STATION CIRCULAR 90. DECEMBER, 1928.

Meaning and Use of Willamette Soil Survey

Agricultural Experiment Station
Oregon State Agricultural College
CORVALLIS

TABLE OF CONTENTS

Meaning and Use of Willamette Soil Survey

By

E. F. Torgerson and W. L. Powers

Soils vary greatly, and for any adequate plan of soil improvement a definite knowledge of various existing kinds or types is a first essential just as in classifying plants or breeds of livestock. To know that a farm contains Carlton silt loam should suggest a group of characteristics just as it should to learn that the place maintained a herd of pure-bred Jersey cattle.

During the past decade soil surveys of all Willamette Valley lands outside the National Forests have been completed by the Agricultural Experiment Station in cooperation with the United States Bureau of Soils covering approximately six million acres. County soil reports and maps are now available for six of the nine counties surveyed and the other three will be published soon.

This circular is intended to help farmers, landowners, land appraisers, and county agents to make use of the fund of information accumulated, so that every farmer may learn to recognize and understand the characteristics of the type or types of soil which are found on his farm, their average composition, crops for which they are suitable, as well as fertilizer needs and soil management methods that should be helpful in soil improvement. Data from experiment fields representing the more extensive types of soil and modern methods of their management are being made accessible through a series of publications issued as a phase of Oregon Soil and Soil Water Investigations.

Value of soil surveys. (1) A soil survey serves as an invoice of the agricultural resources of the country. (2) It gives the farmer information as to methods of soil maintenance and management. (3) It aids the new settler in selecting a location and getting started right. (4) It guides the county agent or soil specialist in advising settlers. (5) It forms a basis for the introduction of new farm crops and practices. (6) It is a valuable guide to the determination of irrigation requirements or feasibility of drainage for different soils. (7) It is useful in locating highways. (8) It lays the foundation for investigations for developing a permanent system of agriculture for every kind of soil and every farm. (9) It furnishes the basis for systematic study of fertilizer needs of different soil types.

Soil surveys of the state should be completed to enable permanent systems of agriculture to be worked out before the virgin fertility is reduced to the point of unprofitable production.

Soil development. Soil may be regarded as a natural, dynamic body, the characteristics of which are determined mainly by climatic conditions and associated plant and animal activities during the time of exposure to weathering. Soil is composed of weathered rock particles and their end products together with organic residues, yet the characteristics of a mature

soil are determined primarily from internal rather than external conditions. Soil may be regarded as having an inert mineral skeleton and an active colloidal covering which is the seat of life of the soil body. As a soil matures, it loses the characteristics of the parent materials and comes to have those acquired as a result of the climatic zone in which it ages.

The soil profile (Fig. 1). A soil profile includes all that may be seen in a fresh vertical cut through the soil layers and into the underlying soil material like a piece of layer cake. Field studies include texture, struc-

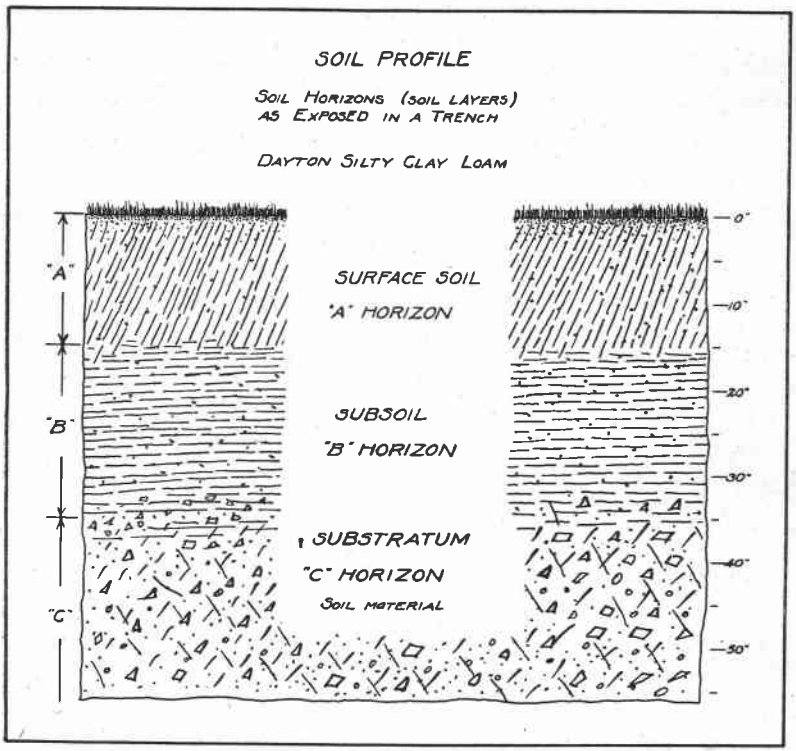


Fig. 1. Profile of Dayton soil profile as exposed in a tile trench.

ture, color, reaction, and organic matter profile characteristics of the different soil layers or horizons. Therein is recorded the history of the soils development. Modern soil classification is based upon these characteristics of the soil itself and not upon the forces or conditions producing them. Some characteristic profiles of the area are sketched (Fig. 2).

Soil horizons. A layer or section of the soil profile, more or less well defined and occupying a position parallel to the soil surface, is called a soil horizon. In a humid climate, some leaching of soluble and translocation of the very fine material from the surface soil into the subsoil occurs,

causing a more dense, compact, less aerated layer or layers below. There is also an accumulation of organic matter in natural surface soils. This weathering of soil material in a humid climate results in a leached *elluvial*

