

**Willamette
Valley**

Soil Quality Card Guide

To accompany
the Willamette Valley
Soil Quality Card,
EM 8711

EM 8710-E
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Willamette Valley

Soil Quality Card Guide

Farmers, conservationists, and other land managers need reliable methods to assess soil quality so they can make management decisions that maintain long-term soil productivity. A group of Oregon farmers has identified 10 soil-quality indicators for the Willamette Valley that can assess the impact of soil management. These indicators are specific to the cropping systems of the Willamette Valley.

These soil-quality indicators have been integrated into the *Willamette Valley Soil Quality Card*, EM 8711, which will help land managers evaluate the condition of agricultural soils. This Guide is designed to supplement the Soil Quality Card by providing information on the role of management, explaining why the soil-quality indicators are important, and giving detailed methods for judging them.

Each field soil that is assessed will start from a unique baseline or reference point, and the changes in indicators from year to year will show how management is affecting soil quality. An important point to remember is that soil-quality indicators are different than inherent soil characteristics, such as clay content, that are not affected by management.

Soil-quality indicators are highly interrelated. For example, conditions of soil structure such as aggregate stability, compaction, and pore size influence and are influenced by the activities of earthworms and other soil organisms. Water infiltration and availability, which are controlled by surface and sub-surface soil structure, affect plant root growth and plant health. Organic residue and root biomass from crop plants feed soil organisms and contribute to soil organic matter, which in turn enhances soil structure. These interrelationships begin to show the complexity of soil systems.

How to use this Guide

For each indicator, this Guide contains:

- A description of the indicator
- An explanation of why the indicator is important for judging soil quality
- A discussion of how management affects the indicator
- Suggestions for when to assess the indicator
- Instructions for performing an accurate assessment

The assessment calendar shows the times of the year that are best suited for assessment of each soil indicator. Times vary according to the crop grown, but it is important to maintain as much consistency as possible from year to year in the assessment of each field. Assessments of some or all of the indicators more than once a year also provide a clearer picture of potential changes in soil quality.

Several indicators include instructions for performing both a basic and a more rigorous assessment. The rigorous assessments give more precise information, but require more time and equipment than the basic assessments.

Regardless of the method used, accuracy increases if the same test or observation is done in several representative locations within a field to get an average rating for the indicator. Assessments performed consistently and carefully each year yield the most reliable information on soil quality.

Suggested Assessment Calendar

Indicator	Before planting	Active crop growth		Late fall	Winter
	Early spring	Spring	Summer/Fall		
1. Soil structure and tilth	✓	✓	✓	✓	
2. Compacted layers	✓	✓	✓	✓	✓
3. Workability		✓		✓	
4. Soil organisms	✓	✓		✓	✓
5. Earthworm abundance	✓	✓		✓	✓
6. Plant residue	✓	✓	✓	✓	✓
7. Plant vigor		✓	✓		
8. Root growth		✓	✓		
9. Water infiltration	✓	✓	✓	✓	✓
10. Water availability		✓	✓		

Management, crop, and climatic factors determine the optimum time of soil quality assessment. The assessment times in this calendar are appropriate for the Willamette Valley of western Oregon.

1 Does the soil have good structure and tilth?

What are soil structure and tilth?

Soil structure is the way the solid particles in a soil are put together. Soil porosity is maintained in part by soils having a good crumb structure. Crumbs are a soil subunit, or aggregate, that allows the free movement of air, water, plant roots, and organisms throughout the soil. Soils that lack a good crumb structure often lack good porosity. Friable soils are those soils with a granular structure in which the crumbs easily break apart from each other.

If the individual soil crumbs break into powder easily, the soil is said to have poor aggregate stability. If the crumbs do not break apart at all, they are too hard or cemented. The formation of stable soil aggregates results from the binding action of humus and other soil organic matter components, the activities of soil organisms, and the growth of plant roots.

Good soil tilth means the soil works easily. Individual crumbs retain their shape under the stresses of tillage, yet the soil still is friable. Also related to tilth is bulk density, which is the weight per unit volume of dry soil. A lower bulk density means a higher soil porosity and better tilth.

Why are soil structure and tilth important?

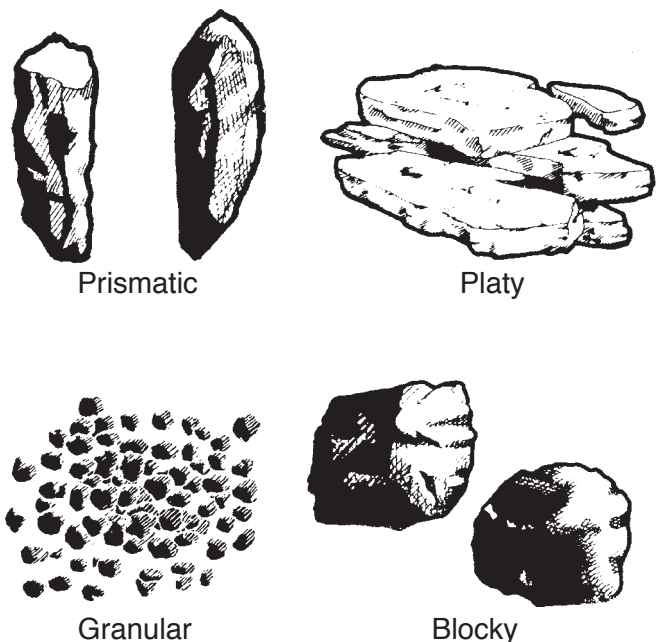
- Soils with ample pore space and an even distribution of large and small pores are well aerated, have good water-holding capacity and infiltration rates, and are easy for roots to grow through.
- Stable crumb aggregates preserve pore space in soils by preventing the clogging of pores with loose particles.

What's management got to do with soil structure and tilth?

Soil management directly affects soil structure and tilth. A seasonal or yearly assessment of this indicator may show whether current management practices are helping or hindering the free movement of air and water through the soil.

- Management of plant residue that encourages biological activity and residue decomposition creates soil organic matter and improves soil tilth and structure.
- Operations that allow erosion and compaction of the soil, such as leaving a field bare over winter or working clay soil when it is too wet, result in poor soil tilth and structure.

Types of soil structure



How is the indicator assessed?

- Assess soil structure and tilth when the soil is not extremely wet or dry. Do not assess frozen soils.
- When you make these assessments, be sure to note how much time has passed since the last tillage operation.

