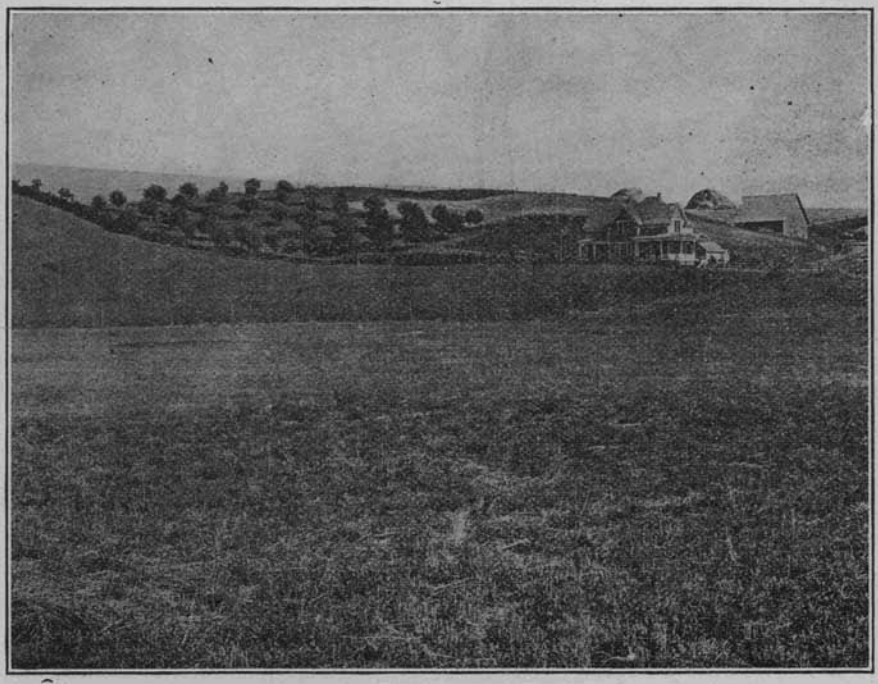
UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION

Soils of Latah County, Idaho



A typical Farm home on the Palouse silt loam.

By P. P. PETERSON

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SOILS OF LATAH COUNTY, IDAHO

The State of Idaho is noted for the great fertility of its soils. Two factors cause this condition of fertility. One is the wealth of plant food that is found in the soil. The second is the practice of irrigation by which water can be supplied to the plants as it is needed. There are certain areas, however, within the State which have very productive soils and yet are not in the irrigation belt. Chief among these is that part of the Palouse belt which lies in Idaho.

The Palouse area lies across the boundary line between the states of Washington and Idaho with the larger portion in the former state. That part in Idaho is found in the counties of Latah, Nez Perce, and Lewis. The area, as a whole, is characterized by the peculiarity of its climate and soil. The climate is a very moderate one, being modified both in winter and summer by the winds which blow in from the coast over the low part of the coast range thru which the Columbia River flows. At times these winds reach very high velocities and carry from the dry area around Pasco, Umatilla, and Walla Walla, Washington, great clouds of dust which are deposited in the Palouse area. As the soil is formed in this way it is piled into great dunes of silt. These are left almost as they were piled because of the soil's great power to absorb falling rain, and to produce abundant vegetation to hold the dust when it is once deposited. The extremely light silty nature of the soil and the rolling contour of the country are characteristic of the area. Latah county, Idaho, the soils of which are discussed in this bulletin, is located in the extreme eastern part of the area between the standard parallels 46 and 47 N.

History of the County.—Up to about the year 1870 very little was known about the phenomenal fertility of the Palouse lands of eastern Washington and western Idaho. The rolling prairie was covered with bunch grass that furnished good pasture for cattle in the spring of the year. In the late seventies it was first discovered that the soil which produced such fine bunch grass also would produce phenomenal yields of wheat, oats, and barley, and it was but a few years thereafter until practically all of the prairie was settled.

The first crops had to be carted to Lewiston whence they were shipped to Portland by water. In 1887 the first railroad to enter the area now occupied by Latah county was built to Genesee by the Northern Pacific company. This event gave great impetus to the development of the country, and also proved a very profitable investment for the road, because of the great tonnage of freight that was turned to it from the water route. So profitable was the traffic on this road that in 1898 the same company extended another branch to Moscow to compete with the Oregon Railroad and Navigation company which in the meantime had built a road to Moscow from Colfax. In 1908 a fourth railroad was built into the county, the Inland Empire electric reaching Moscow in that year. Since that time, two other roads have been built to take care of the traffic in lumber and the products of the mines located at Elk City,

Clearwater county. The Washington, Idaho and Montana was built from Palouse, Washington, to Bovill, Idaho, to handle the traffic of the Potlatch Lumber company. The Chicago, Milwaukee and St. Paul comes in from the northeast and passes thru the northeast corner to reach Elk River. However, it passes thru a part of the county that will doubtless be a very good farming country and so may be said to increase the agricultural outlook of the county.

FIG. 1. To the newcomer the tremendous hills which make the contour of the country are the most impressive feature.

The educational interests of the county have been well taken care of from the first. In 1889 the Territory of Idaho, by legislative act, established the University of Idaho at Moscow. Instruction was begun in 1892, and since that year Latah county has set the pace for the State in educational matters.

Topography.—Upon first entering the county, one's attention is first attracted by the tremendous hills which form the contour of the land. They usually extend from northwest to southeast and the northeast slope is the most abrupt. Often they are from 150 to 200 feet high and partly surrounded by level benches. Along the larger creeks are other level areas of soil of different type. Rising out of the south-central portion of the rolling plain are some comparatively high hills which are covered with a considerable forest growth. These are the Paradise and Tomer Buttes. In the north-central portion of the area is a range of mountains known as the Moscow Mountains or Thatuna Hills. They rise to a height of nearly two thousand feet above the surrounding plain and are also covered with a forest growth. On the northern boundary of the county is a range known as the Hoodoo Mountains. These hills or buttes, as they are called locally, are all granitic peaks which stood out above the lava flow that covered the area in tertiary times.