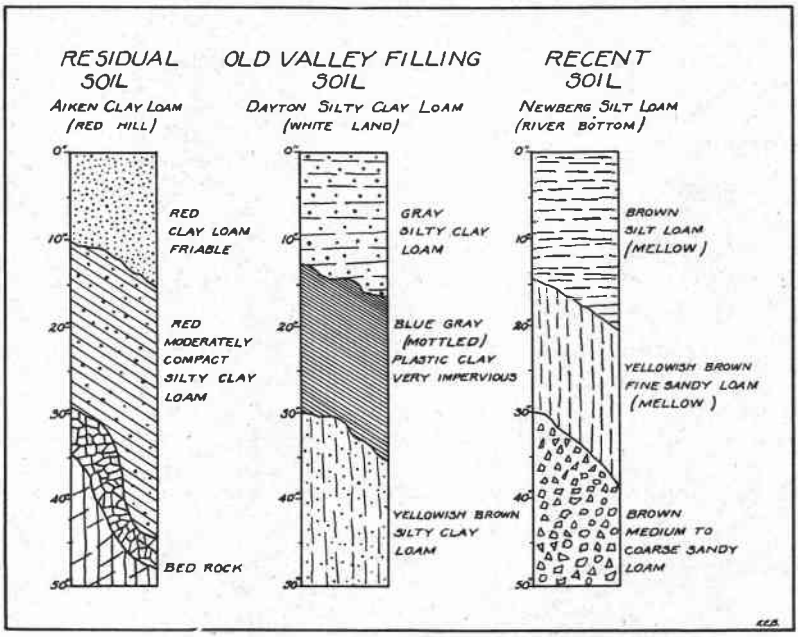


Fig. 2. Typical profiles of soils belonging to different groups.

(A-horizon) or layer, often called the surface soil, and an *illuvial* zone of accumulation (or B-horizon) commonly called the subsoil.

Soil groups (Fig. 3). A scheme of soil classification to be natural and logical should group together those soils that have most in common. Soils of the Willamette Valley region fall into the following three distinct *groups*:

A. Recent alluvial soils, or young soils of the river and stream bottoms with rather uniform profiles and friable subsoils.

B. Old Valley filling soils of the Valley floor including more or less mature soils with moderately compact subsoils, consisting of mixed though largely basaltic material.

C. Residual hill lands, composed of residues of rock materials which have weathered in place, and of variable depth over the underlying parent rock material.

Soil series. Soils of the above groups are divided into series which include soils similar in respect to (1) range of color, (2) subsoil conditions as structure and color, (3) topography, (4) drainage, (5) common origin, and (6) agricultural value. Example: Willamette series or the brown,

gently undulating, naturally drained soil in the old Valley filling group. Owing to different areas of different fineness or coarseness as judged by kneading the moistened soil and feeling its texture between the fingers, a soil series may include several textural classes.

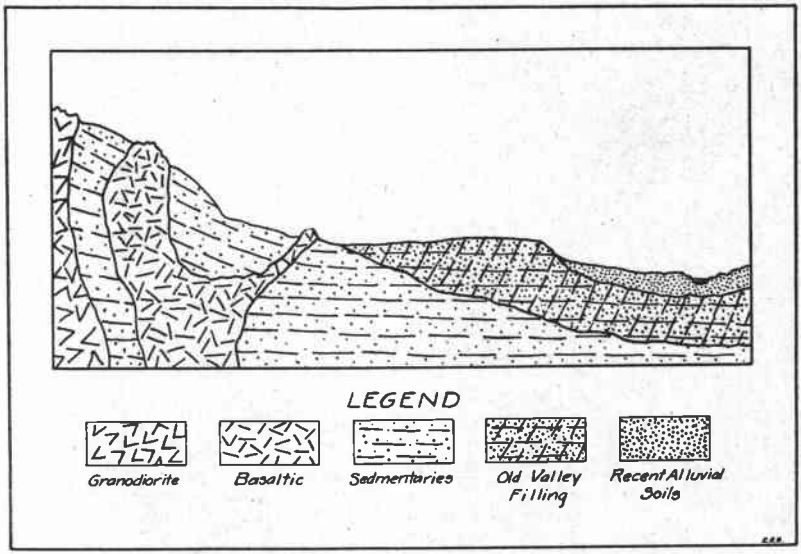


Fig. 3. Geologic section from Coast Range to Willamette River, showing river-bottom, Old Valley filling, and hill groups.

Soil class. All soils of similar texture may be grouped in a class; e.g., clay loams. Constituent mineral particles of soil range from stone to those too small to be seen with a microscope. Particles below two millimeters in diameter are divided by the United States Bureau of Soils into seven classes (see Appendix, page 16).

A. Mineral matter: coarse, medium, fine, very fine sand, silt, and clay. Sizes given page 16.

B. Organic matter. Partly decayed vegetable or organic material is present to some extent.

Mechanical analysis consists in separation of soil into these groups to verify field judgment and determine the soil class. Soils are mixtures of particles of various sizes. Six principal groups of textural classes of soils are:

Sands—less than 20 percent clay.
Sandy loams—20 to 50 percent silt and clay.
Loams—50 percent or more of silt and clay.
Silt loams—50 percent or more silt, 20 percent or less clay.
Clay loams—20 to 30 percent of clay.
Clays—30 percent or more of clay.
Peat—50 percent or more of organic matter.
Muck—15 to 50 percent organic matter plus much silt and clay.

Clay properties predominate over those of other consituents so that 20 percent clay makes a clay loam and more than 30 percent a clay soil.

The accompanying diagram (Fig. 4) will facilitate determination of soil class.

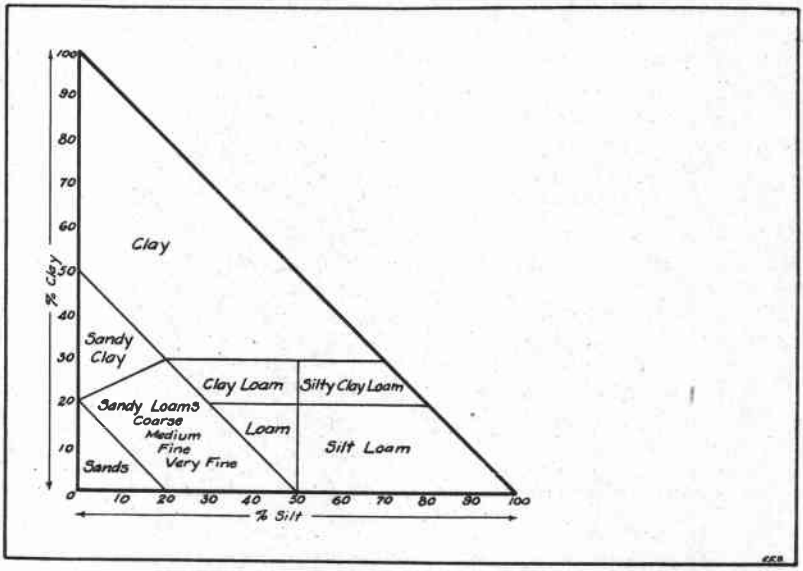


Fig. 4. Diagram for use in determining of soil class.

