Best Management Practices

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What are healthy soils?

- **Plant productivity depends on healthy soils.**
  - Soils are an ecosystem comprised of billions of bacteria, fungi, and other microbes.
  - Healthy soils are similar to other ecosystems in that they are comprised of high levels of biodiversity and balanced nutrient cycles.

- **Different forms of agriculture place an emphasis on different soil properties.**
  - Industrialized agriculture primarily focuses on the nutrient levels of the soil.
  - Sustainable agriculture primarily emphasizes maintaining soil nutrients and biodiversity.
  - Regenerative agriculture primarily emphasizes improving nutrient balance and biodiversity.

The Dust Bowl is a stark reminder that the failure to sustain and regenerate healthy soils will ultimately lead to severe consequences.
What are healthy soils?

• Components of Healthy Soils
  • Balanced Soil Composition (loams that consist of balanced levels of sand, silt, and clay).
  • Appropriate soil structure - 50% porespace and crumbly aggregates.
  • Sufficient soil organic matter (2-10%).
  • Sufficient but not excessive soil nutrients.
  • Neutral or slightly acidic soil pH (usually 6-7).
  • Abundant and diverse soil microbial communities.
Benefits of healthy soils

• Benefits of Healthy Soils:
  • Improved crop productivity
  • Reduced erosion
  • More water infiltration, absorption, & retention
    • Water infiltration describes the rate at which water moves from the soil surface into the soil porespace.
  • Reduced weeds and pests
  • Reduced need for irrigation, fertilizer, and pesticides
  • Improved carbon sequestration (the capacity of soil to store carbon-based molecules and slow the production of carbon dioxide).
Group Questions

• What is a healthy soil?
• What are some factors that determine the health of soil?
• How do different kinds of agriculture differ in regards to what soil properties they prioritize?
• Summarize the benefits of healthy soils.
• Define water infiltration and carbon sequestration and summarize how these properties affect soil health.
Modern Soil Concerns

• Modern US agricultural practices generally do not sufficiently support soil health. For example...
  • The current rate of erosion is ten times greater on average than the rate of soil formation. [Source]
  • An acre of Midwestern cropland loses an average of 1000 lbs. of soil organic carbon per year. [Source]
    • This reduces the water retention of that soil, making it more susceptible to drought and erosion.
  • Agriculture is the leading cause of water contamination in the US, primarily because of runoff from farm fields. [Source]
  • Soil compaction occurs on nearly ever US farm, reducing plant productivity by reducing soil porespace. [Source]
  • Modern agricultural practices generally reduce soil microbe biodiversity, resulting in deceased long-term productivity.
Best Management Practices

- Best Management Practices (BMPs) are options for maintaining current levels of food production without degrading agricultural soils.
  - Best Management Practices (BMPs) are a series of agricultural practices that can maintain agricultural productivity and profitability while minimizing the negative environmental consequences of food and fiber production.
  - BMPs improve the sustainability of agricultural production with minimal impacts on farm income (or sometimes even gains to farm income).
- BMPs reduce soil losses, protect water from contamination, promote biodiversity, and improve air quality.
  - BMPs can also increase profits in some cases and generally reduce the costs of farming.
  - Over the long run, BMPs improve farm productivity by improving soil health.
Best Management Practices

- Best Management Practices (BMPs) apply to a wide range of agricultural practices.
  - Some apply more to cropping systems while others are specific to animal agriculture.

- BMPs for crop production generally support the following soil health principles:
  1. Minimize disturbances
  2. Maximize soil cover
  3. Maximize biodiversity
  4. Maximize presence of living roots

Planting cover crops after harvesting the main crop improves soil health by adding biodiversity, maximizing soil cover, and by keeping roots in the soil.
Group Questions

• Do modern agricultural practices in the US generally support healthy soils? Justify your stance with evidence.
• What are BMPs?
• What are some reasons for why farmers should consider adopting BMPs?
• Summarize four principles for maintaining soil health through BMPs.
BMPs – Nutrient Management

• Crop Nutrient Management is a practice which matches nutrient application to a field with a crop’s need for nutrients.
  • In other words, the goal is to apply fertilizers and other sources of nutrients in a precise manner so that soil nutrient levels are closely matched to plant nutrient needs.

• This reduces the risk of nutrient runoff, which occurs when nutrients like nitrogen and phosphorous are washed into surface water or leached into groundwater.
  • Proper nutrient management can reduce the risk of hypoxia (dangerously low oxygen levels) caused by high levels of nutrients in aquatic ecosystems.
  • This BMP can also increase profit per acre by reducing the need for fertilizer without reducing crop productivity.

• Source: http://www.pvpc.org/sites/default/files/files/PVPC-Agricultural%20BMPs%281%29.pdf

Precise tracking of field nutrient levels minimizes runoff and improves profits.
BMPs – Crop Rotation

• Planting the same crops over multiple years increases susceptibility to disease and insect pressure.
  • This is because some of the pests may overwinter in last year’s plant residues (the leftover leaves, roots, and stalks).

• Monocultures (fields that are planted in the same crop year after year) increase the need for pesticides and are more susceptible to disease outbreaks.
  • Monocultures also reduce soil microbial biodiversity and generally has a higher risk of erosion.

• Crop rotation involves planting different crops in a rotating sequence year after year.
  • Well-planned crop rotations reduce compaction, erosion, disease problems, and weed prevalence while improving soil microbial diversity.
  • Rotating high-residue crops (those that leave large amounts of plant matter after harvest) can also increase soil organic matter.

