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Natural Resources Conservation Service

Resource Concerns

SOIL

Sheet, Rill and Wind Erosion

Soil Erosion - Sheet, Rill and Wind Erosion

Detachment and transportation of soil particles caused by rainfall runoff/splash, irrigation runoff, or wind that degrades soil quality.

What is it?

Wind or water erosion is the physical wearing of the earth's surface. Erosion is not always readily visible, even when soil loss exceeds unsustainable levels. Symptoms of soil erosion by water may be identified by small rills and channels on the soil surface, soil deposited at the base of slopes, sediment in streams, lakes, and reservoirs, and pedestals of soil supporting pebbles and plant material. Water erosion is most obvious on steep, convex landscape positions. Symptoms of wind erosion may be identified by dust clouds, soil accumulation along fence lines or snowbanks, and a drifted appearance of the soil surface.

Why is it important?

Erosion removes surface soil material (topsoil), reduces levels of soil organic matter, and contributes to the breakdown of soil structure. This creates a less favorable environment for plant growth. Loss of only 1/32 of an inch can represent a 5 ton/acre soil loss. In soils that have restrictions to root growth, erosion decreases rooting depth, which decreases the amount of water, air, and nutrients available to plants. Erosion removes surface soil, which often has the highest biological activity and greatest amount of soil organic matter. Nutrients removed by erosion are no longer available to support plant growth on-site, and when they accumulate in water, algal blooms, lake eutrophication, and high dissolved oxygen levels can occur. Deposition of eroded materials can obstruct roadways and fill drainage channels. Blowing dust can affect human health and create public safety hazards.

What can be done about it?

Soil erosion can be avoided by maintaining a protective cover on the soil and modifying the landscape to control runoff amounts and rates. To avoid water erosion, include high residue, perennial, and sod crops in the cropping system, grow cover crops, manage crop residues, and shorten the length and steepness of slopes. To avoid wind erosion, keep soil covered with plants or residue, plant windbreaks, use stripcropping, increase surface roughness, cultivate on the contour, and maintain soil aggregates at a size less likely to be carried by wind.

Sheet, Rill and Wind Erosion at a Glance

Problems / Indicators - Changes in soil horizon thickness, soil deposition in fields and water, and decreased organic matter	
Causes	**Solutions**
• Bare or unprotected soil • Long and steep slopes • Intense rainfall or irrigation events when residue cover is at a minimum • Decreased infiltration by compaction	• Residue management • Crop rotations • Cover crops • Terraces • Contour farming • Stripcropping • Windbreaks • Herbaceous wind barrier

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Resource Concerns

SOIL

Concentrated Flow Erosion

Soil Erosion - Concentrated Flow Erosion

Untreated classic gullies may enlarge progressively by head cutting and/or lateral widening. Ephemeral gullies occur in the same flow area and are obscured by tillage. This includes concentrated flow erosion caused by runoff from rainfall, snowmelt, or irrigation water.

What is it?

Ephemeral and classic gully are forms of erosion created by the concentrated flow of water. They are easily identified through visual observation. An ephemeral cropland gully is larger than a rill and smaller than a classic gully. They usually result from the junction of rills that form a dendritic (branching or tree-like) pattern of channels. Ephemeral gullies usually appear on cultivated fields during the planting or growing season, but are temporarily removed by cultivation. Ephemeral gullies can reappear at or near the same location on a yearly basis because the surface topography of the field does not change appreciably. Classic gully erosion generally occurs in well defined drainage ways and generally is not obliterated by tillage. In some situations, headcuts are present and aid in advancing the gully upstream.

Why is it important?

Concentrated flow erosion removes surface soil, which often has the highest biological activity and most soil organic matter. Nutrients removed by erosion are no longer available to support plant growth on-site, and when they accumulate in water, algal blooms, lake eutrophication, and high dissolved oxygen levels can occur. Deposition of eroded materials can obstruct roadways and fill drainage channels. Gullies can impact farm operations by creating barriers that change traffic patterns and create hazards that can damage farm equipment.