To use the diagram after estimation or determination of the percentage of different soil constituents, find a point on the base corresponding to percentage of silt and on the perpendicular a point for the amount of clay, then drop perpendiculars into the triangle from these boundary lines to the point where the two lines intersect to determine soil class. A soil class includes all soils having the same texture, such as clays, clay loams, etc.

Soil texture refers to the average or effective degree of fineness of a soil. Individual soil particles are irregular in shape and vary in size.

Soil separates such as clay, silt, and sand have definite physical properties which they impart to soils. The finer constituents like silt or clay increase the absorptive capacity of soils and usually retain more plant nutrients and beneficial bacteria.

Clay as a soil constituent is very fine, has high porosity, great surface area, great absorptive capacity, is plastic, sticky, shrinks on drying, and absorbs or gives up water very slowly.

Collodial clay is the finest of soil material with enormous absorptiveness and other properties of clay possessed to a high degree.

Silt includes particles too fine to be detected with the fingers. It feels mealy rather than sticky. Silt makes up the bulk of the great alluvial

soils of the world. Silt has good retentive power and capillary properties and permits fair aeration.

Sands are divided by sieve analyses into coarse, medium, fine, and very fine sand. Sand imparts earliness and free working qualities, permits rapid percolation, but dries out rapidly. It is inclined to "blow." In humid climates sands are inclined to become "leached out." Fine sand is more desirable as a soil constituent than coarse.

Gravel when present in moderate amount and well filled with fine earth may help form a mulch or aid soil in warming up. A large amount of "wash gravel" makes a soil dry out too rapidly.

Normal soils are mixtures of these components, gravel, sand, silt, and clay; and soil properties depend on their collective effect.

Soil structure refers to the arrangement of soil particles. Crumb structure or *good tilth* prevails when the soil particles are held together in clusters, like popcorn after sirup is added, with pore spaces between particles and larger spaces between clusters. *Puddled structure* or a "run together" condition is more like cement, having finer particles filtered in between the larger ones, reducing pore space to a minimum. Texture and structure affect aeration, capillarity, root space, and drainage of soil. Structure may be modified by tillage, liming, organic matter additions, or drainage or even by irrigation.

Sand is loose and single grained. The individual grains can readily be seen or felt. Squeezed in the hand when dry, sand falls apart when the pressure is released; squeezed when moist it forms a cast, but crumbles when touched.

Sandy loam is soil containing much sand together with sufficient silt and clay to make it somewhat coherent. The sand grains contained can readily be seen and felt. If squeezed when dry sandy loam will form a cast which will readily fall apart, but if squeezed when moist it will form a cast which will permit careful handling without breaking.

Sands and sandy loams are classed as coarse, medium, fine, or very fine, depending on the proportion of the different sized particles present.

Loam is soil having a relatively even mixture of the different grades of sand and of silt and clay. It is mellow with a somewhat gritty feel, yet fairly smooth and slightly plastic.

Silt loam is soil having a moderate amount of the fine grades of sand and only a small amount of clay, more than half of the particles being of the size called "silt." When dry it appears rather cloddy, but the lumps can be readily broken, and when pulverized it feels soft and floury.

Clay loam is fine textured soil which breakes into clods or lumps that are hard when dry. When the moist soil is pinched between the thumb and finger it forms a thin "ribbon" which breaks readily, barely sustaining its own weight. Such soil is plastic when moist.

Clay is a very fine textured soil that forms very hard lumps or clods when dry, and is quite plastic and usually sticky when wet.

Characteristics of chief soil classes follow.

Soil types. The unit of classification is the soil type and is based on the following characteristics:

(1) Geological origin of the soil whether residual, glacial, alluvial, etc.

(2) Topography or lay of the land.

(3) Native vegetation such as forest or prairie grasses.

(4) Structure or depth and character of surface, subsoil, and substratum.

(5) Physical or mechanical composition of the different soil layers, such as percentage of gravel, sand, silt, clay and organic matter which they contain.
(6) The texture or porosity, granulation, friability, plasticity, etc.
(7) Color of the strata.
(8) Natural drainage.
(9) Agricultural value, based upon its virgin fertility or productiveness.
(10) The ultimate chemical composition and reaction.
(11) Organic content.

Naming of soils. The name of soil type consists of two parts: (a) the name of the series and (b) the texture of the particular member of the series.

Soil type { Series—All other properties / Class—Texture of surface soil

Example: (a) Dayton (b) silt loam makes Dayton silt loam soil.

(a) The first refers to the series to which the soil belongs as determined by series characteristics above described. In the cooperative work, the method of the United States Bureau of Soils is followed and the series names are taken from the localities where the series were first established and mapped. Since Yamhill was the first county for which a soil survey was made in the Willamette Valley, several names of places in that county were adopted for soil series. For example, the "white land" was first mapped in Dayton prairies and designated a soil series.

(b) The second part of the name shows the textural class of the surface soil of the series to which the particular types of soil belongs, such as silt loam, silty clay loams, etc. Dayton soil series might include several textural classes. Heavy textured soils predominate in the Willamette Valley so that loams, silt loams, and silty clay loam belonging to different series are common.

Key to Willamette Valley soils. The accompanying diagram (see inserted folder) shows the distinguishing soil series characteristics and the subgroups and major groups to which they belong. Only the more important series can be mentioned here.