Drainage.—The western part of the county is drained by small streams which run during the wet season and dry up, or nearly dry up, for the rest of the year. The water which they carry comes mostly from the melting snow on the granitic hills described in the preceding paragraph. Among these small streams are Paradise Creek, which runs thru Moscow, South Fork of the Palouse River, which runs about a mile south of Moscow, and Genesee Creek which runs thru Genesee at the southern boundary of the county. The Palouse River takes the drainage from the northern part of the county, or that part located between the Moscow and Hoodoo Mountains. It also breaks thru the Moscow Mountains and obtains a large part of its flow from the eastern side of this range. During the wet season it carries a considerable amount of water. Most of the eastern part of the county is drained by the Potlatch River and its tributaries. The Potlatch in turn is a tributary of the Clearwater River, and like the latter flows very rapidly and in its lower course has cut a deep canyon or coulee, the sides of which are very abrupt. At Kendrick the Potlatch coulee is nearly 2000 feet deep.

Climate.—In the area no extremes of heat and cold are experienced. Being opposite or nearly opposite the Columbia gap of the Coast Range Mountains, as before pointed out, the area experiences a climate somewhat similar to that of the coast. The westerly winds blow in the moisture from the Pacific Ocean thru the gap, and Latah county, lying as it does, in the eastern part of the area nearest the mountains receives the heaviest deposition of the moisture thus brought into the Palouse area. The southwestern part of the county is the driest and the Palouse Valley is the best watered because of the comparatively high mountains immediately to the eastward of it. The temperature of the area seldom reaches below zero and the summer months generally have hot days, but delightfully cool nights. Altogether, the climate is very temperate for the latitude.. In Table I are given the average monthly temperature and the average monthly rainfall for the last ten years at Moscow. The last column and the last line contain the annual and monthly rainfall respectively for the same period of time. Because of the long, dry period in the summer during which most crops suffer for water the climate should be classified as semi-arid.

Native vegetation.—In the western part of the county little of the native vegetation is left. That which is left consists most largely of timber and underbrush. The prairie sections upon which the grasses grew in great abundance have all been broken up and are being used for grain farming. Only along the roads that have persisted from the breaking up of these lands can the native vegetation be seen, and the change of roads from time to time has left an extremely small area upon which there is now any left. Upon the buttes mentioned in an earlier paragraph a considerable amount of forest growth is found, and among this forest growth, pasturage for cattle is of much value. The eastern boundary of the prairie section runs roughly from Kendrick in a northwesterly direction thru Potlatch to the boundary of the county. The prairie section is roughly triangular with the base of the triangle to the south.

East of the line bounding the prairie, timber is found in abundance. Very large areas of white and yelow pine, and fir, and tamarack are

Table 1.—Mean average monthly temperature and rainfall at Moscow.

YEAR	JAN.		FEB.		MARCH		APRIL		MAY		JUNE		JULY		AUG.		SEPT.		OCT.		NOV.		DEC.		Total Annual Precip't'n
	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.	
1907 ...									56.2	.81	59.8	2.58	67.4	1.58	63.1	.44	54.2	.98	47.9	.78			33.4	2.90	
1908 ...	30.6	1.37	32.4	1.77	35.4	2.76	45.7	1.30	48.6	2.00	56.1	1.07	70.0	.13	66.8	.95	59.1	.93	46.8	1.97	40.4	.85		1.41	16.56
1909 ...		4.11		3.19		1.02	42.8	2.06	51.8	1.62			63.6	3.65	67.6	TR.	60.2	1.54	49.7	1.70	41.6	5.77	26.6	1.48	25.94
1910 ...	26.6	2.58	25.0	3.50			51.2	1.77	55.8	1.92	57.6	TR.	67.0	TR.	63.6	TR.	56.4	.56	49.4	2.21	38.0	4.11	34.0	1.87	18.52
1911 ...	28.7	.98	27.2	1.08	21.3	.37	45.6	.08	49.2	2.17	60.8	.80	68.0	.10	64.4	4.76	55.2	.86	47.0	1.01	35.6	1.59	29.8	1.16	10.95
1912 ...	30.5	2.16	33.6	3.50	34.1	1.17	44.8	1.77	52.5	3.23	61.5	.75	62.4	2.00	62.4	2.00	54.1	1.76	43.5	2.01	38.2	2.60	31.0	2.69	24.10
1913 ...	23.3	9.63	21.2	1.51	33.0	4.42	46.0	1.43	54.8	1.90	57.4	3.20	63.8	.19	66.7	.86	57.5	.91	44.0	2.36	38.3	3.20	30.6	1.03	30.64
1914 ...	34.2	2.51	30.2	1.95	40.8	.76	47.6	1.76	56.0	2.00	57.2	1.36	69.0	.70	67.1	.00	56.1	2.04	49.5	2.04	40.2	1.76	23.5	1.25	18.13
1915 ...	25.5	1.36	36.6	1.32	44.0	1.53	49.0	2.07	52.0	4.08	56.1	.40	65.8	.78	71.5	.08	55.8	.31	49.4	1.66	34.2	3.22	29.3	2.13	18.94
1916 ...	15.2	2.19	32.6	2.03	40.4	4.88	45.3	1.01	48.1	1.36	57.4	2.20	61.6	1.12	65.6	1.17	57.2	.64	45.5	.30	32.9	2.64	23.4	1.90	21.44
Aver. ..		2.99		2.21		2.11		1.47		2.11		1.37		.87		.73		1.06		1.60		2.75		1.78	20.58

T = Mean average temperature.
P = Precipitation.

here observed, and as a matter of fact, one of the largest lumbering mills in the world is located just at the edge of this timbered area, at Potlatch. Generally speaking, the timber is not very dense. Many areas are open enough to afford abundant forage for live stock.

The effect of the difference of native vegetation upon the soils in the eastern and western parts of the county is very marked. The prairie soils on the hills of the western part of the county are very dark brown when wet and of a grayish color when dry. They are of a neutral character and high in their content of humus. The upland soils of the eastern area are of a brownish color, and are almost invariably acid, especially when found in the forest. For this reason the two types of soil, that in the western part of the county and that in the eastern part, have been classified in two different series, tho physically they are very much alike.

