic clay, shallow phase, includes areas in which the bedrock, which is similar to that in more deeply weathered areas, is reached within 6 to 20 inches of the surface. The soil material of this phase has the same color as the typical Olympic clay, but includes darker colored areas in which the material has been subject to seepage or less perfect drainage conditions. Large areas of this phase lie north of Philomath and northwest of Corvallis. The surface features vary from steeply sloping hillsides to the low rolling knolls of the lower foothills.

In places protected from the direct rays of the sun the soil supports a scrubby growth of oak. Grass grows well during wet seasons, but dries up in the late spring so that it no longer provides grazing. None of the phase is under cultivation; the only use made of it is for pasture, and about 7 acres are required to feed one steer for two months of the year. The shallow phase of the Olympic clay is usually sold in connection with the more deeply weathered residual soils.

The table below gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the typical Olympic clay.

Mechanical analyses of Olympic clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
561270...	Soil, 0 to 8 inches ..	<i>Per cent.</i> 2.7	<i>Per cent.</i> 3.1	<i>Per cent.</i> 2.2	<i>Per cent.</i> 12.1	<i>Per cent.</i> 10.0	<i>Per cent.</i> 32.7	<i>Per cent.</i> 37.2
561271.....	Subsurface, 8 to 20 inches.....	2.3	4.0	3.1	16.6	16.8	29.9	27.5
561272.....	Subsoil, 20 to 36 inches.....	4.4	12.4	6.5	21.2	13.4	24.8	17.4

CASCADE CLAY LOAM.

The surface soil of the Cascade clay loam typically consists of 12 to 14 inches of brown to light-brown clay loam, but in small included spots of deficient drainage the color of the surface material is dark brown to grayish black and in places the texture is somewhat light for a clay loam. The subsoil is a yellow or brownish-yellow clay loam of compact structure, which becomes lighter in texture and less compact with increasing depth. Bedrock is reached at depths of 4 to 6 feet.

The largest areas of this soil are northwest of Corvallis, where the type borders the soils of the valley proper and extends back into the foothills for a distance of 2 or 3 miles. Other areas are found in the vicinity of Blodgett and Wren, and along the South Fork of Marys River. The type is closely associated with the Olympic clay and its shallow phase and may include small areas of these soils.

The Cascade clay loam is a residual soil derived from the coarser grained basic igneous rocks. It occupies the crests of the flat or plateau-like lower hills or areas of gently sloping and rolling topography. In all cases the relief is sufficient to afford good drainage.

This soil is retentive of moisture and is covered with a good growth of fir or oak. About 30 per cent of its area has been cleared and is now under cultivation, producing profitable crops of wheat, oats, vetch, and fruit. Apples and prunes grow well and give good yields when properly cared for. Vetch is grown chiefly with oats. It is often sown in the fall and fed green to dairy cattle in the early spring. Later seedings are cut for hay. Wheat yields 15 to 35 bushels, with an average of 22 bushels per acre. Oats yield 50 to 75 bushels, with an average of 55 bushels per acre. Oats and vetch hay yields $2\frac{1}{2}$ to $3\frac{1}{2}$ tons per acre. Corn is grown somewhat for silage, but does not yield as well here as on the bottom soils.

Improved farms of this type sell for \$90 to \$160 an acre. Unimproved land is held at \$15 to \$35 an acre.

This soil is productive, but could be greatly improved by turning under green-manure crops. Deeper plowing to break up the compact layer lying a few inches below the surface and formed by repeated shallow plowing, would allow a better circulation of air and moisture through the soil. Fruit growing, it would seem, could be profitably extended over this type.

Cascade clay loam, shallow phase.—The surface soil of the Cascade clay loam, shallow phase, is a brown to dark-brown clay loam, overlying a subsoil of yellow or brownish-yellow light clay loam. Both surface soil and subsoil contain numerous partly decayed fragments of the parent rock, and the depth to bedrock varies from 10 to 20 inches, or more on the lower slopes.

Only one area occurs in the county, occupying the western slopes of a rather steep hill east of Kings Valley. The topography varies from steep to gently sloping, insuring excellent drainage.

The phase has the same origin as the typical Cascade clay loam and supports the same native vegetation. It is not under cultivation, owing to its shallowness and droughty character, but is used as sheep and cattle pasture for such short periods of the year as the grass remains green. It has little agricultural value and is sold only in connection with adjoining soils.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Cascade clay loam:

Mechanical analyses of Cascade clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
561238....	Soil, 0 to 12 inches..	1.2	2.4	2.6	16.1	14.1	44.3	19.2
561239....	Subsoil, 12 to 36 inches.....	1.6	5.6	5.2	16.3	10.0	34.2	27.2

SITES CLAY.

The surface soil of the Sites clay consists of 8 to 20 inches of brownish-red to dull-red, moderately friable clay containing appreciable quantities of organic matter and red iron concretions or pellets. The subsoil is a compact red clay grading into bedrock at 2 to 4 feet. Broken fragments of shale or sandstone are found locally both in the surface soil and subsoil.

The largest areas of Sites clay occur in the hills west of Monroe and in the vicinity of Alpine. Smaller areas lie in the vicinity of Alsea and at the junction of Salmonberry Creek and the Alsea River. One small body is near the upper end of Kings Valley.

The topography is generally steep and broken, though the crests of the larger hills are comparatively smooth and well adapted to cultivation. Drainage is well developed.

The Sites clay is of residual origin, being derived, through weathering, from sandstone and shale. Small areas of soils of brown or red color derived from igneous rocks are included with this type, as well as some areas of brown soils which would be placed in the Melbourne series if of sufficient size to map separately.

About 40 per cent of the type is in cultivation, and the rest supports a good stand of fir timber. The principal crops are wheat, oats, prunes, and apples. Wheat yields 12 to 20 bushels per acre; oats, 20 to 40 bushels per acre; prunes, one-half to 1½ tons of dried fruit with an average of 1 ton per acre. Apples produce 150 to 300 boxes per acre. Cherries and peaches are also grown to some extent on this soil, but are not as profitable as the other crops mentioned. The orchards are thrifty and for the most part well cared for. Clean cultivation is the general practice, with a cover crop of rye or vetch every third or fourth year. Bearing orchard land sells for \$400 to \$700 an acre; other improved farm lands sell for \$60 to \$100 an acre. Unimproved areas can be bought for \$15 to \$40 an acre.

When cropped to grain for a number of years this soil becomes low in organic matter, which should be supplied by turning under a cover crop or by adding barnyard manure. Experiments conducted by the State Agricultural Experiment Station indicate that the addition of soluble phosphates, if attended by good cultivation and the turning under of organic matter, gives very good results on this type of soil.

Sites clay, friable phase.—The surface soil of the Sites clay, friable phase, has a depth of 10 to 20 inches and consists of a brownish-red or dark-red to red friable clay of rather smooth silty texture. In places it contains small red iron-cemented pellets, locally known as "shot." In its virgin state it is well supplied with organic matter, and in small local areas the soil has a brownish color, due either to the presence of humus or to imperfect drainage. The subsoil consists of a red compact clay which has a smooth, waxy appearance if worked when wet. Bedrock is usually encountered at depths of 5 to 7 feet.

This phase is associated with the soils of the Melbourne or Aiken series, and occupies the crests of the higher elevations and other areas of good drainage. The surface is smooth and gently sloping or rolling and for the most part capable of cultivation, though a few slopes are steep. Several areas of varying size are mapped in the mountainous section of the southern part of the county and in the vicinity of Alsea. Others lie along Trout Creek and Little Lobster Creek, and 3 miles northeast of Blodgett.

The Sites clay, friable phase, is a residual soil derived from the weathering of sandstone and shale. It is rather thoroughly weathered, and rock fragments are rare in the surface soil or upper subsoil, though a zone of partly disintegrated sandstone or shale is commonly encountered immediately above the bedrock. The phase includes small areas of the Aiken and Olympic soils derived from local intrusions of basaltic rocks.

About 20 per cent of this phase is under cultivation, and the remainder supports a good growth of fir and oak. The soil is productive and is adapted to nearly all the crops grown in this section. Wheat, oats, and vetch are the principal crops. Wheat yields 15 to 20 bushels per acre, and oats 25 to 40 bushels. Oats and vetch, grown for hay for dairy cattle, yield from 1½ to 2½ tons per acre. Apples and cherries are grown for home use on nearly all the ranches and yield well.

Improved land of the friable phase sells for \$50 to \$90 an acre, while unimproved land can be bought at \$15 to \$40 an acre.

Prunes and walnuts, of which a few acres have been planted on this phase, are adapted to this soil and their production could well be expanded.

The suggestions made with regard to the use of barnyard manure and phosphate fertilizers upon the typical Sites clay apply to this phase as well.