Basic test

Materials needed

Shovel
Squirt bottle with water

What to do

1. In one or more representative areas of the field, dig out a section of soil 6–10 inches deep.
2. Take an intact portion of soil about the size and volume of a 15-ounce soup can from the shovel.
3. With your finger, lightly break apart this piece of soil. Look for individual granular crumbs. If crumbs are present, squeeze a few of them between your thumb and forefinger and note the amount of pressure required to collapse them.
4. Use the squirt bottle to gently wet some of the remaining intact crumbs. Now see how much

pressure is needed to break them, comparing this effort to the pressure used when the crumbs were not wetted. Note the resistance difference between the wetted and unwetted crumb aggregates.

Kitchen scale test

Materials needed

Shovel
Squirt bottle with water
Small kitchen scale

What to do

Complete steps 1–2 of the basic test. Then substitute the following for steps 3 and 4:

1. Place a soil crumb that is about 1 cubic inch in volume on the tray of the scale. Press down with your forefinger on top of the crumb until it breaks. Record the weight at the time when the crumb broke apart.
2. Repeat this procedure using a moistened soil crumb.
3. Record how many pounds of pressure are needed to break the crumb.

Rating the indicator		
Least desirable=0	Moderate=5	Preferred=10
Soil has a cloddy, powdery, massive, or flaky structure with no visible crumbs.	Soil has some crumb structure. Individual crumbs break under only slight pressure and are much more fragile after wetting.	Soil is friable and crumbly with a definite granular crumb structure. Aggregates maintain their shape under moderate pressure even when wet, but still can be broken between fingers.

Note: Aggregates that cannot be broken with pressure between the thumb and forefinger when either wet or dry and that maintain their shape under at least 15 lb of force or greater are considered too hard and should be rated as least desirable.

2 Is the soil free of compacted layers?

What is compacted soil?

Compacted soil is dense and can have a platy structure. Compaction occurs when farm machinery repeatedly passes over the same area of soil. The weight of the equipment, the number of trips across the field, and the type of soil determine the degree of compaction.

The sliding action of tillage equipment over the same layer of subsoil also can create compaction. Clay smeared across the tops of pores makes an impermeable layer of soil.

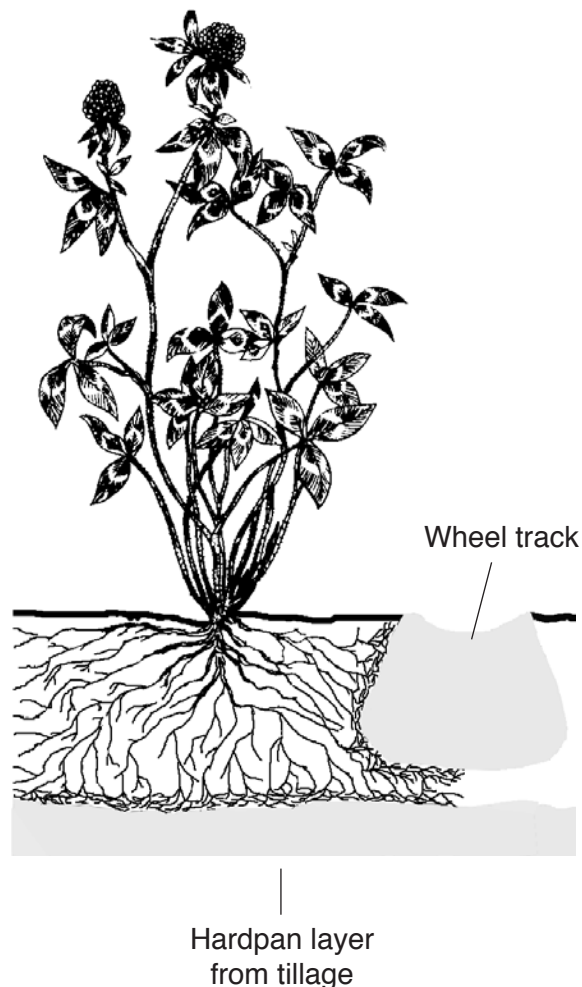
Why is compaction important?

- Compaction can severely restrict air and water movement through the soil.
- Plant root growth is diminished by compacted soil.
- The reduced pore space of compacted soils also limits microbial activity and the ability of earthworms and other organisms to live in the soil.

What's management got to do with compaction?

- The more intensely a soil is tilled, the more likely it is to be compacted. Fewer trips across the field also can reduce compaction.
- Compaction can be prevented or reduced by not working soils when they are too wet.

- Often, compacted layers are found just below the tilling zone. This depth is the downward limit of stirring and loosening action performed by the implements. Physically breaking through a deep compacted layer with subsoiling equipment when the soil is dry can counteract deep compaction.
- Addition of cover crops and other organic residues can build soil organic matter. Inputs of organic residue contribute to biological activity and aggregate stability, which are important in resisting compaction.



How is the indicator assessed?

- Assess soil compaction both before spring tillage and during the crop growing season.
- Soil moisture content greatly affects penetration into the soil. Do this assessment when there is adequate moisture in the soil for crop growth.

Materials needed

Wire flag

What to do

Hold the wire flag near the flag end and push it vertically into the soil at several different locations in the field. Record the depth at which it bends due to resistance in the soil.

Rating the indicator		
Least desirable=0	Moderate=5	Preferred=10
The flag bends readily. Plant roots that turn horizontally indicate a hardpan.	Some restrictions to a penetrating wire flag, some root growth restrictions.	The wire flag can penetrate all the way into the topsoil beyond the tillage layer and into the subsoil without bending.

3 Is the soil worked easily?

What is workability?