Recent alluvial soils of the Willamette river bottom and its tributaries have relatively young or but slightly differentiated profiles. *Newberg series* includes soils of the first bottom deposited in moving water and having coarser textured subsoils. *Chehalis soil series* occupies the second bottoms and was probably formed largely by stream disposition from back-water. While its profile is also young, it has weathered sufficiently long to have had fine material carried into the subsoil so that it is slightly heavier in texture than the surface. Both Newberg and Chehalis soils are brown, gently undulating bottom-lands with yellow-brown subsoils and good natural drainage.

Another important soil of this recent group is designated *Wapato series.* These are ash-swale steeple-brush lands which occur extensively along the Long Tom river and other streams and are frequently uncleared pasture lands. The series runs to heavy textured types of soils, well supplied with organic matter but with mottled subsoil and imperfect drainage. Table 1

TABLE I. APPROXIMATE AREAS OF WILLAMETTE VALLEY SOILS

	Acres
Total area outside National Forests	5,939,323
Area adapted to irrigation. (Newberg, Chehalis, Columbia, Sifton, Hillsboro, Willamette)	500,000
Area needing tiling. (Amity, Dayton, Wapato, Cove, Whiteson, Sauvie, Peat, Viola, Carlton, Grand Ronde, Concord, Holcomb)	711,000
Area needing district outlet ditches	250,000
Area suitable for and requiring clearing (estimated)	250,000

Note: C—Clay; L—Loam; SiCL—Silty clay loam; Gr.—Gravel; S—Sand.

Recent group	Range in types	Improved (Estimate) %	Acres
Chehalis (second bottoms)	FSL—SiCL	60	177,000
Newberg (first bottom)	SL—SiCL	60	80,000
Columbia	SL—SiL	80	6,144
Camas	SL—SiL	60	3,000
Cove (Black sticky)	C	60	25,000
Wapato (Brown sticky)	SiL—SiCL	50	150,000
Whiteson (Bottom white land)	SiL—SiCL	70	6,000
Sauvie (Steeple brush land)	SiL—SiCL	75	24,000
Toutle	GrS	75	4,840
Peat and Muck (Beaverdam)		75	15,000
Riverwash		5	7,000
			497,984
Old Valley Filling			
Willamette	L—SiCL	90	330,000
Amity (half white land)	SiL—SiCL	85	250,000
Hillsboro	L	90	12,000
Salem	Gr—L—GrSiCL	80	75,000
Dayton (white land)	SiL—SiCL	70	90,000
Grand Ronde	CL—SiCL	70	8,000
Powell	SiL	80	46,000
Sifton	GrL—SL	75	5,000
Clackamas	GrL—SiCL	65	18,000
Concord	SiL	80	15,000
Holcomb	SiCL	70	10,000
Salkum		80	22,000
Veneta		60	20,000
Courtney		60	15,000
			916,000
Hill Group			
Olympic (on Basalt)	L—SiCL	60	555,000
Aiken (on Basalt)	CL—SiCL	70	300,000
Viola (on wet subsoil)	CL	50	15,000
Melbourne (on Sandstone)	L—C	70	426,000
Sites (on sandstone)	CL—C	75	45,000
Carlton	SiL—SiCL	80	100,000
Cascade	SiL—CL	75	90,000
Polk		90	3,000
Waldo		85	15,000
Rough stony land		0	30,000
Rough, broken and stony land		0	300,000
Rough Mountainous		0	1,468,400
			3,347,400
Miscellaneous			1,158,363

shows the series of different groups of soils with popular names indicated in many cases and gives the approximate areas and estimated percentage of improved land in each.

Old Valley Filling Soils, or old alluvial material of the Valley floor, includes brown soils having good natural drainage as one general subgroup and soils ranging from gray to dark in color with mottled subsoils included in another group. *Willamette series* includes about one-third million acres and is one of the extensive and valuable agricultural soils of the Valley. It is brown, slightly undulating land with yellow brown subsoil and good natural drainage. *Dayton series* includes much of the so-called "white land" and is a leading representative of the soils having poor drainage. Dayton series has a gray surface soil which changes at ten to sixteen inches depth to a bluish-gray mottled waxy horizon which continues to a depth of thirty to forty inches from the surface. Below this the substratum becomes more friable and is similar to the deep subsoil in the Willamette series. Known information concerning the improvement of these two important soil series is reported elsewhere in special bulletins.

The Residual soils of the so-called red hills fall into two subgroups, those derived from weathering of (A) basaltic rock and (B) sedimentary sandstone, shale, and tuffaceous material.

(A) The leading representatives of the basaltic group is the *Olympic series* which occurs extensively in the Waldo Hills section. This is a rich brown or reddish brown soil with friable structure and bright red subsoil resting on basaltic soil material or even solid basaltic rock.

Aiken is a series name for a bright red soil underlaid with basaltic rock of good texture. The Aiken soils are well adapted to the production of nuts and stone fruits.

(B) *Melbourne series* is a leading representative of the residual soils of sedimentary rock. It is light brown to reddish brown or even buff color with a yellowish subsoil resting on sedimentary soil material. Associated with the Melbourne series in the sedimentary subgroup is the more brightly colored reddish brown *Sites series.* The low slopes in this sedimentary formation give rise to gray brown soils of the Carlton series.

Soil survey field methods. The detailed soil survey of an area consists in ascertaining and indicating on a map the extent and location of each type. Equipment used in the work consists of an accurate base map, compass, colored pencils, drawing instruments, speedometer, odometer or pedometer, soil augers, and perhaps a conductivity bridge, filter, and simple reagents for testing soil reaction. Each soil type is represented on the map in a different color. The usual scale is one square inch per square mile. All roads, streams, houses and other landmarks are indicated on this map. The area occupied by each soil type established is shown in a separate color. The field party of two trained soil surveyors traverses each road in every section and works out over the land in each forty-acre tract indicating the character of soil on the map after test holes or fresh exposures have been examined. Soil areas as small as five to ten acres are shown in the tillable sections while smaller areas or variations are usually described in the report.

Each type of soil in the county is sampled when the field work is nearly completed and these samples are taken to the laboratory for analysis.