The results of mechanical analyses of samples of the soil and subsoil of the typical Sites clay are given in the following table:

Mechanical analyses of Sites clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
561245....	Soil, 0 to 8 inches....	<i>Per cent.</i> 2.5	<i>Per cent.</i> 3.4	<i>Per cent.</i> 1.7	<i>Per cent.</i> 6.7	<i>Per cent.</i> 5.5	<i>Per cent.</i> 38.2	<i>Per cent.</i> 41.9
561246....	Subsoil, 8 to 36 inches.....	1.0	2.8	1.8	6.6	6.0	32.6	49.2

MELBOURNE CLAY LOAM.

The surface soil of the Melbourne clay loam consists of 8 to 10 inches of a brown to light-brown clay loam, containing sufficient fine and very fine sand to give it a comparatively friable structure. The subsoil has two sections, an upper layer consisting of a brown to reddish-brown, friable heavy clay loam or clay, and a lower layer beginning at 20 to 24 inches, consisting of yellow or brownish-yellow moderately compact clay loam. The sandstone or shale from which the soil is derived is encountered at an average depth of 3 feet, although on the more gentle slopes the depth to bedrock is greater. Locally small fragments of these rocks are mixed with the soil and subsoil, though such areas are not large except where the rock formation outcrops.

The Melbourne clay loam is most extensive in the northwestern part of the county where it occupies an area of several square miles in the vicinity of Devitt and Summit. Areas of varying size in all parts of the county are associated with the other residual soils.

The topography is rolling to steep and broken. The lower foothills along the valley are generally gently sloping and rolling, while areas bordering the streams in the middle and western parts of the county are rather steep and broken. The type rarely occupies the crests of

the hills, but occurs rather along the slopes, the higher elevations being occupied by soils of the Sites series. The drainage of the type is good to excessive.

Probably not more than 20 per cent of the type is under cultivation, though several small tracts, comprising in all 4 or 5 square miles, have been burnt over and are now covered with a dense growth of ferns. Uncleared areas support a tree growth consisting principally of fir, and on the lower foothills considerable oak. One of the largest of the burnt-over areas lies southwest of Blodgett, but owing to its rather steep and broken topography and excessive drainage it is not well suited to cultivation.

The principal crops grown are wheat and oats, with a few small fields of corn and rye, or vetch and oats, which are used for hay. Wheat yields 15 to 20 bushels, and oats 25 to 40 bushels per acre. Several young apple orchards on this type, where given good care, are making vigorous growth. About 40 acres are already in bearing and yield from 200 to 400 boxes per acre. The burnt-over areas are used largely for pasture to which use they are best adapted.

Improved land of this type sells for \$70 to \$90 an acre, while unimproved land can be bought for \$15 to \$35 an acre. Land in bearing orchards is held at \$350 to \$800 an acre.

The value of this type for pasture can be greatly increased by seeding some grass mixture, such as rye grass, meadow fescue, and orchard grass. Suggestions for the improvement of the Melbourne silty clay loam are also applicable to this soil type.

Melbourne clay loam, friable phase.—The Melbourne clay loam, friable phase, consists of a light yellowish brown to brown mellow clay loam extending to a depth of 10 to 12 inches, underlain by a yellowish-brown to yellow, permeable clay loam or light-textured clay. Broken fragments of the sandstone from which this type is largely derived are present in the surface soil and subsoil, though in no case in sufficient quantities to interfere with cultivation or greatly affect the physical character of the material. The soil is weathered to an average depth of about 4 feet, and rock outcrops occur only on the steeper slopes or areas of broken topography. Except in areas of restricted drainage, the phase as mapped is lighter in color than is characteristic of the other soils of the series. It is somewhat more friable and permeable to moisture than the typical soil.

This phase occupies several areas of varying size throughout the region of residual soils in the western and northern parts of the county. Spring Hill in the northeastern part of the county is occupied largely by this phase. Another large area lies south of Summit, and other smaller areas are in the vicinity of Bellfountain, Blodgett, Kopplein, and Alsea, and on Lobster Creek.

The topography varies from gently rolling on the hilltops, as at Spring Hill and Summit, to steeply sloping, as on the sides of hills and mountains. The phase includes a few small areas that are too steep for cultivation, but these are not mapped separately on account of their small extent.

Owing to the permeable nature of both surface soil and subsoil, this phase has a high water-holding capacity, and the run-off, which might otherwise cause erosion, is greatly lessened. The soil, however, loses moisture rapidly, and in the late summer crops often suffer for lack of sufficient water.

Nearly 65 per cent of the phase is in cultivation, the rest supporting a forest growth composed largely of merchantable fir, with some maple, willow, alder, and oak along the stream courses. The main crops are wheat and oats. Wheat yields 15 bushels per acre on an average, and oats 25 bushels. Some corn is grown for silage and yields well in favorable seasons. Small fruits, including strawberries and blackberries, are grown in commercial quantities, and yield slightly better than on the Melbourne silty clay loam. Potatoes are also grown to some extent for market and yield from 100 to 150 bushels per acre. Orchard fruits are grown on nearly every farm for home use and give good yields.

The price of improved land of this phase ranges from \$60 to \$90 an acre, depending largely on improvements and accessibility to market. Unimproved areas can be bought for \$15 to \$35 an acre. Some of the more nearly level and better improved farms within easy reach of market, can not be bought for less than \$115 an acre.

This soil is easily worked, and under proper management can be made to produce excellent crops. Cultivated crops are especially well adapted to it, because its lighter texture results in an earlier maturity than on heavier soils. In the western part of the county dairying is practiced extensively on this phase and is quite profitable. However, the greatest profits from this industry will not be obtained until more attention is paid to the improvement of the herds. The growing and feeding of legumes and of corn for silage would result in greater milk production, and at the same time improve the soil. Potatoes would be profitable not only from the standpoint of yields returned, but also in the general betterment of the soil itself through better crop rotation. The addition of organic matter, in which these soils are generally deficient, would materially increase the power of the soil to retain moisture, as well as increase the fertility.

The results of mechanical analyses of samples of the soil, subsurface, and subsoil of the typical Melbourne clay loam are given in the following table:

Mechanical analyses of Melbourne clay 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.	<i>Per cent.</i>
561242....	Soil, 0 to 8 inches..	1.0	3.6	2.6	14.2	18.2	36.3	24.1
561243....	Subsurface, 8 to 20 inches.....	.6	2.0	1.7	11.7	16.8	32.8	34.2
561244....	Subsoil, 20 to 36 inches.....	.2	.6	1.7	14.8	20.7	37.5	24.6

MELBOURNE SILTY CLAY LOAM.

The Melbourne silty clay loam is a brown to light-brown friable silty clay loam, underlain by a subsoil of moderately compact yellow to brownish-yellow clay loam or silty clay loam, which at depths of 3 to 6 feet grades into partly weathered parent sandstone or shale. In places the surface soil contains varying quantities of sandstone or shale fragments, and in the virgin state it has a good supply of

organic matter. Included local areas in which the surface soil is darker in color occur in places of deficient drainage.

The Melbourne silty clay loam is an extensive soil type. It occurs in all parts of the mountainous section of the county, and commonly occupies the lower foothills bordering the valley and the lower slopes of the more mountainous areas. Steep areas appear throughout the type, but in general the slopes are gentle enough to allow easy cultivation. Drainage is well developed.

The type is of residual origin and derived principally from sandstone formations, some of which are very fine grained and hard and closely resemble the lighter colored igneous rocks. Owing to difficulty in identifying the parent material, some material of the Olympic and the Cascade series may be included. Shale is more common in the south-central part of the county bordering the valley proper than in the western or northern sections.

Ferns grow luxuriantly on this soil and form a dense undergrowth in the timbered sections or cover areas that have been burnt off. In places they are 3 to 4 feet high. In cultivated fields considerable cultivation is required to control them. The soil is productive and is agriculturally important, about 60 per cent of it being in cultivation. Wheat and oats are the principal crops, but some fruits, such as apples and cherries, are grown on nearly every ranch and yield well, though given almost no attention. There are a few small commercial orchards of prunes and apples, and, judging from the quantity and quality of fruit, it would seem that the soil is well adapted to their production. Wheat yields 15 to 20 bushels per acre, with an average of 18 bushels; oats, 30 to 50 bushels, with an average of 35 bushels. Corn, which is grown for silage in connection with dairying, gives good yields in favorable seasons, as does also vetch and oat hay. Small commercial plantings of blackberries, including the Logan variety, and strawberries are grown on this type in the northern part of the county and are remunerative. The Logan blackberry yields 2 to 4 tons, other varieties 4 to 6 tons, and strawberries 100 to 300 crates per acre.

