Soil Judging
from the ground up
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Soil Judging

From the Ground Up

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No one expects to pick popcorn from prune trees or to market pork chops from black Angus, but the impossible often is expected of the soil. Nubbins, or nothing may result when potatoes are planted on soil that can produce only poor pasture. Field crops probably will fail on soil fit only for forests. Misused soil means continued disappointment and eventual disaster. On the other hand, the right soil along with good farming means more members of the elite who continually produce 80 bushels of wheat, 400 sacks of potatoes, 6 tons of strawberries, or 7 tons of alfalfa per acre.

Plants and animals are selected on the basis of kind, breed, strain, individual performance, and other important factors to meet certain purposes. The soil, which supports both plants and animals, likewise has definite characteristics that can be recognized, compared, and evaluated as accurately as those of plants and animals. A correct appraisal of these characteristics can be made by soil judging.

Soil and livestock judging are alike in purpose and procedure, but judging soils is more thorough and exact. It would be disastrous to bore into the side of a live cow to determine the toughness of the T-bone. With the soil, either neophyte or expert can dig or probe into the subject as deeply as desired without harm to the patient. This digging will uncover facts that determine what the soil can and cannot do. The facts are based on easily recog-
nized factors, such as color, depth, and texture. With an inventory of these and other features, it is possible to draw practical conclusions about any soil.

With a knowledge of the different soils on a farm gained from this systematic study, a farmer can make more constructive use of other valuable information. Soil survey maps and reports will be better understood. The wealth of information in these reports will become practical and useful. Recommendations based on chemical soil tests can be applied with assurance of beneficial results. Fertilizer recommendations can be followed for top yields without wasting material. Crops, both old and new, can be seeded where they are most likely to succeed. Expensive soil improvements such as irrigation or drainage can be applied to bring greatest possible returns. Before buying or renting land it would pay to make an underground appraisal through the soil judging approach. Such an appraisal provides a basis for determining the productive value of land.

Much can be learned about the soil merely by digging to a depth of 3 or 4 feet, but even more can be discovered with experienced guidance. The Extension Service, the Department of Soils, Oregon State College, and the Soil Conservation Service can aid organized groups in learning how to judge soils. Aid can be in the form of judging demonstrations or, if a bit of competition appeals, as a soil judging contest. Soil judging is a skill that can be acquired and improved only with practice.
Soil Judging Step by Step

First, some tools are needed; a shovel, spade, and mattock or pick for digging holes. A soil reaction or pH test kit will help, but is not absolutely necessary. In the summer, a canteen of water may be needed to moisten dry soils. One Oregon judging score card will be necessary to record the features of each judging location. For the actual judging operation a tape or rule is needed to measure depth and thickness, and a knife is indispensable for prying and breaking the soil into small parts.

Begin by digging a pit at a site that fairly represents a field or definite area.

The pit should be 2 by 3 feet at the surface and 3½ to 5 feet deep. Sometimes rock, hardpan, or other such materials will be encountered before reaching the desired depth, but of course, the soil will be judged only to the depth that roots can penetrate. The pit should be dug to expose at least one smooth perpendicular side. For demonstrations or contests, larger pits are desirable to permit more than one person to work.

Now for the judging itself. The score card will serve as a guide for examining the soil. On it will be recorded important elements controlling the productivity of the soil as it is now, as well as factors that might point the way to substantial improvements. A line by line explanation of the score card will help guide the judging operation.
This record is for identification purposes, obviously necessary in a contest, and highly desirable for identifying a permanent record when studying the soil for farm use.

**Surface soil**

Soils are made up in horizontal layers. The top layer, or surface soil, is of vital importance to the plant, as most of the feeder roots are concentrated there. Because of the influence of air and warm temperature, soil organisms working on organic matter in topsoil provide most of the plant foods available for growing crops. The upper layer is the part of the soil that is plowed or cultivated. It can be changed by management. Differences in color and in the way soil particles fit together usually indicate depth of surface soil.

<table>
<thead>
<tr>
<th>Depth (inches)</th>
<th>Over 18</th>
<th>10 to 18</th>
<th>5 to 10</th>
<th>Less than 5</th>
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The surface soil serves as a feed trough for the growing crop. Obviously, the deeper it is the better. With a surface soil *less than 5 inches* deep, plants might be short rationed or even starved.

*Five- to 10-inch* depth limits not only the supply of plant food but also certain practices, such as leveling land for irrigation. The *10- to 18-inch* range is better. With *more than 18 inches* of surface soil, depth presents no problem.

Here, and with each succeeding section, a check should be put in the box that fits the soil as it is judged.
Darker shades usually indicate higher content of organic matter and more productive soils than lighter shades. However, this is not always a reliable indicator. In arid areas, light coloring does not always mean low fertility, and in areas of high rainfall, dark coloring, even a rich-appearing black, can be caused by poor drainage.

Texture refers to relative proportions of sand, silt, and clay in the soil. Texture influences the ease with which soil can be worked, the amount of air and water it will hold, rates at which water can enter and move through the soil, and the ease of root penetration and expansion. Plant food supplies may be indicated by texture since fine silt and clay particles usually provide more available minerals than coarser sand.