Industries.—Altho the manufacturing interests of the county are not very extensive, they are sufficient to show the thrift of the people who have settled here. The general prosperity of the communities, the presence of large amounts of raw material, and the necessity for a peculiar type of machinery to operate upon the hill-sides have given rise to several industries. Chief among these is perhaps that of lumbering. Early in the settlement small lumber mills sprang up all over the eastern side of the county, but upon the coming of the Potlatch company nearly all shut down or sold to the large operators. Now, but few mills are to be seen, but the industry is as thriving as ever. The making of flour is the second largest industry of the county. Mills are located at Moscow, Genesee, Juliaetta and Kendrick which not only make flour for the communities immediately surrounding these places, but ship a very large amount into adjoining states and to foreign markets.

Recently the fire-brick industry has grown to considerable proportions. The presence of fire-brick clay was first discovered at Troy where the first kilns were located. More recently, clay of exceptional quality has been found nearer to Moscow and during the last year a large plant has been built at that place. At Moscow there is located a large vinegar factory. At Juliaetta, there is a canning factory. A meat-packing plant large enough to take care of all of the live stock of the county is located at Moscow and is handling an ever increasing outside trade. In 1910 a factory was located at Moscow for the purpose of building harvesting machinery better suited to the Palouse conditions than that built for other places. This industry has continued to thrive since its establishment. The Idaho National Harvester Company is sending its products to all western states, and is shipping some abroad.

Altho these industries bring increased activity to the county, they are entirely overshadowed by the agricultural industry.

Agriculture.—Because of the semi-arid nature of the climate, the area has gone largely to the production of grains, wheat being the principal crop. And it must be said in this regard that the area is one of the best grain-growing sections of the United States. At times the yields run as high as seventy and seldom as low as twenty bushels per acre. The most usual system of farming is to grow grain two years and then to fallow one year. The fallowing is made necessary, not so much for the conservation of moisture, as for the eradication of weeds which grow

in great abundance with the crops. Oats are also used in some measure with the rotation. Field peas are now being introduced and are giving great promise of profitable production.

At present the residents are awakening to the necessity of raising more live stock and are, therefore, growing a larger area of pasture than formerly. Until the farmer can be induced to farm on a smaller scale, there is little hope of changing from grain to live-stock farming, except very slowly. At present, individual farms are very large, often ranging in size from 320 acres to over two sections of land. The average size is 140 acres.

The fruit industry has taken on considerable proportions. Apples form the largest part of the fruit produced. Pears, prunes, and cherries also do splendidly, and small fruits can be grown without danger of a failure.

The following paragraphs quoted from the United States Bureau of Soils Report upon the Survey of Latah County describe well the methods of classification used by the government in its work. Upon this scheme of classification the following descriptions are based.

DESCRIPTION OF SOILS

"The soils of Latah county may be broadly divided into three groups —residual, eolian, and alluvial.

"The residual soils are those that have been derived directly from the weathering in place of the underlying rocks. Basalt, granites, quartzites, schists, and gneisses have in this county weathered into light-colored soils, such as are found on most of the buttes and mountains.

"The soils of the second group are derived from finely divided material, probably of wind-borne origin. The deposits extend over a wide area of country and form a mantle, covering the basalt plain and the lower-lying granite buttes. This deposit is the cause of the rounded profiles which characterize the topography of the county.

"The alluvial soils represent recent alluvium brought down by the streams and deposited in the valley-like depressions and along their courses. This alluvium is derived from a wide range of rocks and minerals and consists of reworked eolian and residual material.

"In the classification of soils adopted by the Bureau of Soils the soil type is the unit of classification and mapping. This includes all occurrences of soil of identical or very similar characteristics in color, texture, structure, depth of subsoil or substratum, origin, and mode of formation. Minor variations or local departures from these typical characteristics that are not of sufficient importance or extent to warrant recognition as distinct soil types are recognized as phases. The soil series consists of a number of closely related soil types differing essentially only in texture, which is determined by the relative degree of coarseness or fineness of the compound material. A soil series, therefore, consists of a number of soil types of common origin and mode of formation, similar in color, character of subsoil, etc., and ranging in texture from coarse sand to clay.

"Excluding rough mountainous land and rough, stony land, seven soil types, with three phases, are recognized in Latah county. Two of these are residual, two are derived from eolian or loessial materal, and three

consist of recent-alluvial deposits. The eolian and the residual soils are the most important.

"The residual soils are classed in one series, the Moscow. The surface soils of the Moscow are of light brown to brown, with light grayish-brown to yellowish-brown variations. They overlie subsoils of grayish-yellow, yellowish-brown, to pale yellow color. The deeper subsoil frequently consists largely of disintegrated rock and grades into a substratum of bedrock. The soils of this series are residual from the weathering of granites, schists, gneisses, or quartzites, tho influenced in some localities by admixtures of the fine-grained loessial or wind-laid material. These soils are developed on the buttes and mountains. Rock outcrop is abundant, and the soils are in many places too shallow to cultivate. Most of the areas mapped in this series are forested. The series is represented in this county by two members, the Moscow sandy loam and the Moscow loam. As mapped, the boundary between these two soil types and adjacent loessial soils is frequently arbitrarily placed, and each series may include locally some areas of the other.

"The eolian, or loessial, soils are included under two series, the Palouse, which consists of dark-brown to black soils of the prairie and the Helmer, which consists of light-colored forested soils.

"The alluvial soils are included under three series, the Caldwell, Potlatch and Yakima. The Caldwell has dark surface soils and fair to good drainage; the Potlatch has brown to dark-brown surface soils, with mottled gray and yellowish subsoils and poor drainage; and the Yakima series has light-brown to dark-brown soils, carrying basaltic cobblestones and a substratum of basalt bowlders."

Palouse Series

By far the most important type of soil found in the county is the Palouse silt loam, which is found in three phases, the hill phase, the terrace phase, and the landslide phase. Of these three phases, the hill phase is the most abundant and therefore the most important phase of soil in the county. All of the drumlin-shaped or dome-shaped, or hog-back-shaped hills in the Genesee area, the American Ridge area, the Moscow area, and the Palouse area are of this type of soil, and one traveling over the western part of the county will readily be impressed that this is the most abundant type of soil. It seems that nothing but hills can be seen. Its depth in places is most astonishing. Figure 2, which is a photograph taken on the Inland Empire railroad north of Moscow, shows, in a way, the great depth of it. This cut is over fifty feet deep and is silt loam from the top to the bottom. Figure 3 is a photograph on the same railroad taken about a quarter of a mile south of the first one and shows an outcrop of granite at that point. An X marks the outcrop. These photographs show very conclusively that this soil was not given its contour by the underlying rock, but by the building up, literally, of silt dunes.