Workability is the ease with which a field is prepared for planting. A workable soil is one that:

- Does not form heavy clods or powder when tilled
- Breaks up evenly to form a good seedbed
- Requires a minimum amount of tractor energy to till

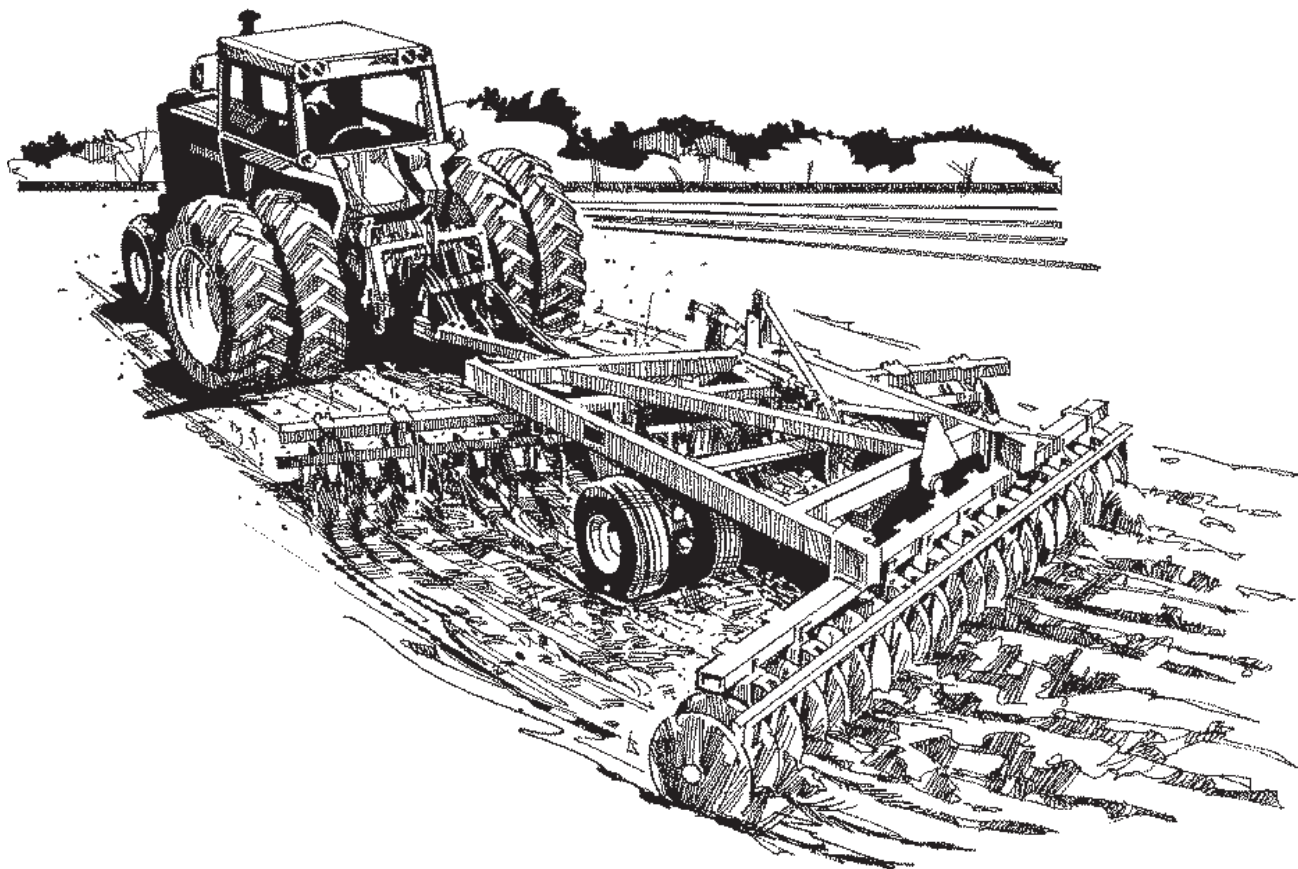
The number of trips across the field needed to prepare the soil, the gear required to pull tillage implements, and the amount of fuel used are gauges of workability.

Why is workability important?

- How easily a seedbed is prepared can indicate whether a soil is workable and therefore in good condition.
- Good workability means that water infiltration and soil structure are in a desirable state.

What's management got to do with workability?

Workability is closely related to soil tilth. Adequate soil organic matter helps to maintain tilth, and reducing tillage can help to avoid compaction.



How is the indicator assessed?

- Assess workability during tillage for seedbed preparation.
- Since different crops demand different kinds of seedbeds, it is very important to record the crop to be planted and time of year the field is prepared.

Materials needed

Notebook for tillage records

What to do

The procedure for this indicator is to keep good records of:

- The horsepower and gear needed to complete tillage
- The number of trips across the field
- Your estimate of the total fuel consumption for seedbed preparation and planting

Rating the indicator		
Least desirable=0	Moderate=5	Preferred=10
Tillage requires a high horsepower and low gears for primary tillage, high fuel consumption, and many cultivation passes to create a seedbed, or good seedbed preparation cannot be accomplished.	Tillage requires a medium amount of power and number of trips to prepare a good seedbed.	Tillage is noticeably easy and requires the minimum amount of tractor power, fuel consumption, and trips across the field to prepare a good seedbed. Primary tillage can be done in a relatively high gear.

4 Is the soil full of living organisms?

What is soil organism diversity?

The soil is a complex place that can support a large variety and abundance of life. Many different kinds of organisms live in the soil, and their activities and interactions affect everything from soil nutrient cycles to soil structure.

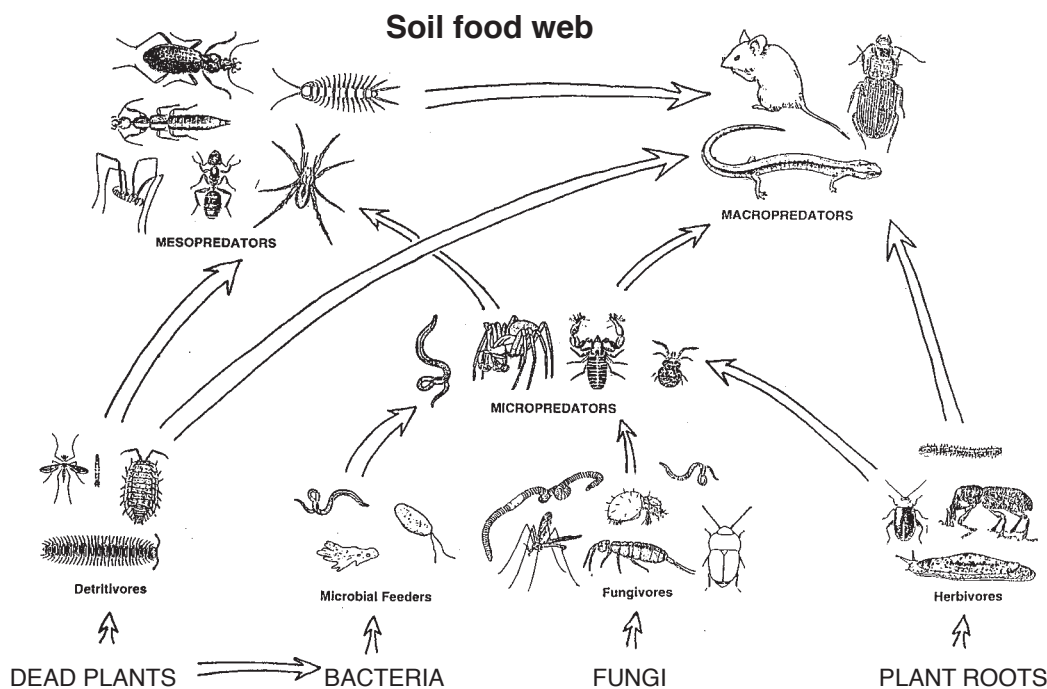
Why are soil organisms important?