It is difficult to determine the true texture of a dry soil. Fine particles stick together and appear larger than they actually are. Close estimates of texture can be made by wetting a bit of soil to a doughlike consistency and giving it a good workout between the thumb and forefinger.

Coarse textured material is mainly sand. The sample definitely will feel gritty. It will crumble readily even when wet.

M. B. R. (Mud Ball Rating) of coarse textured soil—Is good only for splatter shots at short range targets when either wet or dry.

Coarse textured soils are easy to work, but hold little moisture and may
be low in plant food. Without frequent irrigation production may be limited to early season crops.

Sand and loamy sand soils belong in this classification.

*Moderately coarse textured* material contains considerable sand mixed with silt and clay. It will feel gritty when moist, but the grittiness will be tempered with the smoother feel of silt and clay. It holds together when moist.

M.B.R.—Has shotgun pattern when dry. Holds shape to medium range target when wet.

These soils are easy to work. They hold more water and supply more plant food than the coarse textured soils. Moisture may limit production. With irrigation and a good soil fertility program, they are ideal for intensive farming.

Sandy loam and fine sandy loam are classified here.

*Medium textured* soils may be mainly silt or a balanced mixture of sand, silt, and clay. They have a smooth feel, like flour, when moist. If molded when moist they will hold shape well, but are not sticky.

M. B. R.—Will shatter on impact when dry, will cling together when moist, but will not stick to target.

These soils are easy to work, hold good supplies of moisture, and provide generous amounts of plant food. They are ideal for both general and intensive farming.

This division includes very fine sandy loam, loam, silt loam, and silt.

*Moderately fine textured* material is a mixture of clay with silt, or sand, or both. It can be cut or sheared when moist to leave a smooth, shiny surface. Moist material can be molded in many ways.
shapes, which hold their forms. Dry material resists breakage.

M. B. R.—Will store well when dry. Holds shape for long range to target when wet. Sticks to target but is fairly easy to remove.

There may be tillage problems if these soils are worked too wet or too dry. They hold much usable moisture and usually are high in plant food. They are not too well adapted for crops maturing below the surface, such as potatoes or carrots. Tillage difficulties are a handicap for intensely cultivated crops.

Clay loam, sandy clay loam, and silty clay loam classes belong here.

*Fine textured* material is high in clay. When moist it can be formed into thin sheets and ribbons. It definitely is sticky even when quite moist. Wide cracks in a dry soil strongly hint that the texture is fine.

Overgrown particles of sand ranging upward from about one-tenth of an inch in diameter to sizeable pieces of gravel, rocks, stones, or even boulders contribute little to soil productivity. If they make up a high percentage of the soil, moisture holding capacity and supplies of available plant food are reduced. Many large pieces can make tillage difficult or impractical.

*Not stony* merely means that no large stones are present.

*Slightly stony* soil will have noticeable particles of small stones or gravel, but not enough to affect tillage operations.

*Stony soil* is made up largely of stones, rocks, gravel, or small boulders, large enough to handicap plowing and other cultivating. Time, temper, and machinery can be saved by using these soils for perennial crops.

In *very stony soil* tillage is impossible because of the size and number of rocks present. However, if there is enough good soil between the rocks, these soils may be useful for range or forest production.
Tilth refers to the physical condition or structure of the soil. Individual particles of sand, silt, and clay often stick together to appear as larger particles when either dry or moist. With good tilth, many of these fine particles lose some of their tenacious qualities. Good tilth can be influenced by farming operations. Adding organic material helps. Planting to grasses, legumes, or both, for a few years can work wonders. Excessive cultivation, or plowing or cultivating when the soil is either too wet or too dry can deteriorate tilth.

With a loose soil fine particles cling together. These conglomerate particles are uniform in size and shape. They will flow through the fingers almost like grains of wheat when dry or slightly moist. It is almost impossible to dig a straight-sided hole in this soil. A loose soil may dry out to a point where crops suffer without irrigation. It is subject also to erosion. Some soils are so loose that special tillage implements are necessary. Ordinary implements, such as the moldboard plow, may not scour.

A friable or soft soil will hold its shape when moist, but can be crumbled easily even when dry. A friable soil has perfect tilth for intensive cropping.

A firm or hard soil can be crumbled between the fingers when dry, but you may need to work at it. Special attention must be given to plowing and cultivating operations. With a very firm or very hard soil, all of the particles stick together somewhat like concrete. It may require the aid of a hammer to break this soil apart when dry. In preparing a seed bed, many operations may be necessary to break up clods. Generally, only the moderately fine textured soils will fall in this tilth classification, but it is possible for a medium textured soil to be placed here because of poor state of tilth.
The acid or alkaline reaction of a soil is expressed in terms of pH. A pH of 7.0 is neutral. Numbers above 7.0 indicate the degree of alkalinity, while those below show the degree of acidity. A field or laboratory test is necessary here. With a strongly acid or alkaline reaction, the pH reading may not tell the full story of a soil’s ills or possible remedies. The pH reading is merely an indicator, as a person’s temperature reading of 102 indicates fever, and also suggests need for further diagnosis to determine cause and cure.

When the reaction is pH 5.5 or lower only acid loving plants do well. Heavy lime applications may be necessary for the good growth of most cultivated crops.