This type having been carried by the wind is called loessial. Since it has been gathered from far and wide, it is all but impossible to determine from what kind of parent rock it came. As already stated, it is a loam with the silt predominating, therefore, is a silt loam. Being the predominant type in the Palouse region, it is called Palouse silt loam.

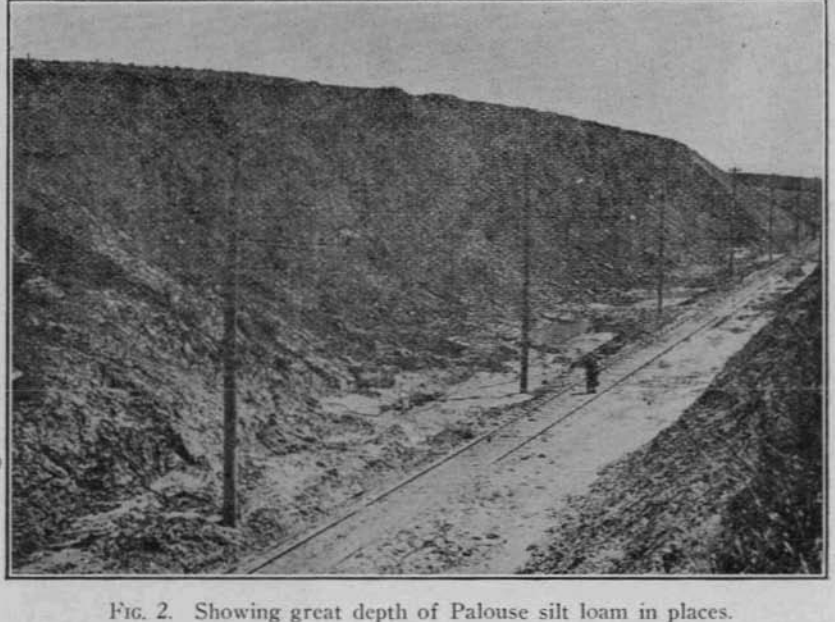

FIG. 2. Showing great depth of Palouse silt loam in places.

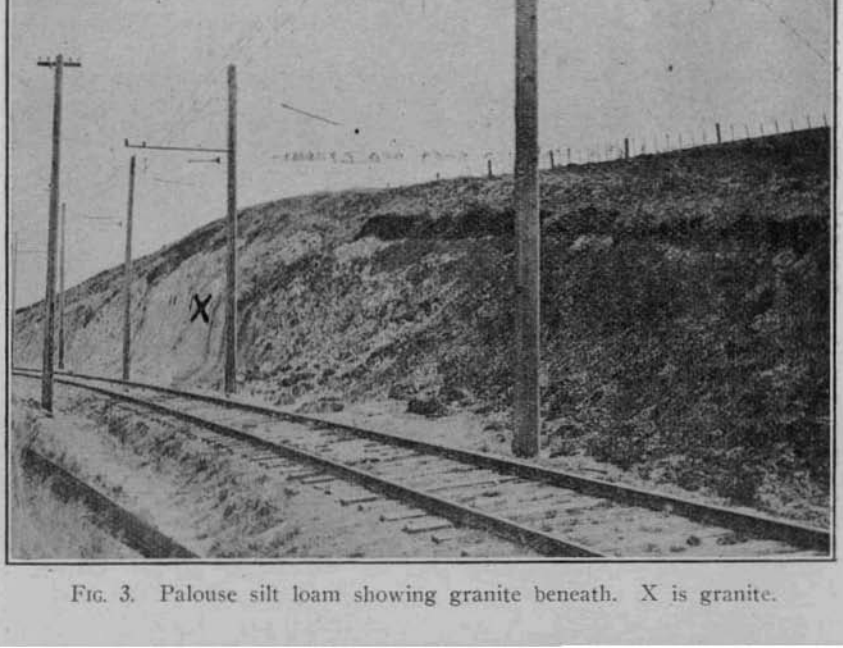

FIG. 3. Palouse silt loam showing granite beneath. X is granite.

The depth of the surface soil in this phase is between eighteen inches and two feet. As is shown by Figure 2, the surface soil is very distinct from the subsoil. The surface soil is of a dark color because of its high content of organic matter. The subsoil contains very little humus and is of a yellowish-brown color. Inspection of Table II will show the amount of organic matter found in each.

Table II.—Chemical composition of Latah county soils.
Figures indicate percentages.

Laboratory No.	101	102	103	104	105	106	107	108	109	110
Silica (SiO_2)	63.07	65.04	61.01	64.60	67.66	68.10	68.00	71.35	64.25	68.21
Alumina (Al_2O_3)	18.19	19.91	18.08	19.12	14.90	14.95	17.40	16.21	14.30	18.60*
Ferric Oxide (Fe_2O_3)	2.42	3.61	4.95	5.30	4.44	4.48	3.48	4.53	3.10	
Lime (CaO)	1.37	1.24	1.71	2.47	2.89	2.57	2.34	2.13	3.78	2.70
Magnesia (MgO)	1.53	1.37	1.77	1.41	1.31	1.60	1.28	2.01	.86	.97
Soda (Na_2O)	1.26	1.87	1.95	2.91	2.72	2.76	1.47	1.47	1.42	2.26
Potash (K_2O)	1.84	1.63	1.57	1.99	1.96	2.05	2.40	2.73	1.66	1.79
Brown Oxide of Manganese (MnO)	TR.	.00	.00	.00	.00	.00	.00	.00	.00	.00
Carbon dioxide (CO_2)	.29	.26	.16	.22	.04	.03	.07	.02	.04	.03
Phosphoric Acid (P_2O_5)	.208	.152	.303	.196	.160	.154	.400	.417	.351	.314
Sulfur trioxide (SO_3)	TR.	TR.	TR.	TR.	TR.	TR.	TR.	TR.	TR.	TR.
Nitrogen (N)	.50	.14	.11	.07	.16	.10	.08	.04	.25	.17
Organic Carbon dioxide	12.51	4.75	8.22	3.63	5.80	3.45	4.61	1.47	9.50	6.49

* This represents the total of Fe_2O_3, Al_2O_3, P_2O_5.