- Each species of soil life contributes to the transformation of organic residue into soil organic matter and to nutrient cycling within the soil. If many different kinds of organisms are present in the soil, nutrients are more likely to be available for crop growth.
- Soil organisms transform residue inputs to form soil organic matter.
- Maintaining soil organic matter helps create a soil with good tilth and a reserve of plant nutrients.

- Diversity and abundance of soil organisms also provides conditions that can suppress pests and diseases.

What's management got to do with soil organisms?

- Management directly affects soil organism populations by affecting their food source. Addition of organic residue and cover crops can increase the activity and abundance of some kinds of soil life.
- Pesticides can suppress soil organism populations, particularly those of some of the larger predatory species.
- Tillage disrupts the habitat of soil organisms, but also helps to distribute organic residue within the soil.
- Strip tillage that leaves areas within the field undisturbed or reduced tillage can enhance soil organism populations.



How is the indicator assessed?

- Soil organisms are not active in hot, dry conditions. Assess this indicator in the late spring and as soon as possible after fall rains when soil is moist and relatively warm.
- Time of day and weather should be consistent among assessments since these factors also affect the activities of soil organisms.

Basic test

Materials needed

Shovel
Watch

What to do

1. Dig out a shovelful of soil down to at least 6 inches.
2. Examine the soil for an exact amount of time (2 to 4 minutes). Keep track of the numbers of individuals of each kind of soil organism you see.

Notes

It is important to search for the organisms for the same amount of time and with the same degree of interest each time so that comparisons are valid.

Many soil organisms avoid the light and are very small. Carefully and patiently pick apart the soil sample to see them.

Soil organisms smaller than ¼ inch require special equipment to be seen. The larger soil animals such as beetles, centipedes, and spiders also are difficult to see because they move quickly. *For these reasons, the more extensive tests described at the right give a more accurate picture of this indicator.*

Pitfall trap and Berlese funnel tests

Materials needed

Shovel
Plastic drinking cups about 6 inches tall
Funnel with a mouth about 6 inches in diameter
Piece of ¼-inch mesh screen
75-watt light bulb
12-ounce jar
Magnifying glass
Vegetable oil
Shallow dish

What to do

Pitfall trap for larger soil organisms

1. Dig a hole in the soil. Place the cup in the hole so the top of the cup is level with the soil surface. Fill in the soil around the outside of the cup.
2. Pour some vegetable oil into the cup.
3. Remove the cup after 1 week and record the number of individuals of each kind of soil organism.

Berlese funnel for smaller soil organisms

1. Put the screen in the top of the funnel.
2. Fill the funnel about halfway with topsoil collected that same day from the field.
3. Put about 1 inch of vegetable oil in the jar, and place the funnel so its spout empties into the jar.
4. Suspend the light bulb on a power cord about 4 inches above the soil in the funnel.
5. Leave the light bulb on until the soil in the funnel is very dry (about 3 days).
6. Pour the vegetable oil into a shallow dish. Using the magnifying glass, record the number of individuals of each kind of organism.

Rating the indicator*		
Least desirable=0	Moderate=5	Preferred=10
<p>Basic test: Almost no moving organisms are seen in the soil after 4 minutes of searching. Pitfall trap: Fewer than three organisms are seen in the trap. Berlese funnel: Fewer than 10 organisms are collected in the jar.</p>	<p>Basic test: One or two individuals of at least two kinds of soil organisms are found in the sample after 2 minutes of searching. Pitfall trap: Several individuals of about five kinds of organisms are seen in the jar. Berlese funnel: Several individuals of at least six kinds of organisms are seen in the jar.</p>	<p>Basic test: Several individuals of at least four different kinds of soil organisms are seen in the shovelful of soil. Pitfall trap: Several individuals of at least 10 different kinds of soil animals are seen in the jar. Berlese funnel: About 5 or 10 individuals of at least 12 different kinds of small soil organisms are seen in the jar.</p>

*The numbers of organisms listed are estimated guidelines. Future research may reveal that these numbers should be revised.

5 Are earthworms abundant in the soil?

What is earthworm abundance?

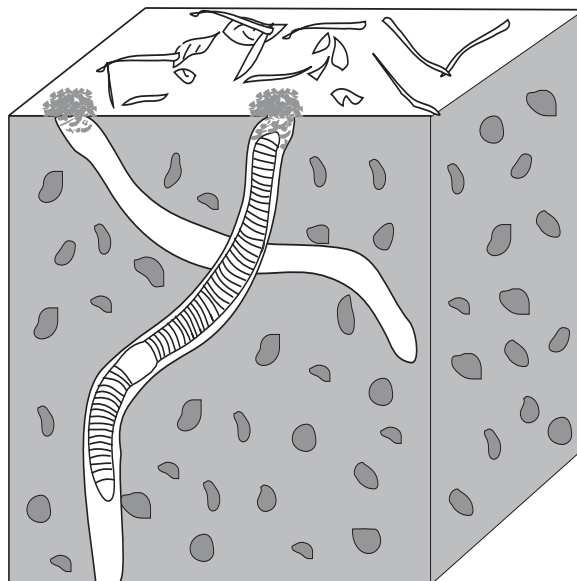
Different types of earthworms occupy specific parts of the soil. Some species create deep burrows, while others live just under the litter layer at the soil surface. Earthworm numbers vary from soil to soil according to soil type and cultivation history.

Why are earthworms important?

- Earthworms long have been recognized as an important part of good agricultural soils. Burrowing types ingest large amounts of organic material and mineral soil and excrete them as casts at the soil surface. Earthworm casts contain more enzymes, bacteria, organic matter, and available plant nutrients than the surrounding soil.
- Earthworms mix the soil and break up raw plant material. Some bring organic residue from the surface down into their burrows and in turn deposit minerals from deep soil layers at the surface with their casts.
- The movement of earthworms through the soil creates passageways that increase aeration and water infiltration. Their lubricating secretions bind soil particles together and increase aggregate stability.

