Land Preparation

Select and implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion.

a. **Improve physical condition of soil:** Producers describe soil's physical conditions using terms such as "softness," "mellowness," "workability," or "tilth." Soil scientists measure soil physical conditions using the terms "bulk density," "penetrability," "water infiltration rate," "water holding capacity," and "erodibility." Soil that has good physical condition is porous, like a sponge, rather than tightly packed, like a ball of modeling clay. Soil in good physical condition provides several benefits for plant growth.

    i. Plant roots can grow through the soil without restriction.

    ii. Air, water, and nutrients needed by plants and soil organisms can move through the soil with relative ease.

    iii. Water from rainfall or irrigation seeps into the soil, rather than flowing over the soil surface as runoff.

    iv. Soil organisms involved in decomposition and mineralization of plant and animal residues are able to thrive and disperse throughout the soil.

b. **Improve chemical properties of soil:** Producers describe soil chemical properties in terms of soil fertility, salinity, and acidity or alkalinity (soil pH). Soil fertility can be subdivided into nutrient availability for plant uptake, the soil's nutrient-holding capacity, and the balances among plant-available nutrients. You can evaluate your soils for good chemical conditions by monitoring the following characteristics.

    i. Soils have a near-neutral pH (unless the soil is used to grow acid-loving crops)

    ii. Sufficient nutrients are available for productive crop growth, but not in excess that causes plant toxicities or contaminates nearby streams or aquifers.

    iii. Soil nutrients are in forms available for plant uptake, but they are held sufficiently enough not to be easily leached or carried away by runoff.

    iv. The availability of plant nutrients is sufficiently balanced to promote healthy plant growth and microbial activity. This objective recognizes that a plant is only as healthy as its most limiting nutrient allows.

    v. Soils do not contain toxins or heavy metals in concentrations high enough to inhibit plant growth or the growth of beneficial soil organisms.

    vi. Soils contain enough moisture to facilitate nutrient movement to plant roots.

    vii. Soils contain sufficient oxygen for plant growth and the growth of soil organisms.

viii. Soils contain relatively high levels of organic matter, which helps them hold water and nutrients.

c. **Improve biological properties of soil:** Improving soil physical and chemical properties is important for both conventional and organic production, but improving biological properties is particularly important for organic production. Producers describe soil biological health in terms of "earthy smell," "soil crumbliness," and "greasy feel." Soil scientists measure soil biological health in terms of microbial biomass, microbial communities, and rate of organic matter decomposition. Organic production relies on nutrients released through the decomposition of plant and animal residues. Decomposition is a biological process involving a variety of soil organisms, including beetles and other insects, worms, nematodes, fungi, bacteria, and algae. You can evaluate your soils for healthy biological properties by monitoring the following characteristics.

i. Plant and animal residues added to the soil are readily broken down and decomposed so that plant nutrients become available.

ii. A good soil structure, provided by stable organic compounds, remains following the decomposition of plant and animal materials.

iii. Soil is well-aggregated; that is, it is composed of soft clumps held together with fungal threads and bacterial gel.

iv. Legumes form healthy nodules and fix abundant nitrogen, especially in nitrogen-depleted soils.

v. Plants have a relatively high resistance to soil-borne diseases.