What can be done about it?

Ephemeral erosion can be controlled using a conservation cropping system that includes residue management. High residue crops and maintaining soil cover throughout the year are effective means for controlling ephemeral erosion and aid in the control of classic gully erosion. Gully formations can be difficult to control if remedial measures are not designed and properly constructed. Correcting concentrated flow erosion involves mitigating the damage and addressing the cause. The cause of increased water flow across the landscape must be considered and the corrective action usually requires a system of conservation practices. Conservation tillage and cropping practices that increase water infiltration into the soil result in less runoff and protect land from erosion.

Concentrated Flow Erosion at a Glance

Problems / Indicators - Branching or tree-like pattern of rills, gullies, headcuts	
Causes	Solutions
• Bare or unprotected soil • Excess runoff • Inadequate outlet for water	• Residue management • Cover crops • Terraces and/or grassed waterways • Grade stabilization structure • Lined waterway or outlet • Water and sediment control basin

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SOIL

Resource Concerns

Shoreline, Bank and Channel Erosion

Soil Erosion - Shoreline, Bank and Channel Erosion

Sediment from banks, shorelines or conveyance channels threatens to degrade water quality and limit use for intended purposes.

What is it?

Stream stability is an active process, and while streambank erosion is a natural part of this process, it is often accelerated by altering the stream system. Streambank erosion is that part of channel erosion in which material is eroded from the streambank and deposited at the base of the slope or in the channel. Streambank erosion is usually associated with erosion of the streambed. It occurs along perennial, intermittent, and ephemeral streams.

Why is it important?

The benefits of proper streambank stabilization go far beyond preventing loss of land and keeping sediment out of streams. Streambank erosion increases sediment in the stream degrading water quality and resulting in the loss of fertile bottomland. The quality of wildlife habitat is impacted both on land and in the stream. Streambank erosion increases the stream's sediment load and changes its shape and function. When this happens the stream loses its ability to transport sediment which causes it to become wide and shallow. The stream channel can become braided, quality habitat is lost and the increased sediment can reduce overall biological productivity.

What can be done about it?

Determining the cause of accelerated streambank erosion is the first step in solving the problem. Development in the watershed often alters the stream equilibrium by changing rainfall-runoff relationships. Many of the traditional methods of dealing with streambank erosion, such as rock revetments, are expensive to install and maintain. While hard solutions are often needed to protect infrastructure, these treatments may solve the problem at the expense of habitat and stream corridor aesthetics. There are some promising developments in the area of streambank stabilization and stream restoration. Greener and more natural treatment alternatives are being more widely adopted. Soil bioengineering practices, native material revetments, combinations of rock and vegetation, and in-stream structures help to stabilize eroding banks. These techniques can be used to move a stream toward a healthy, stable and self-maintaining system.

Shoreline, Bank and Channel Erosion at a Glance

Problems / Indicators - Eroding Banks, degrading streambed, and manipulated stream channels	
Causes	Solutions
• Increased runoff due to land use changes in the watershed • Eroding or unstable streambanks • Exposed tree roots along banks • Large runoff events • Degraded riparian areas • Uncontrolled livestock access	• Bank armor and protection • Soil bioengineering practices • In-stream structures • Native material revetments • Riparian areas with native or locally adapted vegetation • Control livestock access to the water bodies

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Resource Concerns

SOIL

Subsidence

Soil Quality Degradation - Subsidence

Loss of volume and depth of organic soils due to oxidation caused by above normal microbial activity resulting from excessive water drainage, soil disturbance, or extended drought. This excludes karst / sinkholes issues or depressions caused by underground activities.

What is it?

Subsidence is a gradual lowering of the surface elevation of an organic soil, or a reduction in the thickness of organic matter. Organic soils (Histosols) are those that are predominantly organic soil materials. They are commonly called bogs, moors, or peats and mucks. The most important cause of organic soil subsidence is a process commonly termed "oxidation." A high water table creates anaerobic conditions that slow the breakdown of organic materials. The balance between accumulation and decomposition of organic material shifts dramatically when soil is drained. Oxidation under aerobic conditions converts the organic carbon in the plant tissue to carbon dioxide gas and water. Aerobic decomposition under drained conditions is much more efficient thereby causing the loss of organic matter.