NOTE.—The odd numbers are Potlatch silty clay loam, Helmer silt loam, Palouse silt loam, Moscow sandy loam, and Caldwell silt loam, surface soils in the order in which they are given. The corresponding even numbers are the subsoils representing them.

If we estimate that the soil on an acre taken to the depth of one foot weighs three million pounds, calculations by the percentage figures in Table II will show the amount in this soil of the four plant-food substances, the deficiencies of which are thought mostly to *limit* the productiveness of a soil: potash, carbonate of lime, phosphoric acid, and nitrogen. In addition to these, sulfur is thought by some to be an important factor. Of this element, such extremely small amounts were found, that they were unweighable in the amount of soil taken for analysis. Investigators at Washington State College have found the same deficiency in this element. Table III gives the calculated data upon the four substances mentioned above.

Table III.—Amount of plant-food substances in an acre-foot of Palouse silt loam (pounds).

Plant food	Nitrogen	Carbonate of Lime	Potash K_2O	Phosphoric Acid P_2O_5
Amounts	4,800	2,720	58,800	4,800

Soils of this type containing as much as 4500 pounds of nitrogen per acre are generally considered to be amply supplied with this element. Those containing 3000 pounds or less are considered to be deficient. It should be noted that the Palouse silt loam is only slightly above the the first figure given, and it has been found by practical experiment that an application of nitrate of soda increases the yield upon a plat not below the average in fertility. Nitrogen in an available form is, therefore, likely to become a limiting factor in the productiveness of this soil when ample moisture can be supplied. Attention to the conservation of this element by the introduction of leguminous crops in the rotations practiced is therefore urged. At least one year out of every three or four a leguminous crop should be grown on the Palouse silt loam.

What this crop should be may be determined by several factors. At the present price of field peas this crop will doubtless give the best direct returns. When the price of this product goes down, clover may equal or excel peas, but even at a much lower price peas can be made to yield a substantial profit by hogging them off as has been demonstrated by the Department of Animal Husbandry of the University of Idaho during the last few years. As a direct money crop, peas are most probably the best leguminous crop to use. As a hay crop, clover is probably the best.

In this connection it will be beneficial to use a dressing of sulfate of lime of from 50 to 100 pounds per acre, as a surface dressing after the crop is sown. Washington State College and several farmers report especially good results upon alfalfa and clover. This fertilizer supplies the sulfur which is probably deficient in the soil.

Attention is also called to the extremely small amount of carbonate of lime in soil of this type. Notwithstanding the amount of carbonate of lime is so low the soil is not acid. Whether it will become acid in the future is problematical. If it does, a dressing of crushed limestone will be necessary. At the present time it is not advisable to apply this substance.

A mechanical analysis (Table IV) shows that this type is composed mostly of silt, with an admixture of a small amount of sand and a larger amount of clay which gives it a splendid physical structure.

Table IV.—Mechanical analyses of Latah county soils.

Number of Soil	Classification	Mechanical Constituents, per cent.						
		Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt	Clay
101	Potlatch silty clay loam....	.3	1.0	.9	8.7	11.1	49.2	25.7
102	Same, subsurface	.4	1.8	1.4	10.7	11.1	46.2	27.0
103	Helmer silt loam.....	1.2	2.3	1.0	4.3	16.0	66.9	8.8*
104	Same, subsurface	.6	1.8	1.0	4.2	15.1	67.3	10.0*
105	Palouse silt loam.....	.0	.5	.3	1.9	10.4	65.5	20.2
106	Same, subsurface	.0	.5	.4	1.9	7.9	69.9	20.5
107	Moscow sandy loam	12.2	12.6	5.6	22.8	18.0	24.6	4.2*
108	Same, subsurface	20.5	18.0	5.5	16.2	10.0	23.6	6.3*
109	Caldwell silt loam	.1	.7	.5	2.4	9.7	62.3	23.3
110	Same, subsurface	.1	.9	.5	2.2	6.9	70.4	20.0

NOTE.—The analysis for those numbers marked * were taken from the report of the United States Department of Agriculture, Bureau of Soils upon the Soil Survey of Latah County, Idaho. The soil samples were taken to a depth of one foot, the subsurface samples from one foot to two feet deep.

Table IV has been compiled from the data obtained by the mechanical analysis of all the soils of the area. It may be pointed out that the silt content of the Palouse silt loam hovers around sixty-five per cent of the total weight of the soil.

The very large precentage of silt in this soil is accounted for by the mode of its deposition. Wind carries the finer particles of the soil very much more easily than it does the coarser particles. When it picked up the soil that it has deposited in this area, it left behind the coarser grains, or the sand. The finest grains, or clay, are more adhesive than the medium-sized grains, or silt. The clay particles, therefore, adhered largely to the sand and also to one another and formed larger grains or crumbs which the wind could not carry. Silt, separating from its neighbors more easily, was picked up by the wind and carried into the Palouse area where it has been deposited.

The peculiar texture of this soil which is accounted for by its high content of silt, accounts, in its turn, for another desirable quality, the high water-holding capacity. During the fall, winter and spring months from fifteen to eighteen inches of rain falls upon the soil and is tenaciously held by it. Notwithstanding the comparatively heavy rainfall upon the hills, water seldom penetrates to the underlying rocks. The rain of this region, moreover, usually comes very gently and is absorbed as it falls. From the winter snows there sometimes occurs slight gullying as might

have been observed in the spring of 1916, but the summer rains, the spring rains and the fall rains never cause gullying.

The limiting factor of plant growth in this soil is very often found to be moisture. From nineteen to twenty-three inches of rainfall is sufficient to produce a good crop of grain if properly distributed during the growing season. But in this region, since the rain comes very largely out of the growing season, a large loss takes place while the ground is yet bare. In seasons such as that of 1916, when a large rainfall is obtained during the months of May and June, a heavy crop is produced, but in drier seasons, the amount of moisture obtainable may become the limiting factor of production. When moisture does not limit the crop growth, a deficiency of nitrogen in an available form is the factor most likely to do it as is pointed out in an earlier paragraph.