What's management got to do with earthworms?

- Management can directly affect earthworm populations. Addition of organic residues and cover crops provides food sources and can increase the diversity and abundance of earthworms.
- Pesticides can suppress earthworm populations.
- Tillage removes surface residue that feeds and protects earthworms and disrupts their habitat, which can reduce populations.
- Earthworms need a well-aerated but moist habitat with a good supply of organic matter. These conditions are necessary for good soil quality and are indicated when abundant earthworm populations are present in a soil.



How is the indicator assessed?

- Earthworms are very sensitive to soil moisture and temperature. If the topsoil is too dry or saturated, or if the soil temperature is too hot or too cold, you won't see them.
- Assess earthworm abundance in the late spring and late fall when the soil is moist, but not saturated, and relatively warm.
- Time of day and weather should be consistent among assessments since these factors also affect earthworm activities.

Basic test

Materials needed

Shovel

What to do

1. Examine the surface of the soil and note the number of earthworm casts and obvious earthworm burrows.
2. Dig out a shovelful of topsoil down to at least 6 inches and carefully count the earthworms in this section of soil.

Mustard test

Materials needed

Open metal cylinder about 1 foot in diameter and about 1 foot long

Container able to hold ½ gallon of water

Mustard powder

Watch

What to do

1. Scrape off the surface vegetation and soil from an area slightly larger than the metal cylinder.
2. Push the metal cylinder into the soil as deeply as possible, but be sure to leave about an inch of it extending above the soil surface.
3. Mix 3 tablespoons of mustard powder in ½ gallon of water.
4. Carefully pour the mustard water mixture evenly over the soil surface within the cylinder.
5. After 5–10 minutes, count the number of earthworms within the cylinder as they emerge from the soil.

Rating the indicator*		
Least desirable=0	Moderate=5	Preferred=10
No earthworms are seen in a shovelful of topsoil or within the cylinder, and there is no evidence of burrows or casts on the soil surface.	Basic test: About three earthworms are found in the shovelful of soil, and only a few burrows and casts are seen. Mustard test: About five earthworms are counted in 10 minutes.	Basic test: More than five earthworms can be counted in a shovelful of topsoil, and there is abundant evidence of earthworm casts and burrows on the soil surface. Mustard test: Ten or more earthworms appear on the surface within the cylinder in 10 minutes.

*The numbers of earthworms listed are estimated guidelines. Future research may reveal that these numbers should be revised.

6 Is plant residue present and decomposing?

What is residue decomposition?

Plant residue from a previous crop or added organic material such as manure or straw decomposes over time and becomes soil organic matter. When good decomposition is taking place, organic residue is in all stages of breakdown, from recognizable plant parts, to individual plant fibers, to dark staining humus.

Soil organisms break down plant residue and recycle it into many different forms that benefit the soil. Most of the decomposition that takes place in soils is due to microbial activity. As larger soil organisms consume organic residue, they reduce it to smaller pieces, thus allowing bacteria and fungi to work more efficiently.

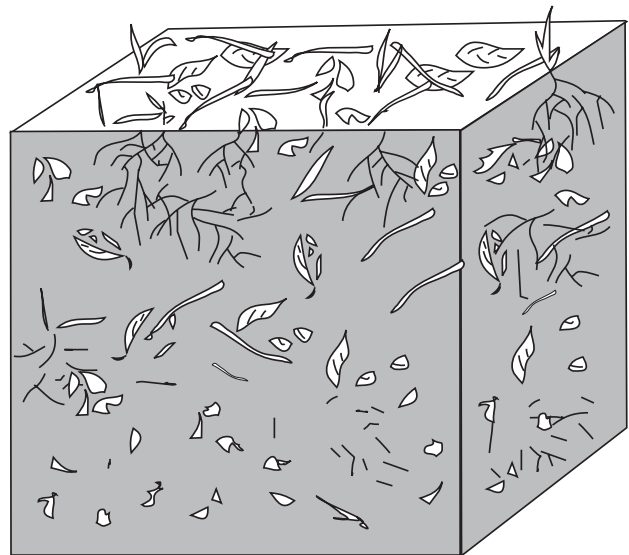
When the soil has enough air, decomposition occurs at an ideal rate and the soil has a fresh, earthy smell. Poorly aerated soil decomposes its organic matter more slowly and has a sour or pungent smell.

Why is residue decomposition important?

- Residue decomposition must take place for the soil to maintain its organic matter content. Organic matter is important to soil quality because it increases the soil's ability to supply essential plant nutrients.
- Soil organic matter helps maintain good soil structure. The activities of soil organisms create air and water passageways that improve soil structure.
- Rapid organic residue decomposition shows that a thriving biological community lives in the soil.
- When organic residue is present, it increases infiltration and water storage. In this way, the potential for erosion by water runoff is reduced.

What's management got to do with residue decomposition?

- Management systems that include cover crops and the addition of organic residues to fields supply the raw materials for organic matter formation.
- Management that allows plant residue to be distributed within the topsoil helps create soil organic matter in all stages of decomposition.



How is the indicator assessed?

- A good time to assess residue decomposition is during the growing season or in the fall, perhaps at the same time that soil structure is assessed.
- Wait at least 1 month after incorporating a cover crop or other residue before assessing this indicator.
- Be sure to do this assessment at the same state of soil moisture and temperature each time because these conditions affect the smell of the soil.

Materials needed

Shovel

Squirt bottle with water

1. Dig down to at least 6 inches and examine the soil for organic residue by breaking the soil apart with your finger. Look for evidence of organic residue in various stages of decomposition.
2. Put your nose close to the soil after breaking it apart and note the smell.
3. Lightly moisten some soil with the squirt bottle. Rub this soil between your fingers and see if it leaves a dark stain that is difficult to remove.

Rating the indicator		
Least desirable=0	Moderate=5	Preferred=10
Organic residue on or in the soil does not decompose for long periods of time; there is a sour, muck-like smell in the soil; and the soil does not stain the fingers.	A substantial amount of undecomposed material from the previous crop is present; there is no distinct smell in the soil; and there is only slight staining of the fingers.	Organic residue from the previous crop is present in the soil in various stages of decomposition; freshly dug soil has a sweet, earthy smell; and fingers are darkly stained after rubbing soil between them.

7 Do crops/weeds appear healthy and vigorous?

What is plant vigor?

Plant vigor is indicated by the health of individual plants in the field. Uniform growth of all crop plants in a field also is a factor in plant vigor. Crop plants within a field that reach maturity at the same time are another sign of good plant vigor.