Improved land of this type within easy reach of markets can be bought for \$75 to \$100 an acre, while in the outlying districts it is valued at \$60 to \$80 an acre. Unimproved land sells for \$15 to \$40 an acre, depending on location, topography, and ease of clearing.

The Melbourne silty clay loam is easily handled, and because of its good drainage and natural productiveness is adapted to a wide range of crops. The present methods of handling, however, do not bring out the best results. Oats and wheat are grown almost exclusively on some farms, and no system of rotation is being practiced that has in view the building up of the soil, with the result that its productiveness is gradually decreasing. Barnyard manure is generally utilized, but it is not available in sufficient quantities to supply the necessary organic matter. This can best be added in the form of a green-manure crop, such as rye or vetch. A system of rotation that includes a tilled crop, such as corn or potatoes, every fourth or fifth year would aid in freeing the soil of weeds and ferns. This soil is relatively low in phosphorus, and small applications of this element in soluble form have given good results. Dairying could be further extended over this type with profit.

CARLTON SILTY CLAY LOAM.

The surface soil the Carlton silty clay loam is a light grayish brown to grayish-brown smooth silty clay loam of friable structure, 8 to 13 inches deep. The subsoil to a depth of 36 inches or more is a dull-brown to grayish-brown compact clay loam or silty clay loam which is mottled with gray or yellow in the lower part, especially in the lower more poorly drained areas. Partly weathered shale, from which rock the type is derived, is commonly not encountered above the depth of 4 feet, and cuts several feet deeper often fail to expose the bedrock. Bordering the hill slopes this type as mapped includes areas of soil of the Grande Ronde series too small to be shown on the map.

The Carlton silty clay loam occurs throughout the foothill section of the county and occupies some of the more gentle slopes bordering the mountain streams or areas of the Melbourne soils. One area extends along both sides of Honey Grove Creek for a distance of 2 miles. Others of relative importance occur three-fourths mile south of Lewisburg and 3 miles south of Philomath. Small areas lie on the lower slopes of the foothills of Spring Hill, in the vicinity of Bell-fountain, Corvallis, Granger, Blodgett, and Summit, and along drainage ways south of Alsea.

The type has a gently rolling or hilly to smoothly sloping surface, and all of it could be placed under cultivation. Surface drainage is well developed, though underdrainage is not good in all places.

The type is derived from the weathering of sandstone or shale. The parent rock is usually not encountered above the depth of 3 feet, and in places wells have been dug 15 to 20 feet before reaching bedrock. Rock fragments are rarely found on the surface.

Though not extensive, the type is of considerable agricultural importance. A large proportion of it is in cultivation and produces good yields of wheat, oats, clover, and corn. On uncleared land oak and fir are the principal trees. Wheat occupies the largest acreage and produces 18 to 40 bushels per acre, with an average of 22 bushels; oats yield 25 to 60 bushels, with an average of 40 bushels per acre. Oats and vetch hay yields 2 to 3½ tons per acre, red clover hay 1 to 2½ tons, and 2 to 8 bushels of seed per acre. The navy bean, which is grown to some extent on this soil, yields 400 to 700 pounds per acre. Corn is grown principally for silage, and the yields compare favorably with those on other soils. A few small commercial plantings of apples, peaches, and prunes have been made. Apples and prunes probably yield slightly less upon the average than on the Aiken and Olympic soils, and peaches have not proved a profitable crop. Small fruits as well as orchard fruits are grown on nearly every farm for home use, and yield well, though given practically no care.

Improved land of this type sells for \$90 to \$150 an acre, though some of the better improved farms with good location can not be bought for less than \$250 an acre. Producing orchard land sells for \$350 to \$700 an acre. Unimproved land is held at \$15 to \$50 an acre.

The Carlton silty clay loam is easily worked, and under good management will continue to produce good crops. General farming is practiced over most of the type, and on the better ranches a 3-year rotation of wheat, clover, and oats is practiced. The wheat is sown in the fall, about the last of October or first of November, and in February or March clover is seeded in the grain, which serves as a

nurse crop for the clover. After harvesting the grain it is a common practice to pasture the stubble fields in the fall and again in the spring. The second year the first crop of clover is used for hay and the second is usually harvested for seed or pastured. The clover sod is plowed up in the fall and a crop of spring oats or wheat follows. Oats and vetch for hay are often substituted for oats in the third year.

Where dairying is practiced and the barnyard manure returned to the land, and a clover sod turned under at regular intervals, the soil is maintained in a good state of productiveness. Where yields are beginning to fall off the cause can usually be traced to a deficiency of organic matter or the failure to keep the soil in condition by a proper rotation of crops. Corn, potatoes, and beans can be grown successfully on this type, and the soil will benefit from their cultivation. A better circulation of air and moisture through the soil and subsoil would result from deeper plowing and the breaking up of the hard compact layer formed by continued plowing to a shallow depth. This soil is low in sulphur and has responded well to applications made experimentally by the Oregon Agricultural Experiment Station.

The results of mechanical analyses of samples of the soil and subsoil of the type are given in the following table:

Mechanical analyses of Carlton silty clay 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.	<i>Per cent.</i>
561229....	Soil, 0 to 10 inches..	0.4	0.5	0.4	2.4	7.8	66.0	22.6
561230....	Subsoil, 10 to 36 inches.....	.2	.9	.8	4.2	7.2	64.7	22.1

WILLAMETTE SILT LOAM.

The surface soil of the Willamette silt loam consists of 10 to 14 inches of a dull-brown to light-brown, smooth, friable silt loam or silty clay loam. The subsoil is a brown to light-brown moderately compact silty clay loam. Small areas in which the subsoil is mottled with gray are included, but areas in which the mottling is developed to a sufficient extent have been separated as a type of the Amity series. In several small areas of Willamette silt loam in the vicinity of North Albany the subsoil is distinctly lighter textured than the surface. Such areas are really Hillsboro silt loam, a type mapped in other parts of the Willamette Valley, and their inclusion here with the Willamette silt loam was made only because of small extent. Several small areas of this type in the vicinity of Alsea, Winkle School, in Kings Valley, and in the northeast corner of the county contain appreciable quantities of rounded or subangular gravel, and are indicated on the soil map by the gravel symbol.

This type occurs in a number of areas of irregular outline scattered through the old-alluvial deposits of the valley section of the county. Some of the larger and more typical areas lie in the vicinity of Granger, Winkle School, and Wellsdale Station. Other areas of considerable size are in Kings Valley, in the vicinity of Spring Hill, and at Barclay, and small areas lie in the vicinity of North Albany and Alsea and along Marys River southwest of Corvallis.

The type has a gently sloping to slightly undulating surface, broken here and there by the steep banks of drainage ways. It occupies positions slightly higher than the surrounding soils, or else better drained areas adjacent to the streams. Drainage is well developed.

The Willamette silt loam is one of the most important soil types in the county. About 80 per cent is under cultivation, and the rest supports a heavy growth of fir. It is adapted to nearly all crops raised in the county, though at present it is devoted principally to the production of wheat, oats, red and alsike clover, and oats and vetch hay, in connection with stock raising and dairying. Wheat, which is grown in a three-year rotation with clover and oats, is the main cash crop on farms devoted to grain growing. Dairying is carried on extensively, and in this connection the clovers, oats, and oats and vetch are grown. Commercial orcharding is not general on the type, because of its unfavorable location with regard to frosts. There are a few plantings of prunes, apples, and walnuts. In addition to the crops named, corn, potatoes, berries, and vegetables are produced on nearly every farm. Hops are grown in a small way. The yield is 1,600 to 1,800 pounds per acre, or somewhat less than on the river-bottom soils.

The average yields on this type are usually slightly higher than those on the Carlton silty clay loam. Wheat yields 20 to 45 bushels, with an average of 25 bushels per acre; oats, 35 to 85 bushels, with an average of 45 bushels; clover hay, from 1 to 3 tons per acre; and clover seed, from 2 to 8 bushels per acre. Oats and vetch hay yields 2 to 4 tons per acre, and potatoes 100 to 225 bushels per acre. Prunes return 1 to 2 tons of dried fruit, and apples 150 to 300 boxes per acre.

The Willamette silt loam is easily cultivated and responds well to good management. Until recent years, however, it has been cropped almost exclusively to grain, so that yields have fallen off to almost half the former rate. Dairying is gradually increasing in favor, and with it necessarily comes a change in cropping systems. Red and alsike clover, vetch, corn, and kale are grown for feeding the milk cows. In producing these crops a three-year rotation similar to that practiced on the Carlton silty clay loam has come into general use.

Selling prices of this land range from \$90 to \$175 an acre, depending on location and improvements. Some of the better improved ranches can not be bought for less than \$250 an acre. Unimproved land is valued at \$30 to \$60 an acre.