  • Source: http://mccc.msu.edu/xps/courses/SD_2009_Tillage-crop-rotations-and-cover-crops-BMPs-for-corn-s.pdf

Monocultural systems require more inputs and have greater susceptibility to pests.
BMPs – Conservation Tillage

• Conservation Tillage is a system of crop production that leaves soil and crop residue undisturbed for as long as possible by minimizing the use of plowing and other forms of tillage.
  • This is sometimes called “no-till” or “reduced-till”.
  • Conservation tillage increases soil organic matter, improves soil quality & productivity, and can reduce soil erosion by as much as 90 percent.
  • Conservation tillage can improve profits by reducing labor, equipment costs, and fuel use.

• Source: http://www.pvpc.org/sites/default/files/files/PVPC-Agricultural%20BMPs(1).pdf

Conservation tillage involves using minimal tillage. In this example, the new crop is being planted in a field where residue from the previous crop is still present.
BMPs – Cover Crops

• **Cover crops** are planted after the primary crop is harvested.
  • Cover crops slow erosion, improve soil health, enhance water availability, smother weeds, help control pests and diseases, and increase biodiversity on a farm.
  • Cover crops are generally not grown for profit; rather, they are meant to improve soil health and increase the productivity of primary crops such as corn, soybeans, or wheat.

• There are three categories of cover crops:
  • **Legumes** (such as clover, peas, & beans) can “fix” (convert) non-useful nitrogen in the air to useful forms for plants, increasing soil fertility.
    • *Legumes also reduce erosion, and support beneficial insects like pollinators.*
  • **Non-legumes** (such as forage grasses and radishes) are used to reduce excess nutrient levels, reduce erosion, suppress weeds, and increase soil organic matter.
  • **Mixture cover crops** consist of a variety of different species to better accomplish a specific objective (such as cold tolerance, supporting pollinators, or weed reduction).

• Source: [https://www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops](https://www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops)
Cover Crop Examples

- Different kinds of cover crops provide different kinds of benefits.
  - For example, sorghum is effective for preventing erosion and reducing soil compaction but does not add nitrogen to the soil.

- Cover crops can be paired with other BMPs to maximize effectiveness.
  - Cover crops are more effective when combined with conservation tillage & nutrient management.
  - Cover crop selections should also be varied to support crop rotation.

<table>
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<th>Species</th>
<th>Erosion Reduction</th>
<th>Biological N Fixation</th>
<th>Supplemental Grazing</th>
<th>Reduce Soil Compaction</th>
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Table Source: [http://mccc.missouri.edu/content/uploads/2016/10/SD_2009_Tillage-crop-rotations-and-cover-crops_BMPs_for_corn1.pdf](http://mccc.missouri.edu/content/uploads/2016/10/SD_2009_Tillage-crop-rotations-and-cover-crops_BMPs_for_corn1.pdf)
BMPs – Conservation Buffers

• Conservation buffers (or “buffer strips”) are strips of vegetated land between cropland and native habitats or surface water.
  • Buffers are meant to reduce nutrient runoff, provide habitat, and stabilize the banks of waterways.
  • Buffers can filter precipitation, reduce wind erosion, and reduce flooding by slowing the rate of runoff.

• Buffers can also provide financial incentives to farmers through programs like the Conservation Reserve Program.
  • This program provides federal rental payments to farmers in exchange for converting agricultural land into habitat.
  • CRP is the largest private land conservation program in the US, protecting tens of millions of acres of wildlife habitat.

Conservation buffers protect aquatic habitats from runoff by establishing a vegetative barrier that traps nutrients and topsoil from the field.

Source: [http://www.pvpc.org/sites/default/files/files/PVPC_Agricultural%20BMPs(1).pdf](http://www.pvpc.org/sites/default/files/files/PVPC_Agricultural%20BMPs(1).pdf)
Soil Health in Gardens

• **Soil health is not only a concern for farmers.**
  • Home owners and gardeners should also adopt practices that improve soil health.

• **Six practices that gardeners should adopt include:**
  • Test soils to maintain balanced nutrient levels.
  • Add organic matter to soil on a regular basis.
  • Utilize compost to reduce compaction, improve porespace, and maximize nutrient and water availability.
  • Use mulch or cover crops between primary crops.
  • Avoid chemical treatments as much as possible by using proper soil and crop management.
  • Rotate crops on a regular basis.

• Source: [https://extension.umn.edu/how-manage-soil-and-nutrients-home-gardens/living-soil-healthy-garden](https://extension.umn.edu/how-manage-soil-and-nutrients-home-gardens/living-soil-healthy-garden)
Group Questions

• Summarize each of the following and describe how they improve soil health:
  • Nutrient Management
  • Crop Rotation
  • Conservation Tillage
  • Cover Crops
  • Conservation Buffers

• Do BMPs apply to gardeners and home owners? Explain.
Summary of Group Questions

• What is a healthy soil?
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• Summarize the benefits of healthy soils.
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• Summarize four principles for maintaining soil health through BMPs.
• Summarize each of the following and describe how they improve soil health: 1) Conservation Tillage; 2) Cover Crops; 3) Crop Rotation; 4) Nutrient Management; 5) Conservation Buffers
• Do BMPs apply to gardeners and home owners? Explain.