Soils with a pH reading of 5.5 to 6.2 are considered moderately acid. If these soils are fertile they will produce good yields of many crops. On the other hand, crops such as legumes may require lime applications for top yields. Lime applications for both strongly and moderately acid soils should be based on a soil test.

Soils with a pH reading of 6.2 to 7.5 are practically neutral. This is the ideal soil reaction for most cultivated crops.

Soils with a pH reading of 7.5 to 8.5 are moderately alkaline. The growth of many crops may be limited in this range. Only alkali tolerant plants can be grown as the reaction approaches 8.5. It often is possible to improve these soils by making additions of sulfur or gypsum. Deep drainage and leaching with irrigation water may help.

Soils with a pH reading above 8.5 are considered strongly alkaline. With special attention, alkali tolerant plants may make fair growth. Usually reclamation measures are necessary before these soils can be used for farming. However, reclamation should not be attempted without further chemical tests to determine the quantity and type of salts present. Reclamation usually will not be effective unless deep drainage is possible and an ample supply of good quality irrigation water is available.

**Subsoil**

The subsoil includes the layers below the surface that can be penetrated by the roots of growing plants. The subsoil does more than add elevation to the surface soil. It holds important reserves of moisture and plant food. A study of the subsoil will indicate whether crop production may be handicapped for lack of drainage and also whether artificial drainage is feasible.
As with the surface soil, the deeper the subsoil the better. Depth is determined by measuring from the lowest part of the surface soil down to where rock or other material stops root growth. The subsoil could include two or more distinct layers or horizons.

If the subsoil is over 18 inches deep and topped with a deep surface soil, depth presents no problem. For orchards, alfalfa, and other deep rooted crops, it would pay to be sure the subsoil depth is substantially over 18 inches.

In the 10 to 18 inch classification depth of the subsoil can become a limiting factor for deep rooted crops.

In the 5 to 10 inch depth limited moisture and mineral reserves may be a handicap to the growth of many crops.

With a subsoil less than 5 inches, unless it is covered with an extremely deep top soil, production definitely may be limited and special cultural practices, such as frequent and careful irrigation, may be needed.

The color of the subsoil is a definite means of identification, but true color is indicated only by a moist soil.

A brown subsoil usually indicates that the soil has good natural drainage.

A black or dark gray color comes from an accumulation of organic matter. In areas of high rainfall this may indicate poor drainage.

A dull gray or a mottled subsoil almost always indicates poor drainage. A mottled subsoil will show definite spots or streaks, reddish, yellowish, or other colors. It might appear like a brindle cow or a speckled rooster. These spots and streaks indicate that excess water has prevented air, and probably roots, from permeating the subsoil.

Light brown or light gray subsoils when found in areas of low rainfall usually indicate a good subsoil for crop growth, providing ample moisture is available.
Texture is recognized in the subsoil by the feel of moist samples, as suggested for the surface soil.

With a coarse textured subsoil, little reserve moisture can be stored. Crops probably will suffer from lack of moisture, unless irrigated. Frequent irrigation will be necessary to maintain a moisture supply.

Moderately coarse textured subsoils will hold more water, but available moisture could be a major limitation for crop production if irrigation is not available.

Medium textured subsoils hold a good reserve of moisture. Water moves through this soil readily; therefore, irrigation rate and frequency can be governed by the needs of the surface soil. Should the soil be subject to a high water table for any length of time, medium textured along with the coarse textured soils can be provided with economical deep drainage, provided adequate outlets are available.

Moderately fine textured subsoils will provide maximum amounts of reserve and available moisture. If they are deep they will provide moisture enough to permit crops to withstand long periods of drought. Deep drainage should be feasible but will be much more costly than with coarser soils.

Fine textured subsoils hold considerable moisture but both moisture and air movement are restricted. After the surface soil is filled with water, runoff losses may be severe during rain storms or when irrigation water is applied faster than it can be absorbed by the subsoil. Crops may be handicapped in these soils because roots grow through them only with difficulty. Should drainage problems exist, deep drainage may not be feasible because tight subsoils resist water movement.

Individual particles in the subsoil often cling together in chunks. Since the subsoil is undisturbed, these conglomerate pieces may be quite large and assume definite forms and shapes. This same basic soil characteristic in the surface soil causes variation in tilth. The characteristic structure of the subsoil can be recognized best when it is dry or only slightly moist.
A soil is classified as having no structure either when the particles show no tendency to cling together, or when the entire subsoil seems cemented in one great mass. The true texture of the soil then governs the movement of water and air and the ease of root penetration.

In a subsoil with a granular structure the particles of sand, silt, and clay are grouped together in small, nearly spherical grains. Finer textured soils, if definitely modified into this granular structure may lose their stubborn resistance to the penetration and movement of water. Included with the granular structures are the soils with weak, angular, blocky structure.

With a blocky structure the particles cling together in nearly square or angular blocks having sharp edges. If the blocks are large, it is an indication the soil resists penetration and movement of water. With small blocks a soil could behave similarly to one having granular structure.