The clover midge and the root borer have given considerable trouble on this soil as well as on others on which clovers are grown. No method for the complete eradication of these pests is known; however, the damage they do can be minimized by proper rotations and by care in the selecting of seed. The midge also can be controlled somewhat by harvesting the crop when first it begins to work on the seed. The addition of organic matter to this soil by plowing under a cover crop of rye or vetch and the application of barnyard manure will increase its productiveness. Phosphates, which are generally helpful on this soil type, as well as on the hill soils of the county, can best be supplied in the form of acid phosphate at the rate of about 250 pounds per acre. The growing of a greater acreage of intertilled crops, like corn, potatoes, and beans, is recommended, as well as substitution of a four-year rotation, including one or more intertilled crops for the three-year rotation at present used. Deeper plowing

and more thorough preparation of the seed bed should be practiced on nearly every farm in the valley. It is also recommended that the wasteful practice of burning straw from the grain and clover-seed crops be discontinued and the straw be plowed under to increase the supply of organic matter.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Willamette silt loam type. Although this analysis would indicate that the texture of the soil is a light silty clay loam, the type was classified as a silt loam because in general its behavior under cultivation is that of a silt loam.

Mechanical analyses of Willamette silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
561264....	Soil, 0 to 10 inches..	<i>Per cent.</i> 0.6	<i>Per cent.</i> 0.9	<i>Per cent.</i> 0.5	<i>Per cent.</i> 3.4	<i>Per cent.</i> 6.6	<i>Per cent.</i> 64.6	<i>Per cent.</i> 23.4
561265....	Subsoil, 10 to 36 inches.....	.2	.5	.6	4.0	7.0	62.3	25.3

DAYTON SILTY CLAY LOAM.

The surface soil of the Dayton silty clay loam is a gray or light grayish brown to dull brownish gray plastic silty clay loam, 12 to 18 inches deep. This layer is low in organic matter and in dry field surfaces has a characteristic white or gray appearance, from which comes the local name of "white land." Brown or yellowish-brown mottling is present locally in the surface soil in the more imperfectly drained areas. The subsoil comprises two layers. The upper one, which varies in thickness from 6 to 14 inches, consists of a heavy drab or dark bluish gray impervious clay, slightly mottled with brown iron stains which become more pronounced with depth, and the lower one is composed of gray to yellowish-gray friable silty clay loam or silt loam, mottled with yellow and yellowish brown. The surface soil, which has a relatively high silt content, becomes sticky when wet, is readily puddled, and upon drying becomes hard. If plowed at the proper time, however, it is loose and friable and can be worked into a mellow seed bed. In this county the surface soil of this type is somewhat darker than in its typical development in areas previously surveyed.

This type is well developed in the eastern part of the county, where it occupies an area varying in width from one-half mile to 2½ miles and about 9 miles long. Smaller areas occur throughout the valley section.

The topography is nearly level, and during the rainy season water often stands on the surface for weeks at a time. Both surface and subsoil drainage are very poor, the impervious subsoil preventing the downward movement of water almost completely (Pl. XXV, fig. 2). When properly installed, tile drains have worked successfully on this type and after several years have caused marked improvement in the soil. Owing to the slow movement of moisture through the clay subsoil, the type dries out quickly in the spring, and cultivation is difficult unless done at the proper time.

The type has little agricultural importance at present. About 20 per cent of it is under cultivation and the rest is used largely for pasture or the production of hay in connection with the dairy or beef-cattle industry. In its virgin state it supports a fair stand of grass and occasional clumps of scrub oak.

The leading crop on the type is oats, though a mixture of oats and vetch is grown occasionally. Cheat hay is cut over large areas of the type and is baled and sold in the local markets as feed for horses, but, owing to its low feeding value, less of this hay is harvested than formerly. Beans have been grown with fair success on this type. When land is to be planted to beans it is plowed in the fall as soon as the first rains have softened the surface crust. The surface is worked up into low rounded ridges, with narrow depressions between them. This facilitates drainage, so that the soil can be conditioned earlier in the spring. The beans are planted as soon as a mellow seed bed is prepared. Under this plan yields of 400 to 600 pounds per acre are obtained. Oats yield 15 to 25 bushels per acre, and oats and vetch hay 1 to 2 tons per acre.

Land of this type sells for \$50 to \$80 an acre, though some better drained areas are held at slightly higher prices.

In many places surface drainage could be improved by digging ditches leading into the drainage ways and by clearing out or deepening the natural outlets. Tile drainage, if properly installed, has proved successful on this type, and where the cost of labor is not prohibitive it is a good investment. However, several years elapse before the drains begin to work to their full capacity, and during that time only fair crops may be expected. By turning under straw or cover crops drainage can be facilitated and the structure and productiveness of this soil can be greatly improved. Following drainage, ground limestone has paid in trials by the Oregon Agricultural Experiment Station on this soil. Alsike clover is grown, both for hay and seed, on a few of the better drained areas, and could well be extended over the more favorable parts of the type.

The table below gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the type:

Mechanical analyses of Dayton silty clay 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.	<i>Per cent.</i>
561207....	Soil, 0 to 18 inches..	0.4	1.4	0.6	1.2	9.0	62.7	24.7
561208....	Subsurface, 18 to 28 inches.....	.8	4.4	2.2	4.4	8.8	49.4	30.0
561209....	Subsoil, 28 to 36 inches.....	.5	2.2	1.8	3.6	9.8	56.0	26.2

AMITY SILTY CLAY LOAM.

The Amity silty clay loam occupies a position intermediate between the Willamette soil and the Dayton silty clay loam with respect to drainage, color, and subsoil. The surface soil consists of 14 to 18 inches of brown or light grayish brown silty clay loam, which is plastic when wet and has a tendency to bake upon drying. The subsoil is a light grayish brown compact silty clay loam or clay loam. It is invariably mottled with gray, yellow, or rusty brown, and

differs from the subsoil of the Willamette series principally in this respect. In some of the flatter areas of this type a thin layer of the drab plastic subsoil characteristic of the Dayton series has developed. Such areas are of minor extent and more nearly resemble the Amity series in color and adaptation, and so have been included with this type. A small area just east of Oak Grove School is somewhat lighter in texture than typical, approximating a silt loam. This also has been included with the Amity.

The Amity silty clay loam is extensive in this county. One of the largest and most typical areas lies about $1\frac{1}{2}$ miles southeast of Philomath. Other areas of varying size and irregular shape are mapped throughout the valley section of the county. They normally occur along the banks of the smaller drainage ways and between bodies of Willamette and Dayton soil, where they represent a transition from the well drained Willamette to the poorly drained Dayton type.

The surface is gently sloping to nearly flat, and during periods of heavy rainfall, water stands on these soils for several days at a time. The type as a whole has somewhat better drainage than the Dayton, and in places the surface drainage is fairly good. The underdrainage, however, is restricted.

The Amity silty clay loam is important both from the standpoint of area and use. About 70 per cent is in cultivation and the rest is utilized largely for pasture, though a small part is in forest of oak and fir. Dairying forms the chief industry, though some grain is grown for market on nearly every farm. The principal crops are wheat, oats, vetch, and red and alsike clover. In addition, corn and beans are grown in a small way, good yields being obtained. A few commercial apple and pear orchards are on this type, and where frosts do not interfere they are doing fairly well, though the soil is not so well adapted to tree fruits as are the better drained types in the valley and hill section. Potatoes, berries, and vegetables are grown for home use and produce abundantly.

A 3-year rotation similar to that practiced on the Carlton silty clay loam is in general use, and the type is maintained in a good state of productiveness. Wheat yields 15 to 35 bushels per acre, with an average of 20 bushels; oats yield 30 to 70 bushels, with an average of 40 bushels; clover hay yields 1 to $2\frac{1}{2}$ tons; and clover seed 1 to 5 bushels, with an average of 4 bushels per acre. Oats and vetch hay yields 2 to 3 tons, corn silage 8 to 12 tons, and beans yield 500 to 700 pounds per acre.

The Amity silty clay loam is held at \$80 to \$140 an acre, depending largely on improvements and the type of soil with which it is associated.

One of the principal needs of this type is drainage. Surface drains would be of considerable assistance in many cases, but would rarely be sufficient. Tile drainage, though expensive, is generally a paying investment upon this soil type when properly installed. The structure and fertility of the soil should be improved by the addition of organic matter, in which these soils are deficient. Suggestions for the improvement of the Willamette silt loam are equally applicable to this type.

SALEM CLAY LOAM.

The surface soil of the Salem clay loam has a depth of 10 to 12 inches and consists of a friable brown to reddish-brown clay loam which locally is of heavy texture, approaching a clay. The subsoil is a reddish-brown to brown heavy clay loam or light-textured clay containing a large quantity of waterworn gravel and cobblestones. In the upper subsoil the gravel is interbedded with the soil material, but below a depth of 30 to 36 inches it predominates. In places there is gravel in the surface soil, but not in quantity sufficient to interfere seriously with cultivation.