Why is it important?

Soil subsidence is usually irreversible. The natural rate of accumulation of organic soil is on the order of a few inches per 100 years; the rate of loss of drained organic soil can be 100 times greater, up to a few inches per year in extreme cases. Thus, deposits that have accumulated over hundreds of years can disappear relatively quickly in response to human activity. In time, the remaining organic material becomes diluted through the incorporation of the organic layer into the mineral subsoil. This reduces the productivity of the soil.

What can be done about it?

Once oxidation depletes the organic matter, it generally cannot be restored. The oxidation rate of organic matter can be minimized by managing water table levels to reduce aeration. In non-crop situations, keep the water table as close to the soil surface as possible. During the cropping season, maintain the water table at the optimum level for the crop being grown. Use cover crops to keep the soil covered and to return organic matter to the soil.

Subsidence at a Glance

Problems / Indicators - Loss of volume and depth of organic soils	
Causes	**Solutions**
• Drainage • Cultivation / Soil disturbance	• Water table management • Diverse, high biomass crop rotations • Cover crops • Conservation tillage • Perennials in rotations

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Resource Concerns

SOIL

Compaction

Soil Quality Degradation - Compaction

Management induced soil compaction resulting in decreased rooting depth that reduces plant growth, animal habitat and soil biological activity.

What is it?

Compaction occurs when soil particles are pressed together, reducing pore space between the particles and pushing out the air normally located there. It is manifested as an increase in bulk density. A severely compacted soil can become effectively impermeable. Soils are either naturally compacted (heavy, clay soil) or compaction is caused by management activities. Compaction is assessed using measurements of bulk density, penetration resistance, porosity, and root growth patterns.

Why is it important?

Compaction reflects the soil's ability to function for structural support, water and solute movement, and soil aeration. It may cause restrictions to root growth, and poor movement of air and water through the soil. Compaction can result in shallow plant rooting and poor plant growth, influencing crop yield and reducing vegetative cover available to protect soil from erosion. By reducing water infiltration into the soil, compaction can lead to increased runoff and erosion from sloping land or waterlogged soils in flatter areas. In general, some soil compaction to restrict water movement through the soil profile is beneficial under arid conditions, but under humid conditions compaction decreases yields.

What can be done about it?

Long-term solutions to soil compaction problems revolve around decreasing soil disturbance and increasing soil organic matter. A system that uses cover crops, crop residues, perennial sod, and/or reduced tillage results in increased soil organic matter, less disturbance and reduced bulk density. Additionally, the use of multi-crop systems involving plants with different rooting depths can help break up compacted soil layers. Grazing systems that minimize livestock traffic and loafing, provide protected heavy use areas, and adhere to recommended minimum grazing heights reduce bulk density by preventing compaction and providing soil cover.

Compaction at a Glance

Problems / Indicators - Bulk density, penetration resistance, porosity, root growth patterns	
Causes	**Solutions**
• Working wet soil • Excess traffic, machinery or livestock • Heavy machinery • Repeated tillage at same depth • Poor aggregation • Low organic matter	• Avoid working wet soil • Reduce traffic/tillage operations, rotate • Controlled traffic patterns • Subsoil or rip compacted areas • Diversify cropping system • Conservation tillage • Cover crops • Animal manures and compost • Non-compacting tillage

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Resource Concerns

SOIL

Organic Matter

Soil Quality Degradation - Organic Matter

Soil organic matter is not adequate to provide a suitable medium for plant growth, animal habitat, and soil biological activity.

What is it?

Soil organic matter is carbon-rich material that includes plant, animal, and microbial residue in various stages of decomposition. Live soil organisms and plant roots are part of the carbon pool in soil but are not considered soil organic matter until they die and begin to decay. The quantity and composition of soil organic matter vary significantly among major ecosystems. Soil in arid, semiarid, and hot, humid regions commonly has less organic matter than soil in other environments.