A prismatic structure indicates the particles have formed themselves into vertical columns or pillars separated by miniature, but definite, vertical cracks. Water, roots, and air tend to move along these cracks, so full use may not be made of all the soil. Prismatic structure often indicates drainage difficulties.
In a platy soil structure the particles are formed in thin plates or sheets piled horizontally on each other. These plates resist water and root penetration. A platy subsoil indicates trouble. Reclamation may be difficult or impossible.

The reaction of the subsoil is almost as important as that of the surface soil. It can either modify or emphasize the top soil's pH. If on the acid side, the surface soil had reaction below pH 5.5, but the subsoil was definitely in the near neutral range, 6.2 to 7.5, less than ordinary rates of lime would be required. On the other hand, if the topsoil was only mildly acid, but the subsoil had a strong acid reaction, more lime would be necessary.

The pH of the subsoil is of even greater importance on the alkali side. Reclamation of a moderately alkaline surface soil on a strongly alkaline subsoil could be extremely difficult. On the other hand, a strongly alkaline soil on top of a neutral or moderately alkaline subsoil might be easy to reclaim, especially if the subsoil is calcareous.

From the practical standpoint, if the subsoil shows either a strongly acid or a strongly alkaline reaction further chemical studies should be made before starting reclamation measures.

The roots of plants spread through the surface and subsoil in search of moisture and food. If conditions permit, the roots of perennial plants, such as trees or alfalfa, might penetrate to a depth of 20 feet or more. The roots of many annual plants go to a depth of 4 to 5 feet, but in many soils the downward growth of roots may be completely stopped by a limiting layer. Hardpan or rock and loose sand or gravel are unfavorable for root development.

If there is no limiting layer roots can draw moisture and plant food from an unlimited depth. Hardpan is cementlike soil material which may even contain large pieces...
of gravel. It will halt root penetration, and only occasionally can it be altered or corrected. If conditions are favorable and the hardpan occurs at a reasonable depth, it might be broken by subsoiling. In areas of light rainfall hardpan sometimes occurs which has been cemented together with water soluble salts. If these soils are irrigated, the water might dissolve the soluble material and eliminate the hardpan. This possibility of reclamation can be confirmed only by chemical tests.

Gravel and coarse sand limit the depth of penetration if they supply limited moisture and plant food. Roots need both to live.

Bedrock definitely stops roots.

The soil depth may be terminated by a clay pan which may be more difficult to detect than other limiting layers. Clay pan is classed as fine textured material, but it is so extremely fine and compact that roots cannot penetrate. Water moves downward only with difficulty. A clay pan often will be quite moist when the subsoil above is dry. Roots cannot enter to obtain the water. Clay pans are like gumbo—sticky and almost rubbery when wet.

Some limiting layers are obvious. With others, the termination of root growth or a concentration of roots running horizontally give evidence that vertical penetration has been halted.

**Whole soil**

Various important factors influence the productivity or use of both surface and subsoil. The term whole soil applies to both layers. Some of the factors must be determined by observation of the area adjacent to the point of study.
<table>
<thead>
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<th>Erosion</th>
<th>None or slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
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</table>

The amount of soil already lost through wind or water erosion is important in determining the productive value of a soil or in planning for its best use.

Soil lost by water erosion may be indicated by a shallow surface soil as compared to the topsoil found in a protected area like a fence row. The subsoil may be exposed. There may be obvious gullies. Others may have been covered by cultivation and a growing crop, but a depression in the soil surface and a color difference in soil and crop will show where gullies have been. Silt deposits in protected or comparatively level areas indicates that soil is moving. The roots of trees and bushes may be uncovered. Vertical streaks of different color in the soil or crops on slopes indicate soil has washed away.

Wind erosion may be suspected if there is a thin surface soil or an exposed subsoil. In an uncultivated place, the soil may be removed around clumps of grass or brush. Areas protected from the wind will accumulate miniature dunes or drifts. In cultivated land, small stones, large particles of sand, or other comparatively heavy objects will seem to be placed on pedestals, since the wind has removed the soil around them. Oval shaped depressions pointed in the direction of the prevailing wind are a sure sign of wind erosion. Varying colors of the soil and crop in oval patterns on cultivated land also indicate wind erosion.

*None or slight* erosion means that little or no soil has been lost. Erosion control might not be a factor in developing the best use for the soil, but this is not always so. There may have been no erosion only because the soil has been properly managed or has had a perfect cover.

With *moderate erosion* there is ample evidence that some topsoil has been removed. There may be existing rills or gullies or evidence of gullies that have been covered by cultivation. A fair amount of topsoil remains, but it is evident that the productivity of the soil has been depreciated and corrective management practices will be necessary.

With *severe erosion* there definitely are gullies, many that cannot be crossed with farm implements. Most or all of the topsoil has been removed. Soil in this classification will need "the works" so far as renovation and future protection are concerned.
Slope is referred to here in terms of percentage, which means the vertical rise in 100 feet of horizontal distance. It is helpful to use some form of leveling instrument to estimate the slope correctly.

With under 3% slope soils can be farmed as if they were level. Usually they will not require corrective measures for the control of water erosion, but surface drainage could be a problem. These soils are usually adapted to surface irrigation.

With a slope of 3% to 8% there may be water runoff, especially if the slopes are long. Soil with this slope is not too well adapted to strip border irrigation, but with good water control, furrows or corrugations can be used satisfactorily.