This type is mapped in two small areas in the upper end of Kings Valley. It occupies a terrace position from 10 to 30 feet above the flood waters of the streams. The surface is gently sloping to undulating and broken here and there by the steep banks of drainage ways. Both surface and internal drainage are good to excessive, and during periods of drought crops are very apt to suffer from lack of moisture.

The type is entirely under cultivation, and during favorable seasons the yields are practically the same as on the Willamette silt loam. The principal crops are wheat, oats, vetch, and clovers. Wheat is grown in a rotation with oats and clover or oats and vetch, and the clover and oats and vetch hay is used on the farms as feed for dairy cattle. Improved land of this type of soil sells for \$80 to \$100 an acre.

This soil is generally deficient in organic matter, which, if supplied would aid in the retention of moisture and otherwise increase productiveness. It is an early soil and well adapted to the production of fruit or truck crops. Fall-sown grain does better than spring-sown grain, owing to the tendency of the soil to dry out in the late summer.

The results of mechanical analyses of samples of the soil and subsoil are given in the following table:

Mechanical analyses of Salem clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
561277....	Soil, 0 to 10 inches..	<i>Per cent</i> 0.8	<i>Pcr cent.</i> 5.0	<i>Per cent.</i> 4.2	<i>Per cent.</i> 13.5	<i>Per cent.</i> 8.8	<i>Per cent.</i> 35.1	<i>Per cent.</i> 32.5
561278....	Subsoil, 10 to 36 inches.....	1.0	4.9	4.1	12.8	7.1	37.4	32.9

GRANDE RONDE SILTY CLAY LOAM.

The surface soil of the Grande Ronde silty clay loam has an average depth of 14 inches and consists of a yellowish-brown to light-brown smooth-textured silty clay loam, low in organic matter. It is plastic when wet and has a tendency to bake upon drying. The subsoil, to a depth of 22 inches, consists of yellowish-brown silty clay, mottled with gray or yellow. The lower subsoil is a brownish-yellow clay, mottled with gray and sometimes with iron stains. In places the surface soil has a brown or light-brown color, resembling the Amity series; the subsoil, however, is always of a yellowish color. The Grande Ronde silty clay loam is not extensive in the county. Some of the larger areas lie in the vicinity of Bellfountain and Monroe and

along Beaver and Bull Run Creeks. Other areas are in the vicinity of Philomath, southeast of Fir Grove School, and along Bowers Slough in the northeastern part of the county.

This soil occupies terraces and alluvial slopes and is derived mainly from water-laid deposits having their source in the sandstone or shale rocks of the adjacent hills. It has an intermediate position between the lower alluvial soils of the valley and the residual soils of the hills. The topography is gently sloping to undulating and surface drainage is usually good, though underdrainage is restricted. Seepage from the hills often keeps this type wet until late in the spring.

The larger part of the type is under cultivation and the rest is forested with fir and oak. The principal crops are wheat, oats, and clover. A considerable area is used as pasture land. A small acreage is in apple orchards, but owing largely to poor drainage the soil is not well adapted to fruit trees. Wheat yields 15 to 25 bushels, with an average of 20 bushels per acre; oats 30 to 50 bushels, with an average of 40 bushels; clover hay 1 to 2 tons, and clover seed 1 to 5 bushels per acre.

Improved land is held at \$50 to \$100 an acre, depending on the soil with which it is associated and its location and improvements.

The Grande Ronde silty clay loam is chiefly in need of drainage, which could be improved in part by installing cut-off drains around the base of the hills which it borders. Addition of organic matter, more thorough cultivation to allow the circulation of air and moisture, and a permanent system of rotation to include legumes and a cultivated crop would also be advisable.

The following table gives the results of mechanical analyses of samples of the soil, upper subsoil, and lower subsoil of the type:

Mechanical analyses of Grande Ronde silty clay 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.	<i>Per cent.</i>
561247....	Soil, 0 to 8 inches....	1.1	1.4	0.8	3.0	3.6	60.6	29.6
561248....	Upper subsoil, 8 to 20 inches.....	.2	1.6	1.1	3.4	3.4	50.6	39.7
561249....	Lower subsoil, 20 to 36 inches.....	.3	1.7	1.0	3.8	4.2	49.8	39.2

CHEHALIS FINE SANDY LOAM.

The surface soil of the Chehalis fine sandy loam consists of a brown to light-brown, friable fine sandy loam 10 to 12 inches deep. Local areas of material of somewhat heavier texture are included, owing to their small extent. The subsoil is of brown color and friable structure, and similar to or heavier than the surface soil in texture. Locally the subsoil contains stone or gravel, and in places these appear on the surface, though in no case in sufficient quantities to interfere with cultivation.

The type, though not extensive, occurs in many of the creek and stream bottoms of the county. The largest areas are on Fisher Island, a mile east of Barclay, and near North Albany. Other areas are associated with the Chehalis silty clay loam in the bottoms of the Alsea River and its tributaries and scattered through the bottoms of the Willamette River.

The topography of the type is variable; the greater part is smooth and gently sloping, but some areas are hummocky and rather badly dissected by small depressions cut by the currents of the flood waters. Along the smaller streams the type is generally developed where the fall is moderately steep and the current in time of flood is rapid. Both surface and internal drainage are good to excessive, and crops often suffer from lack of moisture during dry seasons.

About 20 per cent of the type is under cultivation. The rest is mostly forested with fir, alder, and willow and is devoted largely to pasture. The principal crops are the same as on the Chehalis silty clay loam. Wheat yields 15 to 30 bushels, with an average of 20 bushels per acre; oats yield 20 to 50 bushels, with an average of 35 bushels; and clover hay, 1 to 2 tons per acre. Potatoes, berries, and corn are also grown on this type and do well, the yields being equal to or better than those obtained on some of the heavier soils of the series.

Owing to its small extent, the Chehalis fine sandy loam is sold only in connection with other soils, when it brings \$60 to \$125 an acre.

The principal need of this type is the addition of organic matter, in which it is quite low. The productiveness could be greatly increased by irrigation, which could be practiced on the Chehalis soils by installing pumping plants. The lift would be only 10 to 20 feet.

The results of mechanical analyses of samples of the soil and subsoil of the type are shown in the following table:

Mechanical analyses of Chehalis fine sandy 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.	<i>Per cent.</i>
561212....	Soil, 0 to 10 inches..	0.2	7.1	12.5	42.0	12.8	14.8	10.6
561213....	Subsoil, 10 to 36 inches.....	.1	3.2	5.7	31.6	17.0	27.5	14.9

CHEHALIS SILTY CLAY LOAM.

The Chehalis silty clay loam consists of a brown to reddish-brown friable silty clay loam, 10 to 18 inches deep, resting on a subsoil of brown moderately compact silty clay loam to clay loam or light-textured clay. In places the subsoil grades into lighter textured material, which apparently underlies nearly all the Willamette River bottom soils at depths of 2 to 6 feet or more. Such areas normally occupy depressions and where practicable they have been included in the Newberg series. When wet the surface soil of this type takes on a reddish or rich-brown tint.

The Chehalis silty clay loam, which is extensive, is developed on the flood plains of nearly all the creeks and larger streams of the county. Some of the more important areas lie along the Alsea River and its tributaries, and along the headwaters of Marys River. Other areas of importance lie in the Willamette River bottom east of Monroe, east of North Albany, and in the vicinity of Garlinghouse Lake and Dodge Slough, and on Stallbush and Kiger Islands. Smaller areas are scattered through the alluvial soils of the Willamette River bottom, and along nearly all the minor streams of the county.

This type occupies the first bottoms or flood plains along the streams, lying from 10 to 20 feet above the level of their normal flow. The surface is gently sloping and smooth, except for occasional depressions or steep-sided narrow drainage channels. Most of the type lies above normal overflow, but is completely covered by extremely high floods. Except in a few places drainage is well developed.

The Chehalis silty clay loam is an important recent-alluvial soil and nearly all crops grown in this section are produced successfully on it. About 60 per cent or more is under cultivation; the rest supports a heavy growth of fir, alder, willow, and vine maple, and is used largely for pasture. Wheat yields 20 to 40 bushels, with an average of 30 bushels per acre; oats, 40 to 80 bushels, with an average of 60 bushels per acre; red clover, 2 tons of hay and 3 to 8 bushels of seed, with an average of 6 bushels per acre; vetch hay $2\frac{1}{2}$ to 3 tons, or 15 to 20 bushels of seed per acre. Corn is grown both for grain and silage and yields 60 bushels of grain or 10 to 14 tons of silage. Potatoes yield 100 to 200 bushels per acre. Some hops, peaches, prunes, berries, and vegetables also are raised on this soil and give excellent yields under good management. The cultural methods followed are the same as on the Carlton silty clay loam.