Plant vigor is in some ways difficult to judge because plants respond to fertilizer inputs, pest problems, and other factors not directly related to soil quality.

The vigor of all plants growing in the field, including weeds, can be used to assess this indicator.

Why is plant vigor important?

Good plant growth requires a soil with good structure, water regulation, nutrient cycling ability, and a diversity of soil organisms. Good plant vigor is an indication that these conditions are present.

What's management got to do with plant vigor?

- With this indicator, it is especially important to determine whether the crop was under optimal management. If management was less than optimal (e.g., late planting, insufficient irrigation or rainfall, etc.), then plant vigor may not be a good soil-quality indicator.
- Examine the crop for pest or disease damage. It is important to determine whether the disease problem is related to soil quality. For example, root-borne diseases may be caused in part by compacted soil that remains saturated with water for long periods.



How is the indicator assessed?

- Assess plant vigor during the active growth phase of the plant, before flowering.
- The light conditions during the assessment must be the same each time; for instance, a shade of green looks different in full sunlight at midday than it would under a cloudy sky or later in the day.

What to do

Closely observe the crop plants at the same time each year during the same time of day and sky conditions. Look for:

- Plant color
- Uniformity of plant growth across the field
- General health and vigor of plants
- Appropriate rate of plant growth for current growing conditions

Rating the indicator		
Least desirable=0	Moderate=5	Preferred=10
The crop is uneven, stunted, discolored, and/or never reaches maturity.	The crop shows some uneven growth, is slightly discolored and stunted, and reaches maturity close to the time expected for the crop.	Healthy and vigorously growing plants show uniform growth and reach maturity in the time expected for the crop.

8 Do plant roots grow well?

What is healthy root growth?

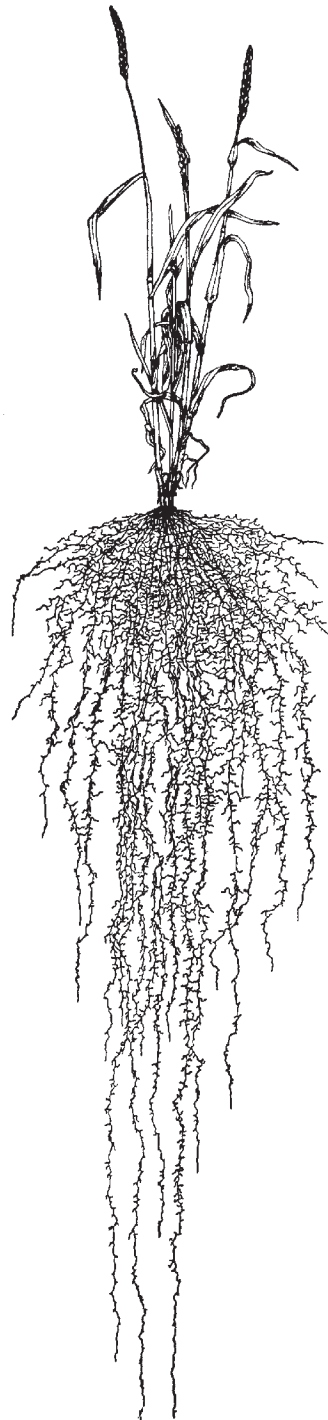
Root growth often is as extensive as above-ground plant growth. Soil with good structure encourages a strong root system that sends out many fine roots to explore as much of the soil as possible.

Why is root growth important?

- Roots are in direct contact with soil constituents such as air, water, organisms, and soil aggregates. If these factors are suboptimal, then plant roots show less than ideal characteristics.
- Plant roots supply the rest of the plant with nutrients and water. A strong root system anchors the plant and supports its upright growth.
- Good root growth may indicate a diverse population of soil organisms supported by abundant organic matter that inhibits the spread of certain root diseases caused by detrimental fungi, bacteria, or nematodes.

What's management got to do with root growth?

- Root growth can be restricted by compacted layers in the soil and by soil that is saturated with water for days at a time. Poor root growth can be an indication of these conditions.
- Management that encourages good soil structure also promotes root growth. Cultivation and compaction can inhibit root growth.
- Factors that contribute to good plant vigor are reflected in healthy roots as well.



How is the indicator assessed?

- Assess root growth at the same time that plant vigor is assessed—during the growing season of the plant.
- Moisture conditions in the soil should be similar for each assessment because the wetness of the soil may change the ease with which finer roots can be observed.

Materials needed

Shovel
Hand trowel

What to do

1. Dig around a crop plant as extensively as possible to get an idea of how deep the roots extend into the soil.
2. Examine the root system by separating the soil from the roots. Look for:
 - Extent of root system development
 - Number of fine roots
 - Color of new roots

Note: Weeds or annual crop plants can be removed completely from the soil for assessment. Examine perennial crop root systems in place by digging soil away from beside the plant and removing soil from around the roots with the trowel.

Rating the indicator		
Least desirable=0	Moderate=5	Preferred=10
A poorly developed root system has only a few fine roots; brown, diseased, or mushy-looking roots extend only a very short distance into the soil away from the crown of the plant.	The plant has some fine roots with a mostly healthy appearance, and only some evidence of restricted growth.	The root system is fully developed with many fine roots; grows into the soil well below the topsoil layer; and (for annuals only) has a white, healthy appearance on the new roots.

9 Does water infiltrate quickly?

What is water infiltration?

Water infiltration is the movement of water into the soil.

An important factor in water infiltration is the porosity of the soil. The number, lengths, and diameters of pores determine water movement and retention. Large pores (greater than ¼ inch in diameter) are responsible for most of the flow through soils.