TABLE II. RECOMMENDATION FOR THE MANAGEMENT OF WILLAMETTE VALLEY SOILS

Soil series	Major soil groups	Important requirements	Crops benefited	Time and method of applying fertilizers	Rate per acre
Aiken Olympic Sites Melbourne	Red hill soils	Superphosphate	Clover, potatoes, grain, corn	Once in 3-year rotation ahead of cash crop. Broadcast on land or drilled in with fertilizer attachment on planter	200 to 300 pounds
		Lime	Clover on old grain land	Broadcast before seeding down	2 to 3 tons
		Land-plaster	Legumes	Broadcast	100 pounds
		Nitrates	Potatoes, corn and grain when following non-legumes	Broadcast	100 to 200 pounds
Salkum Salem Willamette	Valley soils, well drained	Superphosphate	Grain and potatoes	Same as for red hill soils	
		Nitrates	Potatoes when following non-legumes	Broadcast	100 to 200 pounds
Amity Holcomb Dayton Grand Ronde	Valley soils, wet, heavy, "white," and "half-white" land	Lime—after drainage	Clover	Broadcast before seeding down	2 to 3 tons
Chehalis	Brown second bottom soils	Land-plaster	Wheat, barley, legumes		
Newberg	Sandy first-bottom soils	Phosphate with nitrates	Alfalfa, clover, potatoes, corn, grain, beans		Same as for red hill soil
		Land-plaster	Legumes		
Wapato Cove	Recent alluvial soils dark	Drainage	Alsike clover, beans, hairy vetch		

Note: All Valley soils need organic matter. Rotation and manure prove very profitable. Gypsum is excellent for clover and young alfalfa.

Use of the soil map. In map reading it is convenient for most persons first to place the map with the top to the north. Then locate a few of the towns or main landmarks and trace the roads to the locality to be studied. Turns or road corners, farm lanes and buildings will help in identifying the field to be examined. Houses are shown by means of small black squares, main roads by means of solid double lines, and secondary roads by double dotted lines. Streams which flow the year around are indicated by single blue lines. Intermittent streams are shown by broken blue lines. Within each color area is an abbreviation for the soil type name, and the legend on the margin of the map will show the name of the soil type which the color and symbol represent. The legend will also show the scale or inches per mile on which the map is drawn. Soil maps are sectionized to show the township, range, and section numbers. Digging test pits in the larger areas should help one to become familiar with the characteristics of any particular type. All wet soils of the Willamette Valley have mottled subsoils, the light drab, gray, and yellow colors indicating lack of oxidation where water periodically excludes air.

The soil report and its use. A description of each soil type will be found in the soil report in which the county soil map is enclosed. Careful reading of the description of the soil or soils shown on the map as occurring on any legal subdivision will supply information as to characteristics, drainage, crops suitable, range in value, and the means of soil improvement. The report also describes the physiography, climate, agriculture, transportation, and market conditions for the area.

Use of Experiment Station soil plot and analytical data. Chemical analyses have been made of official samples of most soil types from each county or area, and field or greenhouse fertilizer trials have been made with leading soils of the Valley. A fund of information thus accumulated is of great value in advising farmers. This information is being made available in a series of bulletins dealing with special subjects. These studies are calculated to help develop permanent systems of agriculture for these soils. A summary of general recommendations is given in Table II.

Crop rotation is of first importance in maintaining productiveness of Willamette Valley soils. Use of barnyard manure, green manure, and crop residues is very beneficial. Liming is helpful on the wet soils of the Valley floor following drainage and is most needed on the red hill lands which are the most acid sorts. Tiling is needed for nearly a million acres, and half a million acres in the Willamette Valley will respond to supplemental irrigation.

Land-plaster is profitable with legumes such as clover and alfalfa and should be applied very early in the spring. Superphosphates should help the grain yields especially on the older cropped soils and the lighter textured soils in the lower Valley. Potash pays on the local peat areas.

Field examination and judging of soils. The main points in judging a prospective farm are the depth and character of the soil. The soil should be uniform and at least 4 to 6 feet deep. Native vegetation and climatic conditions including the amount and distribution of rainfall and the dates of first and last killing frosts are important. The agricultural experience, kind

and yield of crops that have been grown in the district (as well as public improvements, community indebtedness, transportation and market conditions), should be considered.

The *depth* of soil should be determined by the use of spade or auger. A simple soil auger is made from a carpenter's wood auger by welding it to a half-inch gas pipe which may be cut into 18- or 36-inch sections with extensions and connections for reaching to a depth of six feet or more. A much larger number of test holes may be made in a limited time with an auger of this kind and it is more conveniently carried. Test holes should be made in a number of representative places. A gravelly substratum or hard-pan will be revealed by such examination.

The working properties of the soil may be determined with the fingers, and the percentage of sand, clay, and organic matter may be estimated by putting a tablespoonful of soil into a tumbler partly filled with water, shaking up and allowing it to settle. The coarse layer will form the first layer in the bottom, and the organic matter will tend to float on the surface. Observations and notes taken according to the accompanying form (see Appendix) will be helpful in identification of the soil type.

APPENDIX

HOW SOILS ARE IDENTIFIED FROM SOIL SAMPLES COLLECTED IN THE FIELD

The characteristics of the Soil Profile, together with other data listed below, must be known before the soil can be correctly named according to the Standard Soil Classification method of the United States Bureau of Soils.

PART I. FACTORS TO BE OBSERVED AND RECORDED IN THE FIELD BEFORE SOIL SAMPLES ARE TAKEN.

Record opposite each main group listed below that one of the subgroups A or B or C which best describes your soil.

1. Position
   - A. Residual (Hill Soils) .....
   - B. Old Valley filling (High Terrace) .....
   - C. Recent (Overflow Bottom soils) .....
2. Origin—(Kind of rock)
   - A. Igneous rocks (Basalts, etc.) .....
   - B. Sedimentary Rocks (Sandstone, shale) .....
   - C. Mixed .....
3. Topography
   - A. Level .....
   - B. Undulating .....
   - C. Rolling .....
4. Drainage
   - A. Poor .....
   - B. Medium .....
   - C. Excellent .....
   - D. Excessive .....

PART II. FACTORS TO BE OBSERVED AND RECORDED AS SOIL SAMPLES ARE TAKEN.