With 8 to 15% slope special attention must be paid to the control of water runoff. Surface methods of irrigation usually are not satisfactory, except on well established pastures or meadows of mixed grasses and legumes.

With 15 to 30% slope water runoff is aggravated and the operation of farm machinery is handicapped. Usually it is preferable to put soil in this slope classification into some permanent crop that requires only occasional cultivation.
When the slope exceeds 30% water runoff is especially severe. It may not be possible to operate most farm machinery on these steep soils. They should be left in a permanent cover.

It should be re-emphasized that water runoff not only means loss of soil through erosion, but may mean substantial loss of water that should be stored in the surface and subsoil for

| Parent material | Residuum | Old water deposit | New water deposit | Loess | Peat or muck |

Soil is a complex mixture of mineral material, water, pore-spaces, organic matter, and living organisms. Soil itself developed from parent material. Parent material may have originated and stayed in one place or it may have been transported possibly from distant locations.

Parent material is modified by soil forming factors, such as climate, vegetation, drainage, weathering, leaching, erosion, and the growth of plants and other organisms. Original material of older soils may have changed almost beyond recognition. Newer soil may be largely unchanged parent material.

Residuum is material formed from underlying bedrock, and has not been transported. Soils formed from residuum are commonly found in the hills and extend downward to the foot slopes along the edges of the valleys. Extensive level areas seldom are found. Usually soils classed here range from gently sloping to quite steep. Solid rock or partly decomposed rock material below the subsoil are indications the soil was formed in place.

Old water deposit refers to material that has moved to its present location by water. It could have been formed from flood deposits, from rivers, or in lake beds. These soils have been in place long enough to show distinct layers caused by soil formation processes. They usually are located substantially above the reach of present floods. The topography is likely to be quite level or gently sloping.

New water deposit is material found in river or creek bottoms. It has been moved into place by recent floods; hence, these soils are still subject to occasional flooding, possibly more often than not. Different soil layers are seldom as apparent as they are with old water deposit material. The topography is generally level, but rolling low ridges and hollows are not uncommon. These soils usually are highly productive.
Loess is material that has been de-
posited by the wind. Usually it repre-
sents the best topsoil from other areas.
Rolling or hilly topography is common.
These soils are likely to have good
structure and a good content of or-
ganic matter to substantial depths.
Wind deposited soils often are quite
fertile and hold considerable available
moisture, but may be highly susceptible
to erosion.

Peat or muck is organic material
formed from the decomposition of
plant growth in lakes, bogs, or marshes,
and may be mixed with various quan-
tities of mineral. These soils probably
need to be drained before they can be
used for agricultural purposes. With
adequate drainage, some of the most
productive soils are in this group.

Interpretations

Down to this point, important facts
about the soil have been recorded. It
is time for a backward look and some
arithmetic. It is necessary to add the
good, subtract the bad, multiply, and
divide, if necessary, to determine the
combined effect on crop growth and
soil management.

<table>
<thead>
<tr>
<th>Drainage</th>
<th>Excess</th>
<th>Good</th>
<th>Moderate</th>
<th>Imperfect</th>
<th>Poor</th>
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</table>
| Excess drainage refers to soils that have texture and structure offering practically no resistance to the movement of water downward and away from the root zone. Little is held for crop use. Crops on these soils suffer for lack of moisture unless frequent irrigation is possible.

Good drainage means the ready movement of water and air downward

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Excess drainage refers to soils that have texture and structure offering practically no resistance to the movement of water downward and away from the root zone. Little is held for crop use. Crops on these soils suffer for lack of moisture unless frequent irrigation is possible.

Good drainage means the ready movement of water and air downward
through the soil. The topography is such that excess water never handicaps root growth. Despite the free movement of water, the soils retain generous supplies of useable moisture.

*Moderate drainage* indicates there is some restriction to the movement of water either because of topography or the nature of the soil itself, and that crop growth is handicapped because of excess water in the root zone for brief periods during the year.

*Imperfect drainage* refers to soil where excess water handicaps crop growth somewhat longer than indicated for moderate drainage. Water standing in subsoil could limit the depth of root penetration.

*Poor drainage* indicates that water stands on or near the surface for much of the year and that only those crops adapted to extremely wet soils can exist. Without drainage roots are confined to a shallow depth.

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<table>
<thead>
<tr>
<th>Effective Depth (inches)</th>
<th>10 or less</th>
<th>10 to 20</th>
<th>20 to 36</th>
<th>36 to 60</th>
<th>Over 60</th>
</tr>
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Effective depth means the combined depth of the surface and subsoil. Charles E. Kellogg, head of the soil survey work for the U. S. Department of Agriculture, gives this definition of soil. “Soil is that thin film between the earth and sky that supports all living things. Beneath lie the sterile rocks, above, the air and sunshine—there is no life without soil and no soil without life.” Effective depth is simply the thickness of this thin layer between starvation and plenty, or a vertical measurement from the soil surface down to the limiting layer or water table.

With 10 inches or less the sky and rock are too close together to permit more than limited use.

Only 10 to 20 inches effective depth likewise limits production. Grass seedings on range land may be practical if the depth approaches 20 inches. Frequent irrigation is necessary for any intensive crop production.