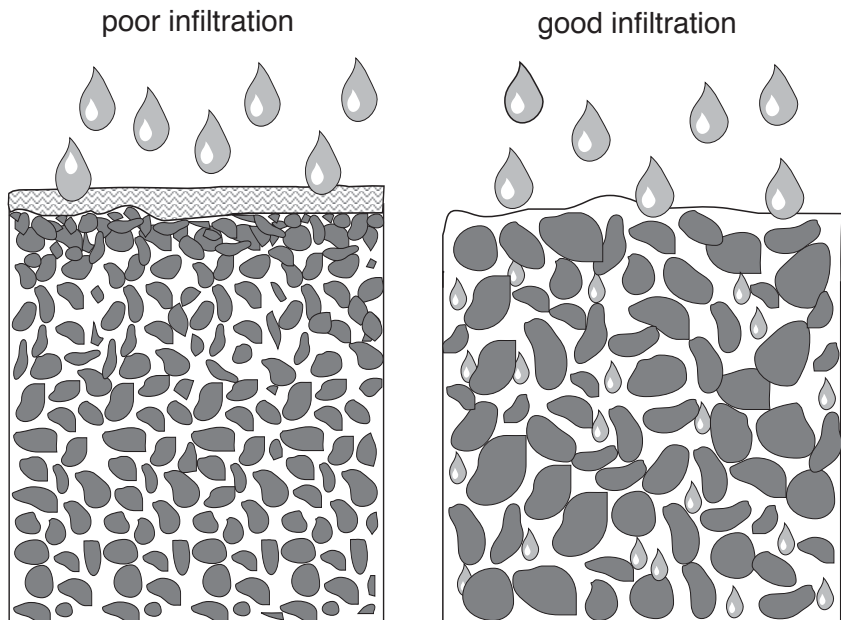
Water infiltration also is affected by factors such as texture and slope. Sandy soils in general have higher infiltration rates than finer-textured (clay) soils. Water tends to drain more quickly from higher ground.

Why is water infiltration important?

- Soil with good infiltration has little surface runoff and resists erosion.
- Good water infiltration means the soil dries out and warms up quickly after heavy rains.
- As water infiltrates into the soil and the surface layers dry, air can move into the pore space.
- Soil structure is an important factor that controls water infiltration. Unstable soil aggregates disintegrate when wet and release small clay particles that clog pores. Compacted layers in the soil slow water infiltration.

What's management got to do with water infiltration?

- Management that promotes topsoil with a loose granular or crumb structure and aggregates that hold together when wet helps maintain good water infiltration.
- Tillage operations that preserve soil structure promote good water infiltration.
- Cover crops or addition of organic residues improves soil aggregate stability.



How is the indicator assessed?

- Assess water infiltration after a heavy rainfall when you know the soil is completely saturated. Observe and record the duration of any ponding on the soil surface.
- If you use the open cylinder method (see below) to determine water infiltration, you can perform the test at any time of year. This assessment method is more quantitative and may be performed at more than one location in the same field.

Basic test

Materials needed

Notebook

What to do

To assess this indicator, observe the field after a saturating rain or irrigation, and record how long water stands in the field.

Cylinder test

Materials needed

Notebook

Open metal cylinder about 1 foot in diameter and about 1 foot long that is sturdy enough to be driven into the soil

Container with several gallons of water

What to do

1. Push the cylinder into the soil so that about 3 inches extend above the top of the soil to allow water to be “ponded” there.
2. Place a cloth or burlap bag on the soil surface to absorb the energy of the water as it is poured.
3. Gently fill the top of the cylinder with water and keep it full by adding water as it percolates down. Note that pouring water too vigorously on the soil surface may disrupt infiltration. Continue adding water and refilling the cylinder for about one-half hour or until you are sure the soil within the cylinder is completely saturated.
4. Observe the amount of time a known amount of water (e.g., 1 gal) remains on the surface within the cylinder after the soil within the cylinder is saturated.
5. It is important to note whether the cylinder has been placed in a tractor wheel track, because these areas usually allow slower infiltration than non-track areas.

Rating the indicator		
Least desirable=0	Moderate=5	Preferred=10
<p><i>Basic and cylinder tests:</i> There is ponding on the soil for 3 or more full days after the saturation event (rainfall, irrigation, or filling of the cylinder) has ended.</p>	<p><i>Basic and cylinder tests:</i> Ponding lasts up to 3 days after the saturation event (rainfall, irrigation, or filling of the cylinder) has ended.</p>	<p><i>Basic and cylinder tests:</i> No ponding is seen on the soil 24 hours after the saturation event (rainfall, irrigation, or filling of the cylinder) has ended.</p>

10 Is water available for plant growth?

What is water availability?

Water held in soil pores that is extractable by plant roots is called available water. This water resists evaporation and percolation due to suction forces within soil pores, but it is not held so strongly that roots cannot absorb it.

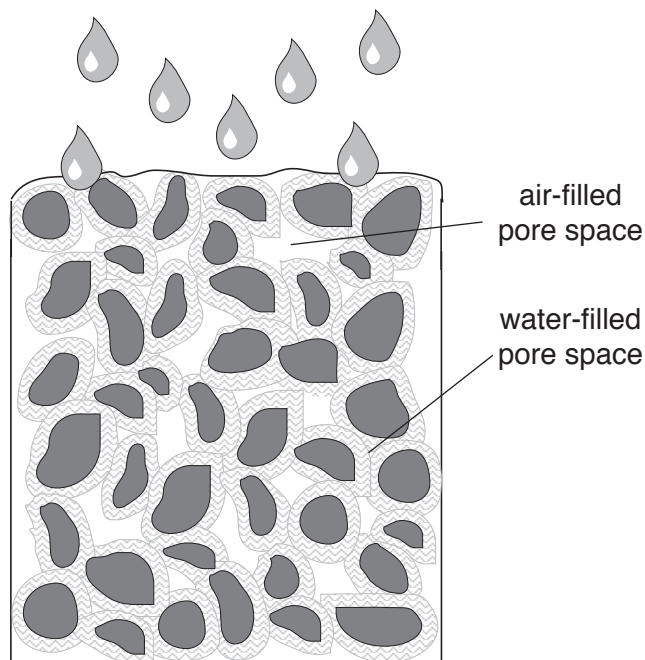
Soils with lower bulk densities (therefore more pore space) tend to have better water availability.

Why is water availability important?

Soil structure and organic matter are soil-quality factors that determine the ability of soil to retain water between rains or irrigations. Good water availability in a soil is another sign that soil structure and organic matter are in a desirable state.

What's management got to do with water availability?

- Practices that reduce compaction and bulk density, such as organic matter additions and not traveling over fields when they are wet, improve water availability in soils.
- Soil aggregate stability preserves pore space in soils and maintains water availability. Management that encourages soil organism populations improves aggregate stability.



How is the indicator assessed?

Assess this indicator during active crop growth when demand for water is high.

Record the amount of time between irrigations for the crop or how long after a soaking rain the crop begins to show signs of water stress. Be sure to record weather observations, because evaporation from the soil also is a factor and plants transpire more moisture on sunny days.

Rating the indicator		
Least desirable=0	Moderate=5	Preferred=10
The soil does not hold water for plant growth; frequent extra irrigation is necessary.	The soil has water available for some time after irrigation or rain.	The soil provides enough water to crops for an adequate period of time between rains or irrigations.