d. **Minimize soil erosion:** Soil erosion is the loss of surface soil to forces of wind and water. Soil erosion reduces soil productivity and can cause water and air pollution. Minimizing soil erosion is critical for sustainable agricultural production, because the top layer of soil has properties—physical, chemical, and biological—that are much more favorable for crop production than the lower layers. The topsoil also contains more organic matter than the lower layers. This native soil organic matter—which represents centuries of plant growth, death, and decomposition in the soil—can both protect soil against erosion and be easily lost to it. Soil aggregates, held together by organic compounds, facilitate water infiltration and enhance water-holding capacity. They also are slow to erode because of their size and weight. However, if soil aggregates are broken down—by dry conditions, excessive tillage, or by raindrop impact—the resulting organic matter particles are very lightweight and easily removed by erosion. Tillage prepares land for seeding or transplanting. Cultivation practices—implemented either before or after crops are in the ground— manage weeds and improve soil aeration and water infiltration. Traditional clean tillage disrupts soil organisms, reducing their numbers and, often, their diversity. Clean tillage also breaks down soil aggregates and produces a bare soil that is vulnerable to erosion and more subject to temperature changes than soils that have a mulch or vegetation cover. Under direct exposure to sun and high temperatures, soil organisms break down soil organic matter rapidly. The rate of organic matter decomposition further increases when tillage breaks soil aggregates into smaller pieces, increasing their surface area and exposure to oxygen. While a rapid breakdown of organic matter can benefit plants by increasing nutrient availability, a substantial decrease in organic matter reduces aggregate stability, decreases soil tilth, and increases the potential for nutrient loss through leaching and runoff. Conventional farmers control weeds through a combination of synthetic herbicides and physical cultivation, including cutting, burning, incorporation, or plowing. Herbicides can harm soil organisms, thereby reducing nutrient cycling and aggregate formation. Physical cultivation methods vary in their impact on soil ecology and soil susceptibility to erosion. For example, plowing under weeds or crop residues can disrupt microbial populations and produce a bare soil that is susceptible to erosion. In contrast, practices that cut weeds and leave them on the soil surface can protect the soil against raindrop impact, the heat of the sun, and drying winds, while providing soil organisms with a source of food and energy. (Unfortunately, these weeds may also be sources of plant diseases.) As stated above organic producers must use tillage and cultivation practices that "maintain or improve the physical, chemical, and biological properties of soil." Tillage and cultivation practices that meet these criteria will have the following general characteristics.

i. Promote water infiltration
ii. Minimize soil compaction
iii. Minimize degradation of soil aggregates
iv. Protect soil from the erosive forces of wind and water
v. Minimally disrupt the habitat of beneficial soil organisms
vi. Return or add plant or animal residues to the soil to serve as food and energy sources for soil organisms. Practices that you can use to reduce soil disturbance, provide a residue cover, or otherwise protect the soil surface from erosion and organic matter loss include;
vii. Minimum tillage
viii. Undercutter or roll-chopper tillage
ix. Mulch tillage or otherwise mulching with organic materials
x. Promoting rapid growth of the crop canopy
xi. Flame weeding.

Choosing the appropriate tillage and cultivation practices and implements for your fields depends on the location of the farm, the soil type, the crop being produced, the time of year, the climate, and weather conditions in a particular year. Tillage tools that are most damaging to soil structure are those that shear soil particles, such as moldboard and disk plows, while sweeps and chisels cause less damage. Environmental and management factors can interact with particular tillage or cultivation practices to increase risks of soil-borne plant diseases and insect infestations, delay seed emergence, or inhibit organic matter decomposition and nutrient mineralization. To further "maintain or improve the physical, chemical, and biological properties of soil" you can use practices that replace organic matter lost to decomposition. These practices include the use of:

xii. Cover crops
xiii. Green manures
xiv. Compost
xv. Mulch
xvi. High residue crops
xvii. Perennial crops

e. **Use of crop rotations and cover cropping as cultivation practices.** Cultivation is any practice used to "improve soil aeration, water infiltration and conservation, and control weeds." In a well-managed cropping system, crop rotations and cover crops can provide the benefits of cultivation and compensate for many of its negative impacts. This is consistent with Crop Rotation Standard, which states that a *"producer must implement a crop rotation including crops that provide the following functions that are applicable to the operation":*

i. Maintain or improve soil organic matter content;
ii. Provide for pest management in annual and perennial crops;
iii. Manage deficient or excess plant nutrients; and
iv. Provide erosion control."

Rotating cold- and warm-weather crops can suppress weeds by disrupting their life cycles. Alternatively, some crops exude chemicals that suppress weeds. Good crop rotations involve crops that have different planting dates, rotation habits, and lengths of production, cultivation requirements, and harvesting requirements. All of these factors affect the ability of plants to compete with weeds. Cover crops effectively reduce weed pressure by occupying the space and using the light, water, and nutrients that would otherwise be available to weeds. Cover crops can also be cut or lightly incorporated just prior to planting the main crop. The residues left after this cutting provides a cover over the soil surface that suppresses seed germination. Cover crops indirectly affect weed growth by increasing soil organic matter and soil tilth. Compacted or infertile soils favor the growth of some weeds, while crop plants compete better in fertile, well aggregated soils.

Contact your local extension agent for further information and assistance…………