Soil samples must be taken by horizon.
Each horizon (layer) must be carefully studied and thickness and depth of each recorded.
The main points to observe are:

a. **Color** of each horizon (layer) if soils have mixed colors, state main color and others present.

b. **Texture** of soils class of each horizon (is it a loam, clay loam, etc.) State whether sand, gravels, rock, etc. are found in any layer.

c. **Structure** of each horizon (namely, is horizon loose, mellow, moderately compact, very compact, tight, or is it cemented enough to have a hard pan.)

	Soil horizons		
	Surface	Subsoil	Substratum
Depth of each horizon			
Color			
Texture (Soil Class)			
Structure			

PART III. NAMING THE SOIL.

Consult inserted folder, Key to Willamette Valley Soils.

Determine to which of the three main divisions your soil belongs.

a. Residual
b. Old Valley filling
c. Recent

If your soil is residual, then consult the residual group in the key and locate the name of the soil which has all the characteristics of your soil.

JUDGING TEXTURE OF SOILS (SOIL CLASS)

Soils are composed of particles ranging in size from the finest clays and colloids, to coarse gravels and stones. The Bureau of Soils places particles within a certain range in size into 7 groups called SOIL SEPARATES.

Each SOIL SEPARATE has the following characteristic feel when particles in each group are moistened and rubbed between the fingers.

1. Fine gravel (2-1) is very gritty
2. Coarse sand (1-5mm) is very gritty.
3. Medium sand (5-.25mm) has medium grittiness.
4. Fine sand (.25-01mm) is slightly gritty.
5. Very fine sand (01.-05.) is very slightly gritty. Particles are so fine it is hard to recognize gritty feel.
6. Silt (05.-005) is very fine, smooth, velvety, floury, very slightly plastic.
7. Clay (.005-less) has very fine particles, smooth, velvety, floury properties similar to silt but in addition is very plastic.
8. Colloid .001 mm or less (ordinarily included in 7); properties similar.

Soils exhibit what is known as a characteristic feel when the correct amount of moisture is added and when the sample is carefully rubbed between the fingers.

CLAY SEPARATES impart a very plastic (sticky) feel to the soil.

SILT SEPARATES impart a smooth, floury feel.

SAND SEPARATES impart a gritty feel depending on the degree of coarseness or fineness of the sand in the soil.

Soils are a mixture of seven separates. The feel will depend on a blending combination of all. Equal amounts of sand, silt and clay separates vary in their ability to impart their characteristics to a soil.

(1) As shown by the triangle, a comparatively small percentage of clay imparts its dominant characteristics to the soil to a marked degree. It requires only 25 percent of clay to class the soil as a clay loam.

(2) Silt separates are next in importance in determining soil characteristics.

(3) Sand has least influence in soil characteristics except as it improves the physical condition.

THE IMPORTANT SOIL CLASS TERMS used in soil survey in the United States are:

1. Coarse sand
2. Medium sand
3. Fine sand
4. Very fine sand
5. Coarse sandy loam
6. Medium sandy loam
7. Fine sandy loam
8. Very fine sandy loam
9. Loam
10. Silt loam
11. Clay loam
12. Silty clay loam
13. Clay

1. A representative sample of the soil in question about the size of a walnut is placed in the palm of the hand.

2. Add sufficient water drop by drop until the soil appears to have moisture content for optimum plant growth.

3. Rub the sample with the thumb to detect presence of sand.

4. Add more water drop by drop to determine whether additional moisture makes the sample feel (1) gritty, (2) smooth or velvety or (3) smooth, velvety, and plastic.

Consult the groups listed below and determine which one of 13 soil class terms best describes the soil you have examined. A considerable amount of practice is required to name soil class correctly.

A. Soils will be grouped as one of the following soil classes when sand separates very largely predominate, with very small amounts of silt or clay separates present.

1. Coarse sand soil—sample will feel very gritty.
2. Medium sand soil—sample will have medium grittiness.
3. Fine sand soil—sample will have fine gritty feel.
4. Very fine sand soil—particles are so fine difficult to detect.

(Sands contain less than 20 percent of silt and clay combined.)

B. Soils will be grouped as one of the following soil classes when sand separates predominate and there is also sufficient silt or clay to give the soil body.

5. Coarse sandy loam
6. Medium sandy loam
7. Fine sandy loam
8. Very fine sandy loam

Each group is much the same as above, but there is much less of the gritty feel in each case, as there is a moderate amount of silt and clay to cover up the distinct gritty feel.

Sandy loams contain 20 to 50 percent silt and clay combined, but do not have more than 15 percent clay.

C. 9. Loam.

A loam is a soil having a relatively even mixture of different grades of sand, silt, and clay. IT IS MELLOW WITH A SOMEWHAT GRITTY FEEL, YET FAIRLY SMOOTH AND SLIGHTLY PLASTIC.

Loams have more than 50 percent of silt and clay combined, but less than 50 percent of silt and less than 20 percent clay.

D. 10. Silt loam

Soil will be classified as a silt loam when it has over 50 percent silt, less than 20 percent clay, and the remainder sand. SILT LOAMS HAVE A VERY SMOOTH, VERY SLIGHTLY GRITTY, AND SLIGHTLY PLASTIC FEEL.

E. 11. Clay loam

Clay loams have a very smooth, velvety, floury feel and MEDIUM PLASTICITY.

Clay—20 to 30 percent
Silt—50 percent or less
Sand—Remainder

F. 12. Silty clay loam

Silty clay loams have a very smooth, velvety, floury feel. The soils are MODERATELY PLASTIC (more plastic than clay loam).

Clay—20 to 30 percent
Silt—50 percent or more
Sand—Remainder

G. 13. Clay soils

Clay soils have a very smooth, velvety, floury feel. The soils are VERY PLASTIC (sticky). The soils are very stiff and compact, and offer considerable resistance when molded in the hand.

Clay—More than 30 percent

Soils that have over 30 percent clay are dominated by the clay characteristics.

DIRECTIONS FOR SOIL SAMPLING

THE PURPOSE OF TAKING SOIL SAMPLES is to obtain information relative to the following points. Where soil surveys have been made, samples are unnecessary for identification.