The farmer's refusal to believe that this type of soil needs manuring, or that it can be manured with profit has become a serious matter in the management of it. Many farmers have come here from places where rainfall occurs during the growing season or where water can be applied by irrigation when needed. In those places they found that manure could be applied and plowed under before the crop was planted. Here they have found that if manure is applied in this manner, the soil dries out or remains in such a porous or fluffy condition that it cannot furnish the moisture and plant food that is necessary to the rootlets of the plant. The plant withers, and the snap judgment is that the manure has burned the soil. This idea, of course, is the height of folly. Manure cannot burn the soil. However, it should be applied in a different manner. Instead of being plowed under and the crop planted afterwards, the manure should be applied as a light surface dressing after the crop has been planted. Then the rains will carry the soluble plant food from it into the soil and leave upon the surface the woody matter that holds the soil open. The application may even be made after the grain is up a few inches without injuring it. The succeeding fall the woody matter of the manure can be plowed under without any injurious effects coming therefrom.

The area occupied by this phase of the Palouse silt loam is approximately 295 sections or nearly 200,000 acres. Table V copied from the report of the United States Bureau of Soils on the Soil Survey of Latah County gives more exact data in this regard.

Table V.—Area of various soil types in Latah county.

Soil	Acres	Per cent	Soil	Acres	Per cent
Palouse silt loam	193984		Moscow loam	37184	6.4
Terrace phase	1664				
Landslide phase	576	33.7	Caldwell silt loam	15424	2.6
Helmer silt loam	148544		Potlatch silty clay loam	9472	1.6
Terrace phase	832	25.7			
			Moscow sandy loam	2304	.4
Rough mountainous land	130816	22.5			
			Yakima loam	576	.1
Rough stony land	41024	7.0			
			Total	582400	

Terrace phase.—The parts of the county in which this phase is located are along the drainage streams. They are somewhat higher than the land immediately surrounding them. The contour is practically level, making the phase appear to have been laid down in still water. However, it has not been deposited in this manner, but is loessial. Examples may be seen immediately south of the Moscow cemetery, a mile north of the city limits of Moscow on the western side of the drainage basin, and about a mile and a half east of this area on the eastern side of the channel. South of the Paradise ridge there are but few small areas of this phase. North of the Palouse River there are some patches that are larger than those in the Genesee region but they are few also. The small percentage of the county that is in this phase makes it of very minor importance. The whole of it does not amount to more than three sections.

Landslide phase.—Along the Bear Creek canyon and Potlatch canyon are small areas of land that seem to have slid out of their places into the canyons. In some instances they are several hundred feet lower than the land to which they conform in texture and other characteristics. The difference in elevation and browner color are the bases for putting them in a separate phase. This area is extremely small, occupying at most but a little more than one section.

Adaptation of the series.—As already stated by far the greater part of the series is devoted to wheat each year. For this crop the soil has a peculiar adaptation. At the proper season of the year it is easily worked and can be brought into a state of splendid tilth for holding the moisture which the crop requires. Wheat sown in September will mature in July. Its season of growth, therefore, is almost entirely within the season of rainfall. Wheat sown in the spring does not do so well as that sown in the fall. Oats do well on this series of soil, but unlike wheat, according to farmers' reports, they give a better crop when sown upon land that has been plowed in the spring. Many farmers alternate oats with wheat, leaving a fallow year after one of them. This is a wasteful practice, but it seems necesary so long as the farms are as large as many of them now are. Altho the crop is limited considerably by the moisture available, potatoes do fairly well upon this series and form a good crop to use on the fallow land. Because of the lack of moisture, they should be planted farther apart than on irrigated land, and they, therefore, do not yield as heavily as in places where a larger amount of moisture is available. One hundred and fifty bushels per acre is considered a fair crop. Field peas have been recently introduced and already have established themselves as a paying crop. The hill phase, because of its fine air drainage, is the best adapted of the series for the production of tender crops. Corn should always be planted on this phase. During cold nights the temperature in the bottoms is often four or five degrees below that on the hills. In this county it is not safe to depend upon getting corn to ripen upon this series of soils, but fair silage corn can usually be produced. The terrace phase which does not dry out as early as the hill phase is better suited to clover and timothy, the best hay crop of the county. The landslide phase, lying lower and therefore having a longer growing season is admirably adapted to more tender crops such as corn and beans. Garden crops of all kinds also do well. Near the Potlatch and Bear Creek coulees

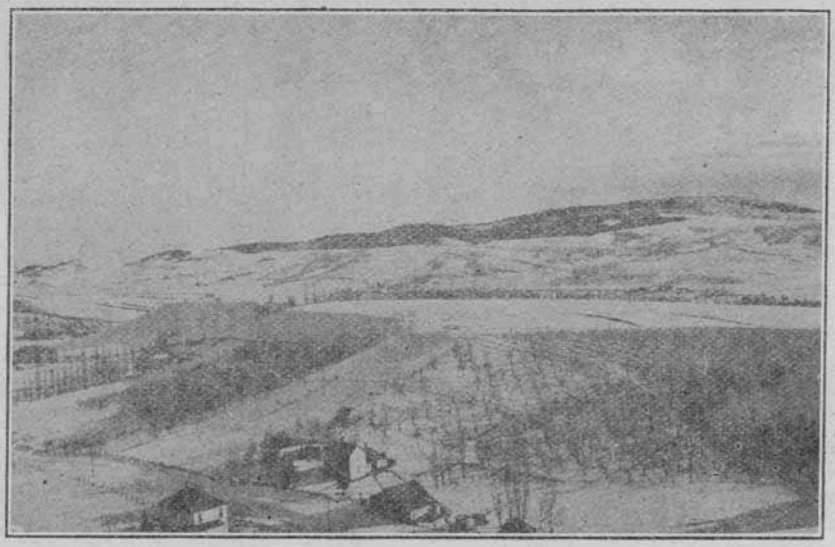

FIG. 4. Looking southeast from the U. of I. water tower. The northeast slope is abrupt. Paradise Butte in the distance.

it seems that the climate warms up earlier than at other points on the series. This difference is thought to account for the peculiar adaptability of this area of the hill phase to beans.