The Chehalis silty clay loam sells for \$80 to \$150 an acre, though some farms near market or those especially well developed sell for \$250 to \$300 an acre.

This soil is naturally productive and requires little fertilization. Its productiveness can be maintained by the use of stable manure and a good system of rotation.

Chehalis silty clay loam, heavy phase.—The surface soil of the Chehalis silty clay loam, heavy phase, varies in depth from 12 to 18 inches, with an average depth of about 14 inches, and consists of a rich-brown heavy silty clay loam. It is somewhat more plastic when wet than the typical Chehalis silty clay loam, but works up easily when dry. The subsoil is a brown to slightly reddish brown, somewhat compact, silty clay loam or light-textured clay, which is readily permeable. The soil takes on a reddish tint when wet and in some places has a slight reddish brown color when dry.

This phase occurs in several large areas in the county. One of the largest is in the Willamette River bottom, extending from the county line on the south northward 13 miles in an almost unbroken body a few rods to a mile or more in width. Another large area lies northeast of North Albany, and others lie along Marys River and elsewhere in the stream bottoms of the county.

The surface is level to gently sloping, except where broken by slight depressions roughly paralleling the stream courses. The soil lies 10 to 20 feet above the normal flow of the streams, and some of it is overflowed only during periods of extremely high water. The drainage is generally good, though some of the depressions having poor outlets retain water for short periods.

This is an important soil both from the standpoint of use and area covered. About 70 per cent is under cultivation, and the rest, which is used largely for pasture, is covered with a heavy growth of fir, willow, alder, and oak. The principal crops grown are wheat, oats, and clover. A 3-year rotation, the same as on the Carlton silty clay loam, is usually followed. Wheat yields 20 to 35 bushels, with an average

of 30 bushels per acre; oats yield 35 to 70 bushels, with an average of 55 bushels; red clover yields 1 to 3 tons of hay, with an average of 2 tons per acre, or 2 to 8 bushels of seed per acre. Alsike clover is not infested by the midge or the root borer as badly as the red clover, and for this reason is grown to some extent on this soil as well as on others in the valley. Hops are grown on a small acreage and yield well. Prunes, peaches, berries, corn, and potatoes give excellent yields.

The Chehalis silty clay loam, heavy phase, is held at \$80 to \$150 an acre, depending on the location and the proportion under cultivation.

This soil has a tendency to bake when dry, and the best results are obtained only when careful cultivation is given. A greater acreage could be profitably utilized in the production of berries, potatoes, prunes, and corn.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the typical Chehalis silty clay loam:

Mechanical analyses of Chehalis silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
561216....	Soil, 0 to 18 inches..	<i>Per cent.</i> 0.0	<i>Per cent.</i> 0.3	<i>Per cent.</i> 0.4	<i>Per cent.</i> 5.0	<i>Per cent.</i> 11.2	<i>Per cent.</i> 53.8	<i>Per cent.</i> 29.4
561217....	Subsoil, 18 to 36 inches.....	.0	.8	1.7	8.2	11.9	43.6	33.8

NEWBERG FINE SANDY LOAM.

The surface soil of the Newberg fine sandy loam consists of 15 to 20 inches of brown mellow fine sandy loam, typically rather low in organic matter. The subsoil consists of light-brown or yellowish-brown fine sandy loam, which at varying depths below 3 feet grades into a fine or medium textured porous sand or loamy sand. Owing to the irregular surface and the varying assorting action of the flood water moving over it, this type is variable in texture.

The Newberg fine sandy loam borders the Willamette River in the eastern part of the county. It occurs in broken, narrow strips lying a few feet to 20 feet above the normal flow of the river, and during periods of high water it is often inundated for days at a time. A few areas lie back from the channel of the river. Some of the larger areas occur on and near John Smith Island. An important area about one-fifth mile wide and 2½ miles long lies northeast of Corvallis. Others are in the vicinity of Ingram Slough and McBee Slough.

The surface of the type is uneven, being marked by numerous ridges and depressions which give the surface a wavy appearance. Some areas, however, are more nearly level, having a gently undulating surface. The drainage, both surface and internal, is excellent, and water seldom stands on the surface for more than a few hours, except during periods of overflow.

The Newberg fine sandy loam is not of great agricultural importance. Only about 15 to 20 per cent of it is cultivated; the rest supports a forest growth of fir, alder, and willow. Owing to the low elevation above the river of much of the type, the water table is rarely below 20 feet and

often stands at 12 to 15 feet. As a result the type is partly subirrigated. The chief crops are potatoes, wheat, oats, corn, and peaches. The ordinary range in yields is as follows: Potatoes 150 to 300 bushels per acre, wheat 20 to 30 bushels, oats 30 to 65 bushels per acre, and corn 10 to 15 tons of silage or 60 to 80 bushels of grain. Peaches yield well, but owing to uncertain markets they are not as profitable as other crops, and in recent years many orchards have been grubbed out. Blackberries and hops are grown with good success. Mint is grown on a small acreage and has proved highly profitable.

Farm lands composed mostly of Newberg fine sandy loam sell for \$90 to \$175 an acre, while unimproved land sells for \$30 to \$75 an acre. Some of the better potato fields on this type are valued at not less than \$300 an acre.

This is a productive soil, well adapted to early fruits and vegetables. The potatoes are of good quality and yield heavily. The type could probably be more generally utilized in the production of berries and of seed and market potatoes.

Newberg fine sandy loam, gravelly phase.—The surface soil of the Newberg fine sandy loam, gravelly phase, consists of 10 to 12 inches of rich-brown to light-brown sandy loam, which contains rather large quantities of rounded waterworn gravel. The subsoil is a brown sandy loam or sand in which the gravel constitutes about 80 per cent of the material. The gravel particles vary from less than an inch to 3 or 4 inches in diameter.

This phase is confined to small local areas, mainly in the first bottoms of the Willamette River. The largest lie south of Irish Bend School. Other areas occur at frequent intervals in association with other recent-alluvial soils of the river bottoms. A few areas lie along the tributaries of the South Fork of the Luckiamute River in Kings Valley.

The Newberg fine sandy loam, gravelly phase, generally occupies positions of slight elevation above the surrounding soils, giving it a knoll-like topography. Along the smaller streams the surface is smooth and gently sloping. The drainage is excessive.

Only about 10 per cent of this phase is in cultivation. The uncleared land supports a forest growth of pine, oak, and vine maple. Wheat and oats are the principal crops, and yields are low except in unusually wet seasons. Because of its excellent drainage the phase is generally used for building sites. The gravel deposits are used as a source of road-building material. The phase is best suited to pasture and forestry. It is sold only in connection with associated soils.

The results of mechanical analyses of samples of the soil and subsoil of the typical Newberg fine sandy loam are given in the following table:

Mechanical analyses of Newberg fine sandy 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.	<i>Per cent.</i>
561210....	Soil, 0 to 18 inches..	0.0	1.6	6.0	34.8	16.7	27.2	13.5
561211....	Subsoil, 18 to 36 inches.....	.0	1.6	6.2	42.2	19.4	21.0	9.6

NEWBERG LOAM.

The surface soil of the Newberg loam typically consists of 15 to 20 inches of brown or dark-brown friable loam. The type as mapped, however, is of somewhat variable texture, in places approaching a light clay loam, and in others a silt loam or very fine sandy loam. The subsoil is a brown fine sandy loam, which becomes lighter in texture in the lower part and finally grades into fine sand at depths between 30 and 60 inches. As with the Newberg silty clay loam this type as mapped includes locally undifferentiated areas of the Chehalis soils.

This type generally borders the deeper inland streams which carry the flood waters of the Willamette River, or else occupies a position intermediate between the sandy soils of this series adjacent to the river and those of heavier texture farther inland. It is somewhat lower in elevation than the heavier textured types and is usually overflowed annually. The largest areas are in the vicinity of Irish Bend School; others of varying size are associated with the alluvial soils from the county line on the south as far north as Kiger Island, and small areas lie in the Willamette River bottom south of Granger.

The surface is irregular, owing to erosion by floods, the depressions being numerous and usually roughly parallel to the course of the river, but only in the case of some of the deeper channels is it so badly gullied as to interfere with cultivation. The drainage is excellent; water rarely stands on the surface for any length of time, and even after overflows it quickly dries out sufficiently to allow cultivation.