1. Identification of soil type (most important reason).
2. Soil reaction.
3. Mechanical or chemical composition.
4. Determine percentage of moisture content during growing season.
5. Determine depth to rock, loose sand or gravel, hard-pan, etc.

SOIL AUGER

The soil auger is the best tool for making rapid borings and examinations of soil to a depth of six feet. The soils capacity for root pasturage cannot be seen from the surface. The soil auger, a very inexpensive tool, should be part of the equipment of every good farmer as it can be easily made by welding a ⅛-inch pipe to a wood auger that has the point dished. Pipes cut into 18-inch lengths are then placed together to give the length desired. Where examination is for orchard location, the auger used should be 6 feet long. If soil auger is not available a post-hole auger or shovel may be used.

SELECTION OF SOIL AREA TO COLLECT SAMPLE

1. If you recognize two or three distinct soils on your farm collect soil samples from each.
2. If one of these soils covers 20 acres or more select a spot in this field that will be a representative of the area.
3. In order to know when you have a representative spot, it may be necessary to make three or more borings. There is no better way to find out.

COLLECTING THE SOIL SAMPLE BY HORIZONS (Consult page 15, Part II)

Take samples from an open field and avoid paths, gopher holes, etc., from which modified and not typical samples are likely to be obtained.

SURFACE SOIL

1. Select an average spot, pull up growing plants, brush aside half decayed vegetable matter, and bore or dig a vertical hole to a depth of 8 to 10 inches (plowing depth).
2. Mix the soil well on a piece of cloth or stout paper. Dry this mixed sample; place cupful of soil in clean canvas bag or can.
3. Label carefully—SURFACE SOIL "0-10".
4. If same kind of soil extends deeper state to what depth.

SUBSOIL

5. Bore down below surface soil until you find a change in either
   (1) Color of soil, (2) Texture, (3) Structure
6. Upon reaching another change stop and mix the soil thoroughly and place in bag.
7. Label SUBSOIL (depth found).

SUBSTRATUM

8. Label SUBSTRATUM (depth found).
9. Dig or bore to the depth of six feet, and if hard-pan or other peculiarity in structure is noted, send sample properly labeled. If solid rock is found, state at what average depth.

MISCELLANEOUS INFORMATION WHICH SHOULD ACCOMPANY SOIL SAMPLES

10. Send "Description of Land" giving as complete a history of the field as possible, name of nearest town, probable selling price of land, elevation above nearest river, direction and grade of slopes, drainage, how long cropped, by what crops or fruits, what yields, whether fertilizers have been applied, and any peculiarities which may have a bearing on the agricultural qualities of soil.
11. State the Township, Range and Section Number of the land from which these samples are taken.
12. Do not fail to label samples carefully, placing name of sender on each sample wrapper. Fasten letter to package.
13. Send samples prepaid to

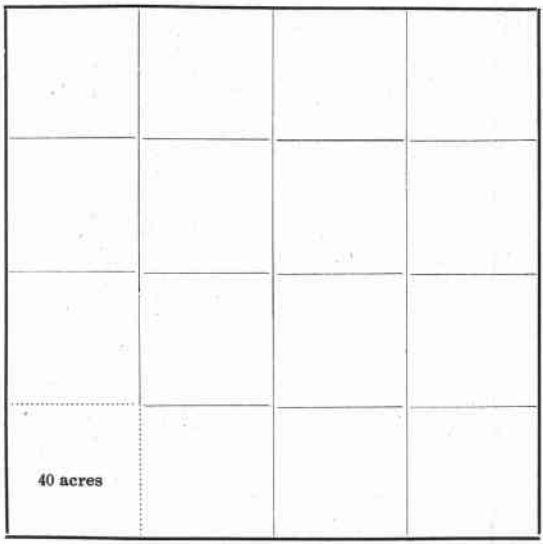
SOILS DEPARTMENT
AGRICULTURAL EXPERIMENT STATION
OREGON STATE AGRICULTURAL COLLEGE
CORVALLIS, OREGON

INFORMATION WHICH MUST ACCOMPANY SOIL SAMPLES

County.....

Legal location: Range..... Township..... Section..... Part of Section.....

1. Fill in Diagram 5 portion of section covered by your farm and sketch to scale the different soils.



Check group to which sample belongs.

Diagram (Section Plot)

Group 1. Recent (Bottom lands).
Group 2. Old Valley filling (Main floor of Valley).
Group 3. Residual (Hill soils).

The answers to these questions will give the Soils department a better idea as to the present condition of each soil type and more complete recommendations can be given.

	Soil	Soil	Soil
1. Is drainage good, medium or poor?			
2. Can clover be grown successfully?			
3. Have you tried lime, and with what results?			
4. Have soils been cropped to grain for years?			
5. Does grain fill well?			
6. Do you consider soil fertile?			
7. What crops do you wish to grow?			

REGENTS OF OREGON STATE AGRICULTURAL COLLEGE

Hon. J. K. Weatherford, *President*.....*Albany*
Hon. E. E. Wilson, *Secretary*.....*Corvallis*
Hon. B. F. Irvine, *Treasurer*.....*Portland*
Hon. I. L. Patterson, *Governor*.....*Salem*
Hon. Hal E. Hoss, *Secretary of State*.....*Salem*
Hon. C. A. Howard, *Superintendent of Public Instruction*.....*Salem*
Hon. George A. Palmiter, *Master of State Grange*.....*Hood River*
Hon. Harry Bailey.....*Lakeview*
Hon. Geo. M. Cornwall.....*Portland*
Hon. E. B. Aldrich.....*Pendleton*
Hon. Jefferson Myers.....*Portland*
Hon. J. F. Yates.....*Corvallis*
Hon. H. J. Elliott.....*Perrydale*