Helmer Series

Physically there is little difference between the Helmer series and the Palouse series. The Helmer series generally contains a little more sand derived from the underlying rock and is somewhat lighter in color as already pointed out. In the wet season of the year the color difference is accentuated. This most probably is due to the heavier growth of native grasses which the Palouse series supported, grasses being conducive to the production of black humus. Table II reveals the difference in the organic matter content of the two soils. The soil of the Helmer series has the characteristic peculiar to nearly all timber soils of this State; it is generally acid to litmus paper. Calculations from Table II in the manner already pointed out give the amounts of plant food per acre-foot shown in Table VI.

Table VI.—Amount of plant food per acre-foot in Helmer silt loam.
(Pounds)

Plant food	Nitrogen	Carbonate of Lime	Potash K_2O	Phosphoric Acid P_2O_5
Amounts	3,300	10,909	47,100	9,090

This table reveals that this type is lower in nitrogen than the Palouse silt loam. Doubtless the problem of supplying more nitrogen will become serious within a short time unless measures for its conservation are adopt-

ed. Apart from the correction of acidity the production of more humus and nitrogen is the greatest immediate problem in the management of this type.

Notwithstanding the comparatively large amounts of carbonate of lime in this soil it usually reacts acid to litmus. Strange as it seems, application of ground limestone or air-slaked lime does produce a beneficial effect, especially when accompanied with a dressing of manure.

Farmers are urged to continue the use of clover and timothy as hay and also as pasture crop. This crop with a liberal application of limestone, about one ton per acre, should increase the humus in the soil and at least conserve what nitrogen there now is in it. The fertility which is removed from the land by harvesting the hay can be returned to the land by feeding it to live stock and applying the manure from them to the clover and timothy field during the fall and winter after the first crop has been harvested. If applied as a thin dressing it will not interfere with the second season's harvest. At the end of the second season the sod should be broken up and another field sown to clover and timothy. By the procedure thus outlined both the humus and the nitrogen supply can be built up with the outlay of but little capital. After the clover and timothy, two crops of grain and one of something else can be grown, when the land again should be sown to clover and timothy.

Collins silt loam.—This is the terrace phase of the Helmer series and corresponds to the same phase in the preceding series. In its adaptation this phase bears the same relation to the hill phase of the Helmer series that the terrace phase of the Palouse series does to that series. Drying out more slowly, it is better adapted to the production of hay than the hill phase.

Adaptation of the series.—Like the Palouse series, this series will produce well any crop for which the climate is adapted. After a few years cultivation the land produces fair grain but will do much better if it is built up as already pointed out. Silage corn can be profitably grown on the hills, field peas produce very good crops upon it, and potatoes yield well when the moisture is sufficient. Upon the hills fruits, both large and small, do very well.

Because of its great abundance and the splendid tilth of this series of soils it is expected that in the near future it will become of almost equal value in this county with the Palouse silt loam. Like the latter, it is exceptionally well drained. In fact the subsoil underlying it never becomes saturated. The area of this series is approximately 150,000 acres.

Caldwell Series

The Caldwell silt loam is the only representative of this series in the county. It is, in a sense, an alluvial soil. It has been deposited in the lower valleys between the Palouse hills by the action of small streams carrying the silt from the hills into the valleys and depositing it in a comparatively level formation. The texture is finer than that of the Palouse and Helmer series. Being in the bottom of the valleys, the soils are sometimes in need of drainage in the spring. This lack of drainage makes the season later on this soil than on those surrounding it, and also sometimes makes the wheat grown upon it lodge. The series is higher in its content of organic matter than any of the other soils of

the county except the Potlatch silty clay loam. It is also high in nitrogen. Neither the depth of the surface soil nor that of the subsoil is so great as in the hill soils. As an illustration of this type, we may cite the flat upon which the county fair grounds at Moscow are located. The flat thru which Cow Creek runs just above the town of Genesee is another illustration. Figure 5 shows Paradise Creek running thru this type in the flat east of Moscow. The air drainage over this type of soil is not so good as that over the hill soils and causes an earlier frost in the fall and a later frost in the spring.

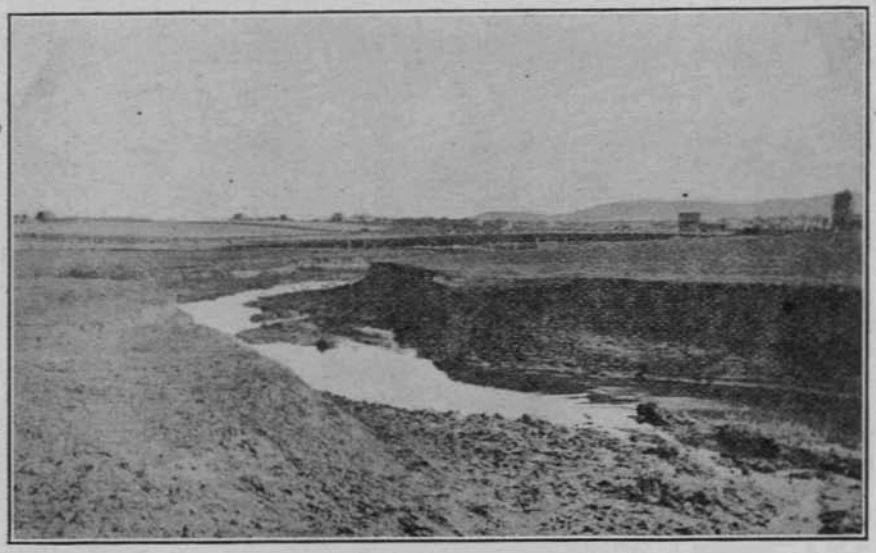

FIG. 5. Caldwell silt loam on Paradise Creek east of Moscow.

Adaptation of the series.—Because of its high moisture supply, the Caldwell series excels both the Palouse and the Helmer series for hay production. Pasture lasts for several weeks longer upon it than upon the others. Peas do well upon this soil and potatoes generally produce a very satisfactory crop. Because of its lower temperature and the lower temperature of the air over it, this series should never be planted to corn, beans, or vegetable garden crops that are very sensitive to frost. Grains generally do well, but sometimes fail to fill properly owing to the high nitrogen and moisture content of the soil during the ripening season.