Although the Newberg loam is not extensive, it has considerable agricultural importance. About 40 per cent of it is under cultivation and the rest is forested with willow, fir, and alder and used largely as sheep or cattle pasture. The type is easily worked and well adapted to all crops grown in this section. Wheat, oats, clover, corn, and potatoes are all grown, the largest acreage probably being devoted to grain production. Wheat yields 25 to 40 bushels, with an average of 30 bushels per acre; oats 40 to 80 bushels, with an average of 65 bushels; clover hay 2 to 4 tons per acre; potatoes 150 to 300 bushels per acre; and corn 60 to 80 bushels of grain or 10 to 15 tons of silage. Hops are grown with good success, yielding 1,500 to 2,500 pounds per acre. Peaches, berries, and vegetables produce abundantly when well cared for.

Systems of rotation are not followed on this type, but owing to the diversity of crops adapted to the soil, the same crop is seldom grown continuously on one field for any period of time. In general the orchards and hop yards are given clean cultivation throughout the year, and the turning under of organic matter is somewhat neglected.

The Newberg loam sells for \$90 to \$200 an acre, though some better improved land near market can not be bought for less than \$300 an acre. Unimproved land sells for \$30 to \$80 an acre.

The turning under of green manure in the orchards and more thorough cultivation of intertilled crops would be advisable on nearly all farms. Old hop yards are in many cases showing a slight decrease in yields, which could largely be restored by a light application of soluble nitrates early in spring.

The results of mechanical analyses of samples of the soil and subsoil are shown in the following table:

Mechanical analyses of Newberg 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.	<i>Per cent.</i>
561218....	Soil, 0 to 16 inches..	0.2	1.2	3.2	21.3	16.0	36.4	21.3
561219....	Subsoil, 16 to 36 inches .....	.0	1.6	5.6	34.0	13.0	29.9	15.9

NEWBERG SILTY CLAY LOAM.

The surface soil of the Newberg silty clay loam consists of 16 to 20 inches of brown to rather dark brown silty clay loam containing sufficient very fine sand to give it a comparatively friable structure. The subsoil is a brown clay loam or silty loam with a tinge of yellow. The content of sand is relatively high, and increases with depth, grading into a fine sand or fine sandy loam at varying depths below 4 feet. The type as mapped includes small areas of Chehalis soils. Small included areas in depressions have a somewhat lighter texture than typical. One area a mile west of Granger has a clay surface soil, but owing to its small extent it was also included.

The type is developed principally in the first bottoms of the Willamette River and is overflowed periodically. The largest area is in the central part of Kiger Island, bordering the middle channel of the Willamette River. Another area of considerable size lies at the junction of Long Tom River and the Willamette River. Other areas of small size occur in the river bottom, and one area a mile west of Granger lies along a minor stream.

The surface is generally slightly undulating, because of long, rounded depressions and low stream-built ridges. Except during overflow periods, the drainage of the type is good.

Although not of great extent, this type is important agriculturally. About one-half of it is under cultivation; the rest is forested with fir, alder, and willow and utilized for pasture. The principal crops are wheat, oats, and clover, which give practically the same yields as on the Newberg loam. Potatoes, corn, berries, vegetables, peaches, and hops do well.

The Newberg silty clay loam sells for \$90 to \$175 an acre, depending on improvements and accessibility to market. Unimproved land sells for \$20 to \$60 an acre.

This soil is naturally fertile and is maintained in a high state of productiveness by the accession of sediments deposited by flood waters. Deeper plowing and more thorough cultivation would generally improve yields.

The results of mechanical analyses of samples of the soil and subsoil of the type are shown in the following table:

Mechanical analyses of Newberg silty clay 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.	<i>Per cent.</i>
561214....	Soil, 0 to 20 inches..	0.1	0.2	0.6	11.6	12.4	50.4	24.7
561215....	Subsoil, 20 to 36 inches .....	.0	.0	.4	13.6	22.8	47.5	15.7

CAMAS CLAY LOAM.

The Camas clay loam consists of 15 to 20 inches of brown to dark-brown friable clay loam, in which the content of silt and fine sand is relatively high. The subsoil is a brown clay loam containing gravel in the upper part, which increases in quantity to a depth of 30 to 40 inches, where a layer of porous gravel and sand is encountered. Gravel appears locally in the surface soil, but nowhere in sufficient quantity to interfere with cultivation or to affect greatly the physical character of the soil.

The type occupies the deeper former channels of Willamette River bottoms, and some of the narrower stream bottoms in the hill section of the county. It is mapped in only a few small areas. The largest is 1 mile east of Greenberry; other areas are at School No. 31, along Ingram Slough, in the channel of Old Long Tom River, on Fisher Island, 2½ miles south of Kings Valley, and 4 miles east of Kings Valley. The topography is smooth and gently sloping, and drainage is well developed.

The Camas clay loam is unimportant agriculturally. About 10 per cent of it is under cultivation, and the rest is covered with willow, alder, and vine maple. The principal cultivated crops are wheat and oats, of which the yields are somewhat less than on the Newberg fine sandy loam. The type is sold only in connection with other soils. This type is well adapted to the production of blackberries and early vegetables.

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

Mechanical analyses of Camas clay 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.	<i>Per cent.</i>
561275....	Soil, 0 to 18 inches	1.1	2.7	2.6	18.0	16.0	37.8	21.8
561276....	Subsoil, 18 to 36 inches	3.8	9.6	5.7	15.3	10.9	25.3	29.4

WAPATO SILTY CLAY LOAM.

The surface soil of the Wapato silty clay loam, where typically developed, is a faintly mottled brown, dark-brown, or dark grayish brown, smooth, heavy silty clay loam, 8 to 12 inches deep. The subsoil, to a depth of 36 inches or more, is a moderately compact drab or brown clay or clay loam mottled with rusty brown, yellow, and gray. As occurring in this survey the surface soil varies in color from gray, in areas closely resembling the soils of the Whiteson series, to black, the type here approximating the Cove soils. The subsoil in places is black, with only a faint mottling of brown, and is much like the Cove subsoil, but the surface soil here is typical Wapato material. The content of organic matter is variable, the soil in some areas being well supplied and in others deficient in this constituent.

As mapped in this survey the type includes some small areas in which the soil has clay texture and is underlain by a subsoil of drab-colored clay, faintly mottled with yellow or rusty brown, changing

below to a drab-colored clay loam or silty clay loam distinctly mottled with yellow and gray. The surface soil in these areas has a tendency to crack badly upon drying and in some areas has a definite adobe structure.

The Wapato silty clay loam is an extensive recent-alluvial soil. It occurs in nearly all the smaller stream valleys, and a few small areas are developed in the bottoms of the Willamette River in the vicinity of Monroe and Greenberry and between Corvallis and North Albany. The largest areas lie along Muddy Creek and its tributaries, notably Oliver, Hammer, Bull Run, and Beaver Creeks. Other areas are mapped along Marys River, Oak Creek, and Bowers Slough and in the vicinity of Granger, Calloway, Sunnyside School, Fir Grove School, and Coffin Butte.

The Wapato silty clay loam has an almost level to gently sloping surface, and the drainage is generally poor. In places the areas occupy slight depressions lying between the stream channel and soils above overflow. Such depressions usually remain wet until late in the season. The soil here is relatively high in organic matter.

Although widely distributed, this type is of little agricultural importance, only about 20 per cent being under cultivation. The rest of the type is devoted largely to pasture. Scrub oak, alder, and willow grow along the stream banks, and in the wetter areas tules and marsh grass make a rank growth. The principal crops are oats, vetch, and alsike clover. Wheat is grown on a small acreage in the better drained areas. Corn is also grown and gives fair yields. Oats yield 30 to 60 bushels per acre, oats and vetch hay 2 to 3 tons, and alsike clover hay, 1 to 3 tons per acre. The type is devoted principally to dairying and the crops raised are fed on the farms.

Improved land of this type sells for \$75 to \$125 an acre. Unimproved land is held at \$20 to \$60 an acre.

The Wapato silty clay loam is naturally fertile and with good drainage could be made productive of berries, corn, and small grain crops. Areas deficient in organic matter could be made more productive and easier to handle by incorporating barnyard manure or turning under cover crops.

WHITESON SILTY CLAY LOAM.

The surface soil of the Whiteson silty clay loam consists of 8 to 10 inches of light-gray to brownish-gray or grayish-brown plastic silty clay loam. The upper subsoil is a drab clay, very compact, plastic, and impervious. The lower subsoil consists of a slightly less compact drab clay mottled with yellow. In some localities the drab impervious layer is better developed than in others, and in such places the lower section is more mottled and friable.

This type is the least extensive type mapped in Benton County. It is found in the stream bottoms, occupying small sinks or depressions only slightly above the normal flow of the stream and containing water for long periods of time. The largest areas of the type are in the vicinity of Sunnyside School and the State Game Farm. Small areas lie near Richland School, east of Union School, and east of Alpine. The surface is nearly level and the drainage is poor.