STAFF OF AGRICULTURAL EXPERIMENT STATION

W. J. Kerr, D.Sc., LL.D.....*President*
J. T. Jardine, B.S.....*Director*
E. T. Reed, B.S., A.B.....*Editor*

H. P. Barss, A.B., S.M.....*Plant Pathologist*
F. D. Bailey, M.S.....*Asst. Pathologist, Insecticide and Fungicide Bd., U. S. D. of A.*
R. S. Besse, M. S.....*Associate in Farm Management*
P. M. Brandt, B.S., A.M.....*Dairy Husband'n*
P. Brierley, M. S.....*Assistant Pathologist, United States Department of Agriculture*
A. G. Bouquet, B.S.....*Horticulturist (Vegetable Gardening)*
E. N. Bressman, M.S.....*Assoc. Agronomist*
G. G. Brown, B.S.....*Horticulturist, Hood River Branch Exp. Station, Hood River*
W. S. Brown, A.B., M.S.....*Horticulturist in Charge*
D. E. Bullis, B.S.....*Assistant Chemist*
A. S. Burrier, M. S.....*Assistant in Farm Management*
Leroy Childs, A.B.....*Superintendent Hood River Branch Exp. Station, Hood River*
G. V. Copson, M.S.....*Bacteriologist*
H. K. Dean, B. S.....*Superintendent Umatilla Branch Exp. Station, Hermiston*
C. R. Donham, M.S., D.V.M.....*Assistant Veterinarian*
E. M. Dickinson, D.V.M.....*Assistant Poultry Pathologist*
W. H. Dreesen, Ph.D.....*Associate Agricultural Economist*
T. P. Dykstra, M.S.....*Assistant Plant Pathologist, U. S. Dept. of Agriculture*
F. M. Edwards, B.S.....*Asst. Animal Husbandman, East. Ore. Br. Exp. Sta., Union*
A. E. Engbretson, B.S.....*Superintendent John Jacob Astor Br. Exp. Sta., Astoria*
L. N. Goodding, B.A., B.S.....*Junior Plant Pathologist, U. S. Department of Agric.*
W. V. Halversen, Ph.D.....*Associate Bacteriologist*
J. R. Haag, Ph.D.....*Chemist*
H. Hartman, M.S.....*Horticulturist (Pom.)*
E. M. Harvey, Ph.D.....*Horticulturist (Physiology)*
D. D. Hill, M.S.....*Assistant Agronomist*
Bertha C. Hite, B.A.....*Scientific Assistant Seed Lab., U. S. D. of A. (Seed Anal't)*
C. J. Hurd, B.S.....*Assistant Agricultural Engineer*
R. E. Hutchinson, B.S.....*Assistant to Supt. of Harney Valley Br. Exp. Sta., Burns*
G. R. Hyslop, B.S.....*Agronomist*
W. T. Johnson, B.S., D.V.M.....*Poultry Pathologist*
I. R. Jones, Ph.D.....*Assoc. Dairy Husband'n*
J. S. Jones, M.S.....*Chemist in Charge*
F. L. Knowlton, B.S.....*Poultry Husbandman*
G. W. Kuhlman, M.S.....*Assistant in Farm Management*
E. S. Larrabee, B.S.....*Dairy Specialist, In Cooperation with U. S. Dept. of Agric.*
M. R. Lewis, B.S.....*Drainage Engineer, Cooperation Bureau of Public Roads*
A. G. Lunn, B.S.....*Poultry Husbandman in Charge*
A. M. McCapes, D.V.M.....*Asst. Veterinarian*
M. B. McKay, M.S.....*Plant Pathologist*
J. F. Martin, B.S.....*Jr. Agron. U. S. D. A.*
G. A. Mitchell, B.S.....*Assistant to Superintendent Pendleton Field Sta., Pendleton*
E. B. Mittelman, Ph.D.....*Associate Agricultural Economist*
Don C. Mote, Ph.D.....*Entomologist in Chg.*
M. N. Nelson, Ph.D.....*Agricultural Economist*
O. M. Nelson, B.S.....*Animal Husbandman*
R. K. Norris, B.S.....*Assistant to Superintendent of S. Or. Br. Exp. Sta., Talent*
A. W. Oliver, M.S.....*Assistant Animal Husbandman*
E. L. Potter, M.S.....*Animal Husbandman in Charge*
W. L. Powers, Ph.D.....*Chief, Dept. of Soils*
F. E. Price, B.S.....*Agricultural Engineer*
F. C. Reimer, M.S.....*Superintendent Southern Oregon Br. Exp. Station, Talent*
G. S. Ridgley.....*Laboratory Technician, Poultry Pathologist*
R. H. Robinson, A.B., M.S.....*Chemist*
C. V. Ruzek, B.S.....*Assoc. in Soils (Fert'y)*
H. A. Schoth, M.S.....*Associate Agronomist, Forage Crops, U. S. Dept. of Agric.*
C. E. Schuster, M.S.....*Horticulturist (Pomology)*
H. D. Scudder, B.S.....*Chief in Farm Management*
Owen Searcy, B.S.....*Technician, Vet. Med.*
H. E. Selby, B.S.....*Associate in Farm Management*
O. Shattuck, M.S.....*Superintendent Harney Valley Branch Experiment Sta., Burns*
J. N. Shaw, D.V.M.....*Asst. Veterinarian*
J. E. Simmons, M.S.....*Asst. Bacteriologist*
B. T. Simms, D.V.M.....*Veterinarian in Chg.*
D. E. Stephens, B.S.....*Superintendent Sherman County Branch Exp. Station, Moro*
R. E. Stephenson, Ph.D.....*Associate Soils Specialist*
B. G. Thompson, M.S.....*Asst. Entomologist*
E. F. Torgerson, B.S.....*Assistant in Soils (Soil Survey)*
A. Walker, B.S.....*Assistant Agronomist, Eastern Oregon Br. Exp. Station, Union*
C. F. Whitaker, B.S.....*Assistant Chemist*
E. H. Wiegand, B.S.....*Horticulturist (Horticultural Products)*
Joseph Wilcox, B.S.....*Asst. in Entomology*
Maud Wilson, B.S.....*Home Economist*
Robt. Withycombe, B.S.....*Superintendent Eastern Oregon Br. Exp. Station, Union*
S. M. Zeller, Ph.D.....*Plant Pathologist*