Similar calculations to those used with the two preceding series show the amounts of plant food per acre-foot given in Table VII.

Table VII.—Amount of plant food per acre-foot in Caldwell silt loam. (*Pounds*)

Plant food	Nitrogen	Carbonate of Lime	Potash K_2O	Phosphoric Acid P_2O_5
Amounts	7,500	2,727	49,800	10,430

Carbonate of lime is the one thing that these figures indicate as being deficient. The addition of a ton per acre of ground limestone or air-slaked lime will improve the tilth of this soil and corect the slight acidity that may come from poor drainage. Improvement of texture will cause the soil to warm up earlier than usual in the spring. Altho the nitrogen supply is high in this type, this essential plant food should not be neglected in the consideration of conservation. Pasturage, which is now quite general, is a good method of conservation on this type. The immediate need of this soil is drainage. Drainage will prevent, to a large extent, the lodging of grain and will enable the soil to produce pasturage earlier in the summer.

It is urged that pastures and hay crops should form the basis of the rotations used on this soil. These with the introduction of peas and hoed crops such as potatoes would form a well balanced rotation system. Where the drainage is even moderately good, the grains, especially oats, can also be used with profit. Approximately 15,000 acres are found in this series.

Potlatch Series

The Potlatch series, in the eastern part of the county, conforms to the Caldwell series in the western part. Its only representative in the area is the Potlatch silty clay loam. It occupies the low-lying valleys between the hills of the Helmer series. The clay content, which is high, characterizes it and separates it from all other soils of the county. In organic matter it is high also.

Table VIII gives the amounts of plant food per acre-foot in this series calculated in the same manner as with previous series.

Table VIII.—Amount of plant food per acre-foot in Potlatch silty clay loam. (Pounds)

Plant food	Nitrogen	Carbonate of Lime	Potash K_2O	Phosphoric Acid P_2O_5
Amounts	15,000	19,773	55,200	6,240

But very small areas of this soil have been broken up. It produces a splendid growth of native pasture grasses and is therefore used as natural pasture by the farmers living upon the higher soils. Occasionally areas are found that have not been covered with timber; these have been broken, but where the land is covered with timber, it is doubtful whether or not the timber should be removed to break the land. At this stage of the development of the country such a procedure is not advised. As the large area of Helmer series in the near vicinity is of much better texture for general farming, it is urged that the Potlatch series should be left for pasture until the whole of the Helmer series has been brought under crop.

Little can be said about this series for the adaptability to crops other than what has already been said. Practically none of it is now under cultivation. However, it seems logical to assume that crops that grow well on the Caldwell will also grow well on the Potlatch series. Such boggy areas as Hog Meadows and Moose Meadows are included in this

type. It is thought that they conform closely to the Clyde series of the Great Lakes area which was formed by the decomposition of peat, which has become so mixed with silt and fine sand as to form a sort of mucky loam. The low-lying areas in which this soil is laid are often incompletely filled marshes and so need drainage upon being subdued from the forest. There are less than 10,000 acres of this type in the county.

Moscow Series

The Moscow series consists of sandy or sandy loam soils upon the higher elevated areas. A large area of it is mapped on the top of Paradise Ridge. Another is on the top of Moscow Mountain. A third is at the top of Hoodoo Mountain. It is essentially a mountain soil. Originally this series of soil was covered with timber and at the present time, by far the greater part of it is still covered. It is largely residual in character, being formed from the underlying rocks. However, a large part of loessial material is mixed with it. Usually its mica content is high. The plates glisten in the sun. Its color is red and its texture such that it will not hold the moisture well.

Of the four plant-food substances spoken of in connection with the preceding series, Table IX gives the amounts in an acre-foot of soil, calculated as previously explained.

Table IX.—Amounts of plant food per acre-foot in Moscow sandy loam.

Plant food	Nitrogen	Carbonate of Lime	Potash K_2O	Phosphoric Acid P_2O_5
Amounts	2,400	4,772	72,000	12,510

After the land is cleared of timber and underbrush the first matter to be considered is the neutralizing of the slight acidity of the soil, and the next is the building up of the nitrogen and organic matter in the soil. Essentially the same procedure as that outlined for the Helmer series should be followed here. See page 17.

Being higher by several hundred feet than the lands surrounding it the soil of this series receives a larger amount of moisture during the growing season. Therefore satisfactory crops not easily injured by frost are obtained. The higher areas are too subject to killing frosts to produce anything but the very hardiest kind of plants. They do produce good natural pastures and for this purpose the farmer uses the Moscow series almost exclusively. Two types of the series are mapped, the sand and the sandy loam. The chemical and physical composition of the loam are given in columns 7 and 8 of Table II, and lines 7 and 8 of Table IV.

Yakima Series

Only the Yakima series remains to be described. Its physical characteristics identify it with a soil that has previously been described from the Yakima area of Washington. This type of soil lies within the Potlatch and Bear Creek valleys and thus the area is very restricted. The soil is alluvial and, being deposited in rather swiftly running water, is coarse in texture—a sandy loam. The organic matter in it is low, the

nitrogen content is low, and the amount of moisture that it receives as rain is low. Irrigation is pacticed wherever the series is used.

The series is splendidly adapted to the growing of vegetables, and is put to that use almost exclusively. Being 1500 to 2000 feet lower, it is earlier than the hill soils in the vicinity by two or three weeks. Application of nitrogenous fertilizer can be made on soil of this type with considerable profit when it is used for gardens. This fertilizer may be barnyard manure.

No analysis of the Yakima sandy loam has been made. It is much more abundant in Nez Perce county, the survey of which has been almost completed. In the report on that county the analysis of this type will be given and discussed.

Rough Stony Land

Aside from these series of soils, about 200 sections of the county outside of the forest reserve are mapped as rough and mountainous land. A large part of the elevation known as Moscow Mountain is thus mapped. In the eastern part of the county where the rivers cut into the contour to quite a depth, rough and stony land appears along the edge of the river. In some places the areas produce a heavy growth of timber. The walls of the canyons are usually of basaltic rock, whereas the elevations are of granitic or schistose rock. Potato Hill is the only elevation that is of basalt.