With 20 to 36 inches there is beginning to be enough soil to work with, though moisture storage can be a handicap without irrigation.

Soil 36 to 60 inches is deep enough to stand intensive farming. Moisture reserves still might limit the production of deep rooted crops, such as fruit or nut trees.

When over 60 inches there is little worry as far as depth is concerned.

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<table>
<thead>
<tr>
<th>Tillage problems</th>
<th>None</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
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Tillage is a necessary farming operation. If tillage is difficult, high farming costs may limit the return.

Soils rating *none* present no problems from the standpoint of tillage.

If *slight* the slope, texture, stoniness, or lack of drainage might handicap tillage to a degree, but not enough to influence the use of the soil.

When *moderate* the tillage handicap indicates a preference for long-lived or perennial crops that do not require much cultivation.

If *severe* the tillage problems are great either because the land is too steep, too stony, too heavy and sticky, or too wet. Here it may be best to struggle through the pasture or range seeding or forest planting process once and hope it will last indefinitely.
The fertility level of a soil can be determined best with the aid of chemical tests or fertilizer trials. However, a study of the soil itself and the surrounding area will uncover some valuable clues. The appearance of growing crops or native vegetation will add substantiating evidence. The cropping history also provides a good indication of what the soil will do in the future.

If high, the surface soil is dark in comparison to other soils in the area. Growing vegetation has a vigorous, healthy appearance. Soil tests, when available, show an ample supply of mineral plant foods. Past yields are tops.

When medium, soils are lighter in color, indicating less organic matter. Vegetation appears off color and not too vigorous. Cropping history indicates only fair yields. Soil tests show the need for the addition of one or more mineral plant foods.

Low soils obviously are low in organic matter. Vegetation is sparse and stunted. Crop history shows low yields. Soil tests might show the need for heavy application of several mineral fertilizers.

Despite the fact that all other factors are highly favorable, one unfavorable soil factor could limit or prevent the use of most soils for many purposes. The principle is the same as in the old saying, “The war was lost for the want of a horseshoe nail.”

The steeper and longer the slope, the greater the danger from erosion and the greater the loss from runoff. Even if erosion were not a factor, steep slopes limit or prevent the use of farm machinery. If it is necessary to use an outrigger to keep a diskharrow right side up, the soil is on the steep side for continued cultivation.

Stoniness is indicated when there are more stones, rock, and gravel than there is soil. Moisture and plant food are scarce. When the soil contains
many rocks and boulders, it may be impractical to use farm machinery.

*Effective depth* obviously could restrict use. The best soil in the world, if only six inches deep, could not be highly productive.

*Fertility* is limiting if the soil cannot provide adequate amounts of all of the necessary plant foods. Production will be limited unless fertilizer is added.

*Flooding* is the major limiting factor along many of our streams. Most crops are killed when covered with water any length of time. The flowing water also could create a severe erosion problem.

*Too dry* refers to a shallow or a coarse textured soil that retains only enough moisture following rain or irrigation to last a growing crop a few days. Lack of moisture greatly limits the use of these soils.

*Too wet* a condition results when surface or under drainage is not adequate. Water may stand on or near the surface for long periods during the important part of the growing season. Production is limited to water-tolerant plants.

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The Soil Conservation Service has developed a nationwide system of land classification. Soils are grouped into eight capability classes, depending on the seriousness of the hazards or limitations noted above. This system of classification is based on the most intensive land use possible and the intensity of management required if the productivity of the soil is to be maintained for an indefinitely long period.

**CLASS I.** "Very good land that can be cultivated safely with ordinary good farming methods; subject to very slight or no continuing limitations in use or risks of damage because of permanent land characteristics."

**CLASS II.** "Good land that can be cultivated with easily-applied protective measures; subject to moderate limitations in use, or moderate risks of damage, because of permanent land characteristics."

**CLASS III.** "Moderately good land that can be used regularly for crops in a good rotation but needs intensive treatment; subject to severe limitations in use for cropland, or severe risks of damage, because of permanent land characteristics."

**CLASS IV.** "Fairly good land that is best maintained in perennial vegetation but can be cultivated occasionally or in a limited way, if handled with great care; subject to very severe permanent limitations or hazards in use for cropland."

**CLASS V.** "Land very well suited for
grazing or forestry, or both, with few or no permanent limitations or hazards in use.”

CLASS VI. “Land well suited for grazing or forestry, or both; subject to moderate permanent limitations or hazards under grazing or forestry use.”

CLASS VII. “Land fairly well suited for grazing or forestry or both; subject to severe hazards or limitations in use.”

CLASS VIII. “Land that is suited only for wildlife, recreation, or watershed protection; has some limitations or hazards that make it unfit for cultivation, grazing, or forestry use.”
Permanent sod soils cannot be cultivated but are suitable for pasture production either with or without seeding. Some western Oregon soils too steep for cultivation produce top pasture yields.

Range is the eastern Oregon word for “permanent sod.” Shrubs and other plants could supplement grass in supplying forage. Brush control and seeding might increase production.

Forest indicates the land is best suited for the production of trees. Planting or other management practices may be necessary to get adequate stands.

The classification of cultivated crops includes any soil that can be cultivated, even with difficulty.

Suggested management practices

Observation and interpretation of soil characteristics give valuable hints for management practices to bring the greatest return. In considering management practices, careful thought should be given to the soil’s characteristics already noted. Practices in present use may or may not be right. Possibly the operator did not follow the judging approach in developing his farm program.

Furrow irrigation requires fields of uniform slope. Furrows should not be too steep. Unless the topography is very smooth, the nature of the surface and subsoil should be such that the land can be leveled without destroying productivity.

Border irrigation requires fields that are nearly level or only gently sloping. Often much leveling is required. As with furrow irrigation, the surface and subsoil should permit these leveling operations.

Subirrigation is feasible only on soils that are practically level, with subsoil porous enough to allow rapid lateral movement of water and to permit raising and lowering the water table as needed by the crop.

Except with peat soils, the use of subirrigation in the state of Oregon is limited.
In contour tillage all plowing, cultivation, and planting are done on the contour or at right angles to the slope. It is used to reduce water erosion.

Subsoiling indicates the soil is to be broken below normal plow depth. It is beneficial only when it can break a hardpan or some other layer limiting root and water penetration. Though not in general use in Oregon, subsoiling sometimes can be used to bury an unfavorable top soil in a desirable subsoil.

Summer fallow indicates that the land lies idle during all or most of the growing season with enough cultivation to control weeds. Its primary use is to store additional moisture in the subsoil. It can be used to build additional supplies of available nitrates. Summer fallow sometimes is necessary before establishing seedings where heavy sod has been broken up or brush removed.

Stubble mulch indicates the soil is plowed and cultivated with implements that leave most of the straw, stubble, and other crop residue on the surface for protection against wind and water erosion.

Sprinkler irrigation can be used on soils suitable for either furrow or border irrigation. It also can be adapted to soil too steep or rough for surface irrigation or on soil that is too permeable or porous for surface methods.
Practices for controlling wind erosion should be included here.

With *strip cropping* alternate strips of different crops are seeded parallel to each other so a strip of erosion-resisting crop will protect a strip of soil susceptible to erosion. Alternate strips of grain and fallow serve the same purpose. To prevent wind erosion, strip cropping must run perpendicular to the prevailing direction of the wind, and to prevent water erosion, strips must run across the slope or on the contour.

*Diversion ditches* are channels built to catch and carry water moving down from the slopes above. They are most effective if used in connection with contour farming.

Under a *terrace system*, a series of cross slope channels and ridges are built to control runoff and reduce water erosion. They usually are spaced closer together than diversion ditches and may be constructed so the entire area can be farmed.

*Cover crops* are those used to protect the soil when the land is not producing crops intended for sale. Cover crops commonly are used in western Oregon to protect the soil during winter months, and are plowed under in the spring, adding to the supply of active organic matter.

*Gully control* is possible with the construction of dams, drops, and spillways to prevent further washing and to trap soil washed from above. Often gullies are shaped so they can be crossed with farm machinery. Then if a protective cover of perennial grasses and legumes is established, the gully may be healed permanently.
None is required on soils with a good surface and subsoil.

Surface drainage is used where deep drainage is not possible. It may be accomplished by the construction of outlet ditches with supplementing furrows or ditches through low areas. Sometimes surface drainage can be aided by plowing in "lands" or "beds." The dead furrows serve as surface drainage channels.

Deep drains, open, are possible if an outlet is available and the subsoil permits. Deep drainage usually is much more effective and profitable than surface drainage. If only surface drainage is possible, production still is limited to shallow rooted crops. With deep drainage, almost any crop can be grown.

Open ditches can be used to provide deep drainage when the subsoils permit the ready movement of water. Open drains, which often must be 4 to 8 feet or more in depth, waste considerable land and interfere with farm operations. They are practical only when they can be spaced far enough apart to permit economical farm operations.

Deep drains, tile mean that drainage is accomplished with the installation of tile. With this method all of the land can be farmed. Drains can be placed close together if necessary. Tile drains provide more effective drainage than open ditches. With only a little care, tile drainage becomes a permanent improvement.
Many crop rotations are possible in Oregon. Any rotation should be based on the proportion of time soil should be in a sod crop, grass, legumes, or a mixture, in proportion to the time it could be used for intensive crops.

Not cultivated land includes that which should be left in sod on a near permanent basis either because of erosion or other unfavorable conditions. If in sod more than two-thirds of the time, rotation is developed to build organic matter and control erosion. This is on the basis that at least two acres of the farm is in sod while one is in annual crops. Erosion control probably is the main reason for the emphasis on sod.

Land in sod one-third to two-thirds of the time includes much of the good general farm land in western Oregon and in the irrigated areas. A balance of soil building and annual crops maintains fertility and solves moderate erosion problems.

In sod less than one-third of the time applies only to soil suited for intensive use. Erosion is no problem or is controlled permanently by other measures. Rotation is practiced to maintain fertility although cover or green manure crops might prove economical substitutes.

Suggested rotation. This square can be used to list any of the hundreds of rotation possibilities in Oregon.

<table>
<thead>
<tr>
<th>Rotation...</th>
<th>Not cultivated</th>
<th>In sod more than two-thirds of time</th>
<th>In sod one-third to two-thirds of time</th>
<th>In sod less than one-third of time</th>
<th>Suggested rotation</th>
</tr>
</thead>
</table>

Soil tests help greatly to determine whether additions to the soil are desirable. It may be necessary to get a chemical analysis before the appraisal can be completed.

None indicates either a highly productive soil or a soil suited only for limited grazing, forests, or non-agricultural use.

Manure can improve most soils in Oregon, although its use is limited in low rainfall areas. Unfortunately, there is never enough manure to solve the soil fertility problem.

Lime addition should be guided by a soil test.

Gypsum may be needed to supply sulfur as a plant food. Heavier applications sometimes are used to aid in reclaiming alkali land. The use of gypsum for reclamation should be guided by chemical soil tests.

Agricultural sulfur can be used as a plant food but applications should be limited to soils showing an alkaline reaction. If use is based on chemical tests, sulfur also may aid in reclaiming alkali land.

There are few systems of farming adapted to Oregon soils that cannot be improved with the help of some commercial fertilizer. Soil tests are helpful guides. Growing crops often show an obvious need for additional plant food.

None is possible on one end of the
scale for a few soils on which crop production would not be helped by commercial fertilizers. On the opposite end are vast areas of range and forest lands where increased yields from fertilizers might not be profitable.

Nitrogen fertilizers are beneficial to crops other than legumes on most Oregon soils. Soil tests do not adequately show the need for nitrogen. The rate of use should be guided by fertilizer trials and crop response.

Phosphorus need will be shown by soil tests.

Potassium applications should be based on soil tests.

Need of minor elements can be found in soil tests. Results of fertilizer experiments applicable to the area also are helpful.

This fills out the score card. If completed during a contest or demonstration, it is both interesting and helpful to compare findings with those of the judges and others. With only a little guided practice, most amateurs can compete with experts in pinpointing the most important soil features.

The procedure has greatest value when applied to soils in which a person has a special interest, possibly on his own farm.

**Completing a Farm Soil Inventory**

Few well managed businesses operate without periodic inventories of materials and facilities. Farming is the business of taking plant food from the soil, converting it to some marketable product, and selling it. Properly prepared score cards for each soil on the farm can serve as a permanent inventory of the production facilities (the soil as a medium for plant growth), and the supply of raw materials, (the soil as a source of plant food).

A complete farm soil inventory is made up of cards completed for recognized locations indicated on a map of the farm. Should a county, area, or farm soil survey map be available, it would serve as an ideal basis for specifying locations. Once the score card is completed through the soil judging procedure, it serves as a near permanent record. Most important soil characteristics do not change from year to year.

The inventory can serve as a source of detailed information about the different soils any time, anywhere. It can be used in the winter when plans are made even though it may be difficult to get out in the field. It can be used in discussing farm problems on an intelligent basis with merchants, bankers, or technical people. The following illustrates some of the day-to-day uses:

In farm planning the inventory helps put the right crops on the right soils. This is basically essential to good farming.

In erosion control it points out those areas on the farm that need special control measures, and it will provide basic information from which effective measures can be developed.

For a soil survey, properly prepared cards for each soil type give soil survey maps an invaluable third dimension. The map becomes a part of the farm, and the wealth of information from soil survey reports can be applied effectively for better farming.

Machinery purchases cost money. Manufacturers have developed a wide selection of machinery adapted to different soil conditions. The inventory aids in selecting and adapting the right tillage implements.

The Agricultural Conservation Program provides for cost-sharing assistance to farmers for applying soil con-
serving practices on farm lands. The application of these measures according to soil needs and capabilities can result in the sound expenditure of both public and private funds.

Soil tests supply only part of the information needed for adding fertilizers, using soil amendments, or other soil treatments. With basic soil information available, technicians can recommend a more complete and accurate prescription. A farm operator can both make and save money by gauging treatments according to depth and other soil characteristics.

Planning an orchard or a similar long-lived crop can mean that a sizeable investment in time and money must be made before the crop income pays off. A soil inventory will show if and where such crops have reasonable chance for success.

Drainage represents a sizeable, though often highly profitable, investment. Time and financial limitation seldom permit complete installation of a drainage system at one time. With a soil inventory, it is possible to plan an efficient system that can be installed over a period of years for complete effectiveness without waste of time or effort.

Irrigation by any method must be designed and operated according to the ability of the soil to take up and hold usable moisture. Soil conditions further determine whether extensive leveling is possible.

In range improvement the soil or lack thereof often is a controlling factor in determining whether range improvement practices are economically feasible.

Weedicides and pesticides are improved each year. Methods of use and effectiveness of many of these materials are influenced by soil characteristics.

Accomplishments within Soil Conservation Districts are based on the use of land according to capability of the different soils included. A farm soil inventory provides essential information for the preparation of individual and group farm plans. It will further be a permanent guide for the complete application of these plans on the farm and in the community.

In buying, selling, or renting land a person profits by knowing something about soil. Few people buy cars without some investigation, including kicking the tires, honking the horn, and lifting the hood. “Lifting the hood” of the soil surface reveals more than the number of cylinders. A guided peek underground can show true performance, long-time dependability, and future productive value.