**Willamette Valley
Soil Quality Card**

EM 8711

Date: July 11, '97 Crop: Sweet corn Soil moisture
Field location: North Creek Year of planting: _____

- Good for planting
 Too dry for planting
 Too wet for planting

Indicator	Observations										Rating the indicator				
	1	2	3	4	5	6	7	8	9	10	1	5	10		
1. Does the soil have good structure and tilth?								<input checked="" type="checkbox"/>			Cloddy, powdery, massive, or flaky	Some visible crumb structure	Friable, <u>crumbly</u>		
2. Is the soil free of compacted layers?			<input checked="" type="checkbox"/>								Wire flag bends readily; <u>obvious hardpan</u> ; turned roots	Some restrictions to penetrating flag and root growth	Easy penetration of wire flag beyond tillage layer		
3. Is the soil worked easily?						<input checked="" type="checkbox"/>					Many passes and horsepower needed	Medium amount of power and passes needed	Tills easily; requires little power to pull tillage implements		
4. Is the soil full of living organisms?					<input checked="" type="checkbox"/>						Little or no observable soil life	Some (moving) soil critters	Soil is full of a variety of soil organisms		
5. Are earthworms abundant in the soil?								<input checked="" type="checkbox"/>			No earthworms	Few earthworms, earthworm holes, or casts	Many earthworms, earthworm holes, and casts		
6. Is plant residue present and decomposing?			<input checked="" type="checkbox"/>								No residue or not decomposing for long periods	Some plant residue slowly decomposing	Residue in all stages of decomposition; earthy, sweet smell		
7. Do crops/weeds appear healthy and vigorous?					<input checked="" type="checkbox"/>						Stunted growth, discoloration, uneven stand	Some uneven, stunted growth; slight discoloration	Healthy, vigorously and uniformly growing plants		
8. Do plant roots grow well?						<input checked="" type="checkbox"/>					Poor root growth and structure; brown or mushy roots	Some <u>fine</u> roots; mostly healthy	Vigorous, healthy root system with desirable root color		
9. Does water infiltrate quickly?					<input checked="" type="checkbox"/>						Water on surface for long periods after light rain	Water drains slowly; some <u>ponding</u>	No ponding after heavy rain or irrigation		
10. Is water available for plant growth?		<input checked="" type="checkbox"/>									<u>Droughty</u> soil, requires frequent irrigation	Moderate degree of water availability	The right amount of water available at the right time		
Other											<u>Little organic material</u>	<u>Medium</u>	<u>Lots of organic material; dark</u>		

Field Notes

Current field management (tillage, fertilizer, irrigation, crop rotation, other)

- Fall plow, 3x discing in spring
- Corn - beans - corn - beans

Ideas for changes in field management

- Deep ripping this fall
- More vetch in cover crop mixture

Credits

Twenty-four farmers representing a wide variety of farming operations and crops contributed to the design of this Willamette Valley Soil Quality Assessment Card. Development of the card was facilitated by Stefan Seiter, consultant in integrated agricultural systems; Arlene Tugel, soil scientist, USDA-NRCS Soil Quality Institute; John Burket, soil scientist, Agro-Ecology Northwest; Dan McGrath, Extension agent, Willamette Valley, Oregon State University; Richard Dick, professor of soil science, Oregon State University; and Cathy Seybold, soil scientist, USDA-NRCS Soil Quality Institute. Support was provided by NRCS field office staff, your local Soil and Water Conservation District, Oregon State University Extension Service personnel, and the USDA SARE program.

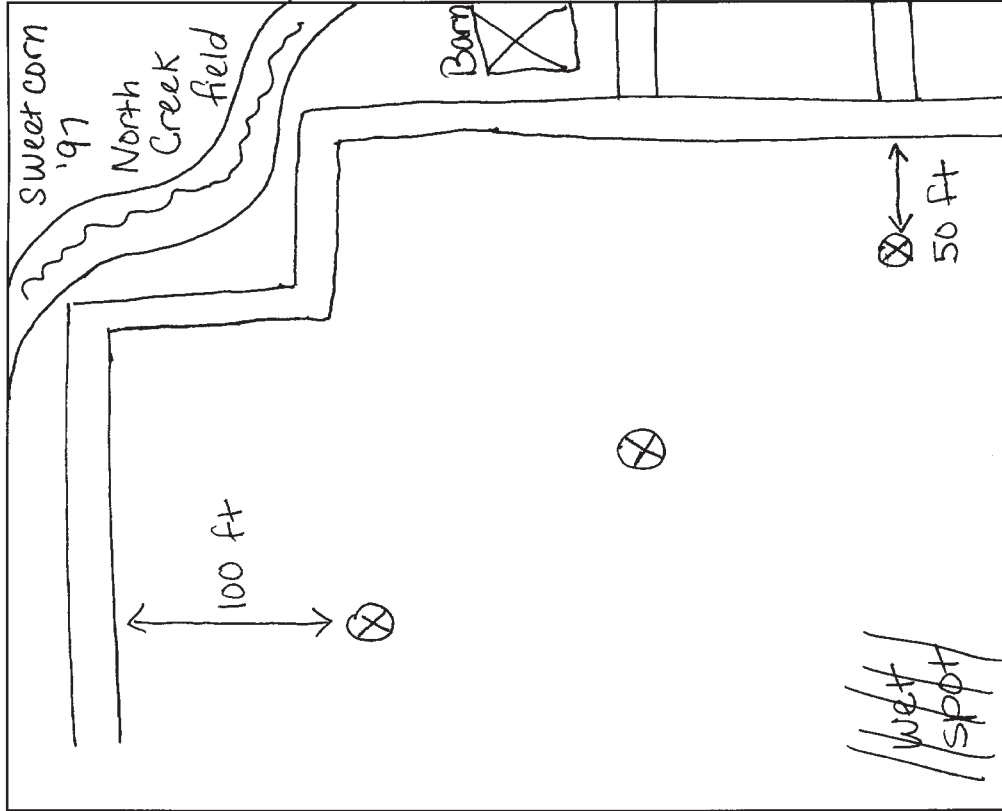
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Additional copies

The *Willamette Valley Soil Quality Card* (EM 8711) is available in printed sets of 25. For additional information, see the OSU Extension online catalog (<http://extension.oregonstate.edu/catalog/>), email puborders@oregonstate.edu, or phone 1-800-561-6719.

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Map of field sampling locations



Soil Quality Institute
Natural Resources Conservation Service