The type is unimportant agriculturally. About 20 per cent is under cultivation, being devoted principally to alsike clover, oats, and

vetch. The rest is covered with a good growth of grass and is used for pasture. This type is adapted to the same crops as the Wapato silty clay loam, but the yields are somewhat lower. Owing to its small extent, the type is not sold alone. Drainage is the principal need of this soil, after which the addition of organic matter would be beneficial.

The table below gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the type:

Mechanical analyses of Whiteson silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
561261....	Soil, 0 to 8 inches...	<i>Per cent.</i> 0.5	<i>Per cent.</i> 0.6	<i>Per cent.</i> 0.6	<i>Per cent.</i> 2.0	<i>Per cent.</i> 6.9	<i>Per cent.</i> 67.1	<i>Per cent.</i> 22.3
561262....	Subsurface, 8 to 18 inches.....	.2	.7	.5	2.8	7.6	56.5	31.7
561263....	Subsoil, 18 to 36 inches.....	.2	1.2	2.0	6.1	4.2	53.6	32.8

COVE CLAY.

The Cove clay consists of 15 to 20 inches of black, dark-gray, or very dark brown clay, underlain by a black waxy clay mottled with yellow or rusty brown. As mapped in this county, the subsoil usually grades into lighter textured, grayish, mottled material at depths ranging from 36 to 60 inches. The surface soil, which varies somewhat, in places closely approaches the Wapato silty clay loam in color. The soil is very plastic when wet and has a tendency to puddle if care is not taken to work it when in the proper moisture condition. Upon drying it checks badly and unless cultivated it loses moisture very rapidly. An adobe structure is developed in places, especially in an area just north of Richland School.

The Cove clay is developed principally along the smaller stream channels, where it is subject to annual overflow, but small areas of alluvial-fan deposits along hill slopes are included. The most important stream-bottom area of the type is a strip about 4 miles long and from a few rods to nearly a half mile wide, which lies just north of Sunnyside School. Other areas lie along Dixon Creek and in the bed of a creek three-fourths mile northeast of Philomath and in various other places in the flood plains of the smaller creeks. The alluvial-fan areas are inextensive, the largest occurring on Dixon and Oak Creeks and two other small creeks in the same vicinity. Other small areas of this character lie north of Philomath, west of Noon, and west of Wren.

The type occupies low areas bordering the base of the higher terraces, or areas of outwash from the adjacent hills. Drainage is generally poorly developed, both for surface and subsoil, though some of the alluvial-fan areas have well-developed surface drainage.

Only about 10 per cent of the type is in cultivation. The rest is utilized mainly for pasture. The wet areas support a heavy growth of rushes. Dairying is the chief industry, the native grasses affording pasture for a few months of the year. Alsike clover, red clover, oats, and vetch are the principal crops. The first clover crop is cut for hay and the second for seed. Alsike clover yields 1 to 2½ tons of hay per acre and 2 to 5 bushels of seed; and red clover, 1 to 2 tons of hay and 1 to 4 bushels of seed. Oats and vetch hay yields 1 to 3 tons per acre.

The price of this land ranges from \$25 to \$90 an acre, depending largely on location and improvements.

The Cove clay is a productive soil, but owing to the difficulty of working it in its present condition it has not given satisfactory results. Additions of organic matter and the installation of good surface or subsurface drains will make the type much easier to handle. A good permanent grass mixture should be sown and more care should be used in pasturing to prevent puddling of the soil when wet.

ROUGH MOUNTAINOUS LAND.

The Rough mountainous land consists mainly of areas in the mountainous parts of the county which are entirely undeveloped because of their steep and broken topography, and are accessible only by means of a few poorly defined trails. The soils are of residual origin and derived either from igneous or sedimentary rocks. Bedrock is encountered at depths of 6 to 36 inches, and detached rock fragments or boulders are numerous on the surface. Rock outcrops are common along the breaks and steeper mountain sides. Small areas in the developed agricultural parts of the county, which are unfit for agriculture because of their shallow and rocky character or steep and broken topography, are included with Rough mountainous land.

Except for a few small areas which have been burnt over, this land is heavily forested with fir and supports a dense growth of underbrush, which makes it accessible for purposes of soil determination only with great difficulty. However, with the removal of the timber and extension of agricultural development, small arable areas will doubtless be found. Under the limitations of the present survey it was not deemed expedient to map these areas in detail.

Some areas of this land in the vicinity of settlements are used as pasture for goats or cattle, but in general the type at present has no value for agriculture and under prevailing conditions is best adapted to forestry.

RIVERWASH.

Riverwash is a nonagricultural type of material, consisting of unassorted sand, gravel, and cobble, which lies only a few feet above the normal flow of the rivers, ordinarily in open channels or as low terraces along the banks. In general the type supports no vegetation, owing to the frequency of overflow, though in some of the better protected areas a few alders or willows have found a foothold. Riverwash in this survey is confined to the banks and old channels of the Willamette River.

SUMMARY.

Benton County is situated in the middle western part of Oregon. Approximately three-fourths of it lies in the drainage area of the Willamette River and one-fourth on the western slopes of the Coast Range, with drainage into the Alsea River. It has an area of 648 square miles or 414,720 acres. A large proportion of the western part of the county is unsettled and undeveloped because of the broken topography. The lower foothills are sufficiently smooth for cultivation and are largely developed.

In 1920 the county had a population of 13,744. Fifty-eight per cent of this is classed as rural. Corvallis, the principal town and county seat, has a population of 5,752. It is an important railroad and shipping point and an educational center.

The climate of Benton County is mild, the mean annual temperature, as reported at Corvallis, being 51.5° F. In the valley the average length of the growing season is 175 days, and the normal seasonal rainfall is 42.30 inches.

The agriculture consists of general farming, dairying, fruit growing, and a little truck growing. The principal crops are wheat, oats, clover, vetch, apples, and prunes. The sale of dairy products constitutes the chief source of income on many farms. Farm improvements are generally better than in most farming communities of this region.

A 3-year rotation consisting of wheat, clover, and oats is generally practiced, though potatoes, beans, and corn are coming into general favor and are being used to extend the rotation to 4 years. Farm labor at the time of this survey was scarce and expensive.

There are 1,320 farms in Benton County, with an average size of 176.8 acres. Farm lands sell for \$50 to \$180 an acre. Apple and prune orchards sell for \$500 to \$700 an acre.

Benton County lies in the Pacific Coast soil region. The residual soils are underlain by either basalt, andesite, dolerite, sandstone, or shale. The sandstone formation is quite extensive in the western part of the county, while the basalt and other igneous rocks border the Willamette Valley. The igneous rocks give rise to the Aiken, Olympic, and Cascade series of soils, and the sedimentary rocks to the Sites, Melbourne, and Carlton series.

The soil-forming materials of the valley fall into two divisions: Old unconsolidated valley-filling deposits, and recent-alluvial deposits. The old valley-filling deposits give rise to the Willamette, Dayton, Amity, Salem, and Grande Ronde series. The recent-alluvial soils belong to the Chehalis, Newberg, Camas, Wapato, Whiteson, and Cove series.

The Aiken, Sites, Melbourne, and Olympic soils are well adapted to fruits, such as prunes and apples. The Carlton soils are productive of fruits as well as of grains and clover.

Red clover and wheat are grown extensively on the Willamette and Salem soils, while alsike clover and oats are grown on the poorer drained Amity, Dayton, and Grande Ronde soils.

The Chehalis, Newberg, and Camas soils are well suited to corn, wheat, clover, potatoes, peaches, and berries.

The Wapato, Whiteson, and Cove soils are in need of drainage. Where cultivated, the principal crops are oats, alsike clover, and vetch. At present these soils are utilized largely as pasture land.

The soils of the county are variable in productiveness, drainage usually being the limiting factor. The well drained soils are productive and well adapted to general farming and dairying.

Dairy farming and walnut and prune culture could well be extended.

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at <http://offices.sc.egov.usda.gov/locator/app>.

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers. If you believe you experienced discrimination when obtaining services from USDA, participating in a USDA program, or participating in a program that receives financial assistance from USDA, you may file a complaint with USDA. Information about how to file a discrimination complaint is available from the Office of the Assistant Secretary for Civil Rights. USDA prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex (including gender identity and expression), marital status, familial status, parental status, religion, sexual orientation, political beliefs, genetic information, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.)

To file a complaint of discrimination, complete, sign, and mail a program discrimination complaint form, available at any USDA office location or online at www.ascr.usda.gov, or write to:

USDA
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, S.W.
Washington, DC 20250-9410

Or call toll free at (866) 632-9992 (voice) to obtain additional information, the appropriate office or to request documents. Individuals who are deaf, hard of hearing, or have speech disabilities may contact USDA through the Federal Relay service at (800) 877-8339 or (800) 845-6136 (in Spanish). USDA is an equal opportunity provider, employer, and lender.

Persons with disabilities who require alternative means for communication of program information (e.g., Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).