Why is it important?

Many soil properties impact soil quality/soil health, but organic matter deserves special attention. It affects several critical soil functions, can be manipulated by land management practices, and is important in most agricultural settings across the country. Because organic matter improves soil structure and enhances water and nutrient holding capacity, managing for soil carbon can enhance soil productivity and environmental quality, and it can reduce the severity and costs of natural phenomena, such as drought, flood, and disease. In addition, increasing soil organic matter levels can reduce atmospheric CO_2 levels that contribute to climate change, and improved soil quality/soil health reduces dust, allergens, and pathogens in the air. Ground and surface water quality improve because better structure, infiltration, and biological activity make soil a more effective filter. For example, organic matter may bind pesticides, making them less active.

What can be done about it?

The most practical way to enhance soil quality/soil health, and as a result air and water quality, is to promote better management of soil organic matter or carbon. Practices that increase organic matter include: leaving crop residues in the field, choosing crop rotations that include high residue plants, using optimal nutrient and water management practices to grow healthy plants with large amounts of roots and residue, growing cover crops, applying manure or compost, using low or no tillage systems, and mulching.

Organic Matter at a Glance

Problems / Indicators - Compaction, slaking, soil crusting, crop moisture stress, poor soil structure	
Causes	**Solutions**
• Soil disturbance • Intensive tillage systems • Low crop biomass (surface and subsurface) • Burning, harvesting or otherwise removing crop residues	• Diverse, high biomass crop rotations • Cover crops • Conservation tillage • Rotational or prescribed grazing • Perennials in rotations • Maintain crop residues on soil surface • Animal manure and compost • Water table management

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Resource Concerns

SOIL

Salts and Chemicals

Soil Quality Degradation - Salts and Chemicals

Concentration of salts leading to salinity and/or sodicity reducing productivity or limiting desired use. The resource concern is also applicable to concentrations of other chemicals impacting productivity or limiting desired use.

What is it?

Salinity is a process by which water-soluble salts accumulate in the soil. Saline soils are indicative of inadequate drainage to leach salts from the soil or upward migration of salt from shallow ground water. Sodic soils are high in sodium relative to concentrations of calcium and magnesium. Salinity or sodicity occurs naturally or may result from management practices. Soil formed on parent material high in salts, such as marine deposits, and with inadequate drainage, will be high in salts. Fertilizers, soil amendments (gypsum, lime), and manure may contribute to salinity problems, as well. Applications of saline and/or sodic water without adequate leaching or in the presence of a high water table will increase soil electrical conductivity over time, eventually resulting in saline soil. Soils can also become saline through the process of saline seeps.

Why is it important?

Since few plants grow well on saline/sodic soils, cropping options on these soils may be limited. Salts in the soil can negatively affect water uptake by plants, and saline soils tend to inhibit germination and plant emergence. Growth patterns in cropped fields can be poor, with spotty stand establishment. Under severe salt stress, herbaceous crops appear bluish-green. Leaf tip burn and die-off of older leaves in cereal grains can result from salinity or related drought stress. Salinization degrades the quality of shallow ground water and surface water resources, such as ponds, sloughs, and dugouts.

What can be done about it?

Reducing the severity and extent of soil salinity is accomplished primarily with recharge and discharge water management. Recharge management is used on areas that contribute excess water to the soil and includes decreasing infiltration of excess saline/sodic water and irrigation to maintain salts at a level below the root zone. Discharge management is used on areas where excess water comes to the soil surface and includes growing salt tolerant crops, reducing deep tillage and eliminating seepage.

Salts and Chemicals at a Glance

Problems / Indicators - White crusting of soil, irregular crop growth, and lack of plant vigor	
Causes	**Solutions**
• Naturally occurring in soils with high concentrations of soluble salts, e.g., sodium, calcium, and magnesium sulfates • Inadequate drainage to leach salt from the soil • Upward migration of salt from shallow ground water • Application of saline and/or sodic water	• Proper use of irrigation water • Salt-tolerant crops • Removal of excess water from recharge areas • Maintenance of the water table at safe levels • Cropping and tillage systems that promote adequate infiltration and permeability • Reducing deep tillage

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Resource Concerns

WATER

Ponding, Flooding, Other Excess

Excess Water - Ponding, Flooding, Other Excess

Surface water or poor subsurface drainage restricts land use and management goals. Wind-blown snow accumulates around and over surface structures, restricting access to humans and animals.

What is it?

Water can flood or pond and restrict plant growth and land use. Water may flow into or around buildings if they are constructed over or near a spring or seep. If the soil has a dense layer, especially a layer of clay, flow of water through the soil may be restricted and water may pond.

Why is it important?

Flooding and ponding impacts plant grow and land use. Plant growth is essential for improving soil quality and increasing soil organic matter. Saturated soils increase the likelihood of diseases, significant losses of soil nitrogen due to denitrification and leaching of nitrate N, and soil damage due to heavy equipment. Seeps and high water tables must be taken into account for conservation plantings and when evaluating sites for construction. Excess water can affect structures and slope stability while drifting snow may prevent access to livestock or farmsteads. Drifting snow can block access.

What can be done about it?

Using a systems approach can help address excess water. Strategies include managing for drainage, conveyance, and multiple uses for crops and wildlife. Drainage systems must be compatible with crops grown, field layouts, and cultural practices such as crop rotation and cultivation. System choices include open ditches, tile drains, mole drains, and land forming for increased surface runoff. Planned systems can include diverting excess water and infiltration basins combined with roof runoff management systems. Restored and enhanced wetlands can also be key components in water management.

Ponding, Flooding, Other Excess at a Glance

Problems / Indicators - Little to no established vegetation due to excess water, wet areas due to restrictive soil layers, flood prone buildings and structures	
Causes	**Solutions**
• Ponding and seeps • Stormwater runoff • Flood prone areas	• Drainage management and structures for water control • Roof runoff structures and capture for reuse methods • Floodplain management • Wetland restoration or enhancement • Windbreak placement for protection and to provide access

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Resource Concerns

WATER

Inefficient Moisture Management

Insufficient Water - Inefficient Moisture Management

Natural precipitation is not optimally managed to support desired land use goals or ecological processes.

What is it?

In dryland conditions, management of available water is critical to production and to maintain natural systems.

Why is it important?

Water is important to farming and natural systems. In cropland, poor yields may be related to an insufficiency of soil moisture rather than an insufficiency of rainfall. Inefficient moisture management can result in increased runoff and reduced soil moisture. In some grassland systems, available water can be tied up by brush.

What can be done about it?

Managing residue and cover will aid in utilizing available soil moisture. Establish mulch and residue management systems to conserve soil moisture. New weed control techniques and tools, along with cover crops can help manage available water for crops. Minimize soil compaction to maintain water movement through the soil by reducing soil hydraulic properties such as infiltration. In some grassland systems, brush management can help restore a natural water regime. Using plants that are more tolerant of drought conditions is an effective measure in optimize existing soil moisture.

Inefficient Moisture Management at a Glance

Problems / Indicators - Dryland farming in low rainfall areas	
Causes	**Solutions**
• No soil cover in the winter to prevent moisture loss • Excess soil tillage and disturbance destroys soil organic matter and structure • Unchecked brush growth creating potential for less available moisture for desired plants	• Cover crops • Conservation tillage • Brush management

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Resource Concerns

WATER

Inefficient Use of Irrigation Water

Insufficient Water - Inefficient Use of Irrigation Water

Irrigation water is not stored, delivered, scheduled and/or applied efficiently. Aquifer or surface water withdrawals threaten sustained availability of ground or surface water. Available irrigation water supplies have been reduced due to aquifer depletion, competition, regulation and/or drought.

What is it?

Inefficient use of irrigation water impacts on- and off-site water quantity and quality. Irrigation systems and water management practices can waste water and negatively affect farm profitability.

Why is it important?

Irrigated agriculture is essential in meeting the nation's food and fiber production needs. Agriculture is the nation's largest water user, accounting for more than 85% of the nation's annual water consumption. Emerging problems that further complicate resource protection and water allocation include: serious long-term drought conditions, critical ground water declines occurring in agricultural production areas, saltwater intrusion into ground water supplies, and competition for water among a multitude of water users, including power generation, drinking water supplies, minimum stream flows, etc.

What can be done about it?

Solutions are available to address many of the competing water resource needs. Choices generally include conservation of the water used, conversion to other crops that utilize less water, and conversion to other sources of water. Conserving water could include improvements in irrigation water use efficiencies, off stream storage of water during periods of excess runoff, water re-use and water recycling, and ground water recharge.

Inefficient Use of Irrigation Water at a Glance

Problems / Indicators - Irrigated crops, plant stress, insufficient water supply	
Causes	**Solutions**
• Open earthen ditches • Irrigation water allowed to run off of fields • Losses due to improper system design, installation, or maintenance	• Line ditches or install pipe; improve water transport systems • Manage applications to reduce runoff; tailwater return systems • Audit system and retrofit or replace where warranted

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Resource Concerns

WATER

Nutrients

Water Quality Degradation - Nutrients

Nutrients (organics and inorganics) are transported to receiving waters through surface runoff and/or leaching into shallow ground waters in quantities that degrade water quality and limit use for intended purposes.

What is it?

Water bodies require nutrients, such as nitrogen and phosphorus, to be healthy, but too many nutrients can be harmful. Many of our nation's waters, including streams, rivers, wetlands, estuaries, and coastal waters, are affected by excess nutrients. The effect of nutrients for a given water body depends on its ecoregion and the source of nutrients.

Why is it important?

Increased nitrogen and phosphorus levels in water can produce excessive aquatic vegetation and algal blooms resulting in reduced dissolved oxygen, harmful toxins, and increased water temperature. In extreme cases dissolved oxygen may be so low that dead zones, known as hypoxia, exist where most aquatic life cannot survive. Algal blooms can also impart an undesirable taste to potable water that is difficult to remove by water treatment. High ammonia levels are toxic to some freshwater fish species.

What can be done about it?

Management is the key to protecting water quality from excess nutrients. Nutrient management shall specify the source, amount, timing and method of application of nutrients on each field to achieve realistic production goals, while minimizing movement of nutrients and other potential contaminants to surface and/or ground waters. Realistic yield goals shall be established based on soil productivity information, historical yield data, climatic conditions, level of management and/or local research on similar soil, cropping systems, and soil and manure/organic by-products tests. Areas contained within established minimum application setbacks (e.g., sinkholes, wells, or rapidly permeable soil areas) should not receive direct application of nutrients. Nutrients may also be lost due to erosion, runoff, irrigation and drainage, so applicable practices should be installed to address these concerns.

Nutrients at a Glance

Problems / Indicators - Algae blooms, mass death of fish or aquatic organisms, dissolved oxygen concentrations, hypoxia	
Causes	**Solutions**
• Overusing fertilizer (both residential and agricultural usage) • Soluble nutrients • Erosion of nutrient-laden soil • Rainfall flowing over cropland, animal feeding operations and pastures, picking up animal waste and depositing it in water bodies • Low organic matter	• Nutrient management to address the form, rate, placement and timing of nutrient application • Cover crops • Crop rotations • Increased crop diversity • Conservation buffers • Residue management

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Resource Concerns

WATER
Pesticides

Water Quality Degradation - Pesticides

Pest control chemicals are transported to receiving waters in quantities that degrade water quality and limit use for intended purposes.

What is it?

The term "pesticide" is a composite term that includes all chemicals that are used to kill or control pests. Pesticides can be harmful to people and the environment. Part of the problem is the toxicity of some pesticides, but even more important is the sheer volume of pesticides used in this country every year. Some of this pesticide finds its way to our water, air, and soil.

Why is it important?

Protecting ground and surface water from chemical pollutants is a national initiative. Water is an exceptionally valuable natural asset. The health and livelihood of Americans depends on the availability of a safe drinking water supply. Equally important is the role of water quality on fish and aquatic ecosystems. Indirect benefits of water quality are provided by recreational boating, sport fishing, swimming, relaxation, and natural beauty.

What can be done about it?

The ecological impacts of pesticides in water are determined by their toxicity, persistence, degradates, and environmental fate. The use of Integrated Pest Management strategies and techniques involving prevention, avoidance, monitoring, and suppression are effective means to reduce the risks associated with pesticide use. A risk assessment tool can be used to identify risks and guide the mitigation of off-site pesticide hazards. Mitigating practices include residue management, cover crops, conservation crop rotation, and Integrated Pest Management.

Pesticides at a Glance

Problems / Indicators - Pesticide use in the farm/ranch operation	
Causes	**Solutions**
• Pesticide use in sensitive watersheds • Use of pesticides with intermediate or higher hazard risk	• Residue management • Cover crops • Conservation crop rotation • Integrated pest management strategies • Alternative pest suppression strategies • Conservation buffers • Proper use and storage • Drainage water management

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Resource Concerns

WATER

Pathogens

Water Quality Degradation - Pathogens

Pathogens, pharmaceuticals, and other chemicals are carried by soil amendments that are applied to the land and are subsequently transported to receiving waters in quantities that degrade water quality and limit use for intended purposes. This resource concern also includes the off-site transport of leachate and runoff from compost or other organic materials of animal origin.

What is it?

Many potential pathogens (disease-causing microorganisms) can be found in manure. These pathogens include bacteria, protozoa, and viruses. If effected soil amendments are not adequately treated and contained, pathogens may enter ground or surface water posing a potential risk to human and animal health.

Why is it important?

Pathogens can be transmitted to humans directly through contact with animals and animal waste or indirectly through contaminated water or food. Human illness and death has resulted from exposure to pathogens from livestock and poultry manure. Pathogens can also be transmitted to domestic and wild animals with similar results.

What can be done about it?

The most effective tool in eliminating pathogens from manure, from both practical and economic standpoints, is time. If manure is allowed to sit undisturbed in storage or in soil, the concentration of pathogens will decrease with time as they die off or are overgrown by native microbes. Managing manure for pathogens is approached in two phases: 1) collection and storage and 2) land treatment. In the collection and storage of manure, pathogens can be addressed by biological control (composting, anaerobic digesters, etc.), chemical methods, and control of runoff and leaching. It is also important to manage livestock access to streams, rivers and water bodies. Land application is commonly a critical process in manure management. Pathogens from manure can threaten humans who are exposed to runoff, have direct contact with manure, or consume food or water contaminated with manure. Application rate and seasonal conditions are important factors contributing to the transfer of pathogens from lands where manure has recently been applied to nearby surface water. Managing the rate, timing and method of application of manure are critical elements in managing for pathogens. Keeping a buffer zone or setback distance between manure application areas and water bodies is a common practice that greatly decreases the transport of pathogens to those water bodies.

Pathogens at a Glance

Problems / Indicators - Storage, handling, and application of manure, bio-solids, or compost	
Causes	**Solutions**
• Collection, handling and storage of manure • Land application of manure	• Biological treatment (anaerobic storage, composting, anaerobic digesters) • Vegetative filter strips, setbacks and buffer zones • Managing livestock access to water • Managing the rate, timing, and method of application of manure

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Resource Concerns

WATER

Salts

Water Quality Degradation - Salts

Irrigation or rainfall runoff transports salts to receiving waters in quantities that degrade water quality and limit use for intended purposes.

What is it?

Salinity is a process by which water-soluble salts accumulate in the soil and water. Nearly all waters contain dissolved salts and trace elements, many of which result from the natural weathering of the earth's surface. In addition, drainage waters from irrigated lands and effluent from city sewage and industrial waste water can impact water quality. In most irrigation situations, the primary water quality concern is salinity levels since salts can affect both the soil structure and crop yield. Most salinity problems in agriculture result directly from the salts carried in irrigation water.

Why is it important?

Salinity increases the cost of treating water for drinking, reduces the availability of water for irrigation, and renders farmland useless, costing the economy millions each year. Salinity is an ecological factor, influencing the types of organisms that live in a body of water. It influences the kinds of plants that will grow either in a water body, or on land fed by irrigation water or groundwater. If water containing too much salt is applied during irrigation, salt tends to build up in the soil, reducing the amount of water available to plants. Salts in the soil increase the efforts by plant roots to take in water and can make water unavailable to plants at higher salt levels. Few plants grow well on saline soils; often restricting options for cropping in a given land area.

What can be done about it?

Salinity as a water quality issue is addressed through soil management activities. Reducing the severity and extent of salinity is accomplished primarily with recharge and discharge water management. Recharge management is used on areas that contribute excess water to the soil and includes decreasing infiltration of excess saline water and irrigation to maintain salts at a level below the root zone. Discharge management is used on areas where excess water comes to the soil surface and includes growing salt tolerant crops, reducing deep tillage and eliminating seepage.

Salts at a Glance

Problems / Indicators - White crusting of soil, irregular crop growth, and lack of plant vigor	
Causes	**Solutions**
• Naturally occurring in soils with concentrations of soluble salts, such as sulfates of sodium, calcium, and magnesium in the soil • Inadequate drainage to leach salt from the soil • Upward migration of salt from shallow ground water • Application of saline water	• Proper use of irrigation water • Salt-tolerant crops • Removal of excess water from recharge areas • Maintain water table at a safe levels • Cropping and tillage systems that promote adequate infiltration and permeability • Reducing deep tillage

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Resource Concerns

WATER

Petroleum and Heavy Metals

Water Quality Degradation - Petroleum and Heavy Metals

Heavy metals, petroleum and other pollutants are transported to receiving water sources in quantities that degrade water quality and limit use for intended purposes.

What is it?

Petroleum is generally thought of in terms of crude oil products but also includes all liquid, gaseous, and solid hydrocarbons. Petroleum contamination in agriculture typically occurs through point source spills and from nonpoint sources, where small amounts of petroleum are collected through runoff from asphalt-covered roads and parking areas, and over a long period of time add up to large-scale effects. A heavy metal can be defined as a chemical element with a specific gravity that is at least five times that of water. Examples of heavy metals include arsenic, cadmium, iron, lead, chromium, copper, zinc, nickel, and mercury. Heavy metal contamination is typically through the use and application of biosludge, contaminated animal manure, and artificial fertilizers.

Why is it important?

Protecting ground and surface water from chemical pollutants is a national initiative. Water is an exceptionally valuable natural asset. The health and livelihood of Americans depends on the availability of a safe drinking water supply. Equally important is the role of water quality on fish and aquatic ecosystems. Indirect benefits of water quality are provided by recreational boating, sport fishing, swimming, relaxation, and natural beauty. In large concentrations, the hydrocarbon molecules that make up crude oil and petroleum products are highly toxic to many organisms, including humans. Petroleum products can have a detrimental effect on oxygen demand and transfer in surface water, and it can restrict the penetration of sunlight to aquatic plants. Heavy metals are also toxic, and they can build up in the soil and plant tissue. Most of the ingestion of heavy metals occurs from consumption of plants.

What can be done about it?

The key to addressing petroleum and heavy metal contamination is prevention. The proper handling and storage of petroleum and chemical products can prevent contamination of the soil and water. Containment systems are very effective in containing spills. Heavy metals build up can be addressed through the proper use and application of biosludge, animal manure and artificial fertilizers. The use of soil testing and managing the rate and application of soil amendments are effective preventive measures.

Petroleum and Heavy Metals at a Glance

Problems / Indicators - Storage and handling of petroleum; use of biosludge, contaminated animal manure, and artificial fertilizers	
Causes	**Solutions**
• Inