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 soil, either the 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 University, 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. An Oregon Soil 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>
</tr>
</thead>
</table>

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.

A 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 over 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.
Be sure the soil is moist before judging color. Darker shades usually indicate higher content of organic matter and more productive soils than lighter shades. However, this is not always true. In arid areas, light coloring does not always mean low fertility, and in areas of high rainfall, dark coloring can be caused by poor drainage.

<table>
<thead>
<tr>
<th>Color</th>
<th>Black or dark gray</th>
<th>Dark brown or reddish brown</th>
<th>Light brown or yellow</th>
<th>Light gray</th>
</tr>
</thead>
</table>

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—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 texturbed* 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
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.

<table>
<thead>
<tr>
<th>Stony or gravelly</th>
<th>Not stony</th>
<th>Slightly stony</th>
<th>Stony</th>
<th>Very stony</th>
</tr>
</thead>
</table>

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.

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, it may be used for forest or range.
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 seedbed, many operations may be necessary to break up clods. Generally, only the moderately fine and 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.

<table>
<thead>
<tr>
<th>Tilth</th>
<th>Loose</th>
<th>Friable or Soft</th>
<th>Firm or Hard</th>
<th>Very Firm or Hard</th>
</tr>
</thead>
</table>
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 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 soil tests.

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 problems. For orchards, alfalfa, and other deep-rooted crops, it would pay to be sure the subsoil depth is well 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 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.

<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>
</tr>
</thead>
</table>

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 mottled subsoil is marked with reddish or yellowish spots or streaks. They may look like rust stains, freckles, or streaks on a brindle cow. Mottling along with any dull color, usually gray, is a sure sign of drainage troubles for a good share of the year regardless of the immediate presence of water. Disregard mottling if it appears in an otherwise bright-colored subsoil.

Light brown or light gray subsoils when found in areas of low rainfall usually indicate good subsoil for crops provided ample moisture is available.
Texture is recognized in the subsoil by the feel of moist samples. With a coarse-textured subsoil, little reserve moisture can be stored. Crops probably will suffer from lack of moisture, unless frequently irrigated. Moderately coarse-textured subsoils will hold more water, but available moisture without irrigation could be a major limitation for crop production. Medium-textured subsoil 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.

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.

---

**Texture**  
Coarse  
Moderately coarse  
Medium  
Moderately fine  
Fine

---

**Structure**  
None  
Granular  
Blocky  
Prismatic  
Platy

---
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.

![Platy Soil](image)

The root system 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.

A *hardpan or claypan* can stop root penetration. A hardpan is a layer made

<table>
<thead>
<tr>
<th>pH</th>
<th>Below 5.5</th>
<th>5.5 to 6.2</th>
<th>6.2 to 7.5</th>
<th>7.5 to 8.5</th>
<th>Above 8.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limiting layer</td>
<td>None</td>
<td>Hardpan or claypan</td>
<td>Gravel or sand</td>
<td>Bedrock</td>
<td>Water</td>
</tr>
</tbody>
</table>

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 a pH reaction below 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 top-soil was only mildly acid, but the sub-soil 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.
up of soil particles, clay, silt, sand, and often gravel or broken rock cemented together and resembling a poor grade of concrete. Hardpans can completely stop root penetration and water penetration is limited. A claypan is made up of a high percentage of clay so compacted and tight that roots cannot penetrate and moisture movement is extremely slow. Hardpans are hard and brittle while claypans are tough and rubbery.

Hardpans and claypans may be quite obvious or they may be hard to detect. Clues that call for special attention are an accumulation of roots growing horizontally along the upper surface of the suspected layer and an abrupt change in soil moisture. Roots grow horizontally to seek a way downward. Abrupt change from a moist subsoil to dry material could indicate that a pan of some type stopped the downward movement of water. A sharp change from a dry subsoil to moist material could show that a claypan or hardpan had kept roots from taking out the water.

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

Bedrock definitely stops roots.

Water standing at the same level for most of the year often completely stops root penetration.

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.
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. Other gullies 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 they have been. Silt deposits in protected or comparatively level areas indicate 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 slope.

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.

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.

<table>
<thead>
<tr>
<th>Slope (per cent)</th>
<th>0-3</th>
<th>3-8</th>
<th>8-15</th>
<th>15-30</th>
<th>Over 30</th>
</tr>
</thead>
</table>

![Diagram of 5% Slope]

![Diagram of 25% Slope]
When the slope is over 30% water runoff is especially severe. It may not be possible to operate most farm machinery on these steep soils. They usually should be left in a permanent cover.

<table>
<thead>
<tr>
<th>Parent material</th>
<th>Residuum</th>
<th>Old water deposit</th>
<th>New water deposit</th>
<th>Loess</th>
<th>Peat or muck</th>
</tr>
</thead>
</table>

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 crop use.

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 it 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 been 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 deposited by the wind. Usually it represents 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 organic matter to substantial depths. Wind-deposited soils often are quite fertile and hold considerable available moisture, but may be highly erosible.

*Peat or muck* is organic material formed from the decomposition of plant growth in lakes, bogs, or marshes, and may be mixed with various quantities of mineral. These soils probably need to be drained before they can be used for farming; with good drainage they can be productive.

**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>Reclaimable</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Drainage refers to the movement of excess water through the soil. Root growth requires a good balance of water and air in the soil. If the movement of excess water out of the soil is slow or stopped entirely, there can be little or no root growth.

Check back on subsoil color here—mottling and dull color strongly hint drainage trouble.

*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 good 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 usable 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.

If a poorly drained soil has a texture and structure that permits ready movement of water downward to a depth of 30 inches or more, it can be classified as reclaimable. It may pay big dividends to provide deep drainage with ditches or tile.

Poor drainage means that water stands on or near the surface most of the year. If poor drainage is not corrected, cropping is limited to water-tolerant plants. Mark this square if fine texture and poor structure in the soil would prevent the movement of water to deep drains. Surface drains help some soils in this category.

<table>
<thead>
<tr>
<th>Effective depth (in.)</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>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Tillage problems</th>
<th>None</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Tillage is a necessary farming operation. If tillage is difficult, high farming costs may limit returns.

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.

### Major use limitations

<table>
<thead>
<tr>
<th>None</th>
<th>Wind erosion</th>
<th>Acid</th>
<th>Alkali</th>
<th>Slope</th>
<th>Stony</th>
<th>Depth</th>
<th>Flood</th>
<th>Drought</th>
<th>Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

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.”

If the soil shows nothing that would limit the growth of any crop climatically adapted to the area it is classified as having no limitations (none).

**Wind** erosion imposes a real limitation on land in exposed areas where the weather refuses to stand still.

With a pH reading of 5.3, 5.4, or lower, **acid** soil is a major use limitation. The need for lime is apparent for many crops.

If the pH reading is upward toward pH 8.0 or higher, **alkalinity** or an excess of harmful salts can limit crop production unless reclamation measures are effectively applied.

The steeper and longer the **slope**, the greater the danger from erosion and the greater the runoff. Steep slopes limit or prevent the use of farm machinery. If it is necessary to use an outrigger to keep a disk harrow right side up, the soil is on the steep side for continued cultivation.

Soils are **stony** when there are more stones, rock, and gravel than there is soil, and moisture and plant food are scarce. Rocks and boulders impair the use of farm machinery.

**Depth** obviously could restrict use. The best soil in the world, if only six inches deep, could not be highly productive.
Flooding is the major limiting factor along many of our streams. Most crops are killed when covered with water for any length of time. The flowing water also could create severe erosion.

Drought 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.

Drainage is a limitation 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.

<table>
<thead>
<tr>
<th>Capability class</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Forest or range</th>
</tr>
</thead>
</table>

The Soil Conservation Service has developed a nationwide system of land classification. This system is based on the most intensive use possible along with a system of management that will maintain permanent or near permanent productivity. We follow this system for land that can be farmed, rating the soil on the seriousness of major use limitations.

Class I is a soil on which there are no “use limitations.” It will grow any of the deep-rooted or intensive crops climatically adapted to the area—without fear of erosion.

Class II will have one or more use limitations but only to a minor degree; nevertheless, these limitations will require special management or corrective measures.

Class III implies limitations of greater intensity than Class II. Full corrective measures may not be feasible and management is much more restricted.

Class IV includes land with one or more incorrectable use limitations or a combination of lesser limitations that often restrict cropping to long-lived perennials. A good farmer would like to seed down Class IV land and forget it; and the best use for large areas of Class IV land is the production of timber or forests.

Forest or range land cannot be farmed because of slope, depth, stoniness, or other reasons. Forest land includes trees—either planted or from natural reproduction. Range includes both native grass and seeded domestic varieties. Special tillage methods are often used for establishing trees or grass although the routine use of ordinary farm equipment is impractical.
In judging the soil, climate, rainfall, temperature, and the like should not be considered in determining the capability class. Weather records for local areas provide accurate information on climate.

**Suggested management practices**

Observation and interpretation of soil characteristics give valuable hints for management practices to bring the greatest returns. 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.
Do not be concerned about available water in developing irrigation recommendations. Water supply can only be assured by engineering and other local information.

No irrigation method is recommended if slope, depth, or other factors indicate that irrigation would not pay or when the soil is suitable only for forest or range.

*Surface* irrigation—furrows, borders, or flooding—requires fields that are nearly level or with gentle or moderate uniform slopes. If the top soil is deep, rough topography can be leveled. Surface methods of irrigation may not be feasible on soils with a loose subsoil having excess drainage.

*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.

*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.

<table>
<thead>
<tr>
<th>Crop management</th>
<th>None</th>
<th>Contour</th>
<th>Strip crop</th>
<th>Cover</th>
<th>Stubble mulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation method</td>
<td>None</td>
<td>Surface</td>
<td>Subirrigation</td>
<td>Sprinkler</td>
<td></td>
</tr>
</tbody>
</table>

Crop management and tillage practices often prevent wind and water erosion, conserve moisture and plant nutrients, and build up organic matter. If no special practices are needed or if the soil is judged suitable only for range or forest, crop management can be marked as *none*.
Contour Farming

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.

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.

**Cover**, either living or dead, is the most universally effective measure for controlling erosion. It can be in the form of a growing crop, stubble or other dead growth, perennial grass, or on intensively cultivated land—especially seeded cover crops. Even on level land, a living cover of some kinds adds organic matter and prevents losses from leaching. Mark cover for any cultivated soil, and you will usually be right.

*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.
Special practices in addition to cropping and tillage are sometimes needed to prevent or correct erosion, reduce runoff, or aid water penetration.

None indicates that no special practices are needed. Usually, special practices are not practical on forest or range land.

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.

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.

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.

Artificial drainage as used here applies only to the soil. Outlets and the design of drainage systems are separate engineering problems.

None is required on soils with excess or good drainage. Soils that are shallow, stony, or on which drainage would not pay should also be included. Drainage rarely pays on forest or range land. Use your judgment on soils with moderate drainage.

Surface drainage should be used when there is evidence that water stands on the surface for a good share of the time. It is also advisable where the texture and structure of the subsoil would hold the water back from deep drains.

Deep drains are recommended when subsoil conditions show that drains could be effectively installed to a depth of 36 inches or more. Either tile or open ditches can be used. The choice would depend on engineering recommendations and costs.
Crop rotation is used here in a broad sense. A good system of management for any cultivated soil must provide for the renewal of organic material. Often, this can best be accomplished through rotations with sod crops—long- or short-lived grasses and legumes. The utilization of residues and cover or green manure crops can accomplish the same purpose. On many soils, sod crops are needed for erosion control or to restore soil structure as well as to maintain fertility.

Soils marked none should include land permanently in range, pasture, or forest.

Forest should be indicated if crop land (possibly Class III or IV) might best be planted to trees.

Primarily sod includes soils that can be farmed. Because of slope, depth, drainage, erosion, tillage problems, or other limitations, its best use is permanent sod. This soil would be cultivated only to establish or re-establish a stand.

Sod  $\frac{1}{2}-\frac{2}{3}$ of time means that soils can be used for annual or cultivated crops if sod crops are systematically used in the rotation to control erosion, build fertility, and restore soil structure.

Crop rotation for fertility only is indicated if soil building or sod crops are needed only to maintain fertility. This would apply to soils with no erosion hazard, no tillage difficulties, or other limitations. Usually, this means Class I or II soil. Judge this item on the ability of the soil. Many soils in this category are profitably used for improved pasture, hay, seed, or similar long-lived crops.

Reaction correction measures are often needed to improve acid or alkaline soils. A pH test kit or the results of a soil test is needed to fill in this section. If neither one is available, do not guess.

When using a pH kit, fill this section in as follows:

Mark none here if the pH reading is between 6.7 and 7.5 showing an almost ideal soil reaction. Also, mark here if the soil is suitable only for range or forest or if it has serious limitations such as slope, depth, or drainage to an extent that measures to correct acidity or alkalinity could not pay.

The addition of some form of agricultural lime is the recognized corrective measure for acid soils. Mark this square if the reaction is pH 6.5 or lower. This does not mean that lime should always be added for soils with this reaction. The application of lime should always be guided by a complete soil test and the fertilizer treatment recommended for each crop.

Correct alkali should be marked for soils with a pH reaction above 7.5. Corrective measures might begin with improved irrigation or drainage or the use of fertilizer with an acid reaction. A reaction of 8.0 or above calls for further special tests that might indicate the use of sulfur or gypsum.
Disregard this section unless the complete test results from the Oregon State University Soil Testing Laboratory and fertilizer recommendations for specific crops are available. If the test results and recommendations are available proceed as follows:

None should be marked for forest or range land or for soil with limitations so serious that fertilizer could not pay.

When the soil test level is below the adequate level indicated in the fertilizer recommendations, the use of phosphorus is indicated.

Follow the same procedure for potash, boron, and magnesium. Often more than one is needed.

### 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 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 provides 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-
servation 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 a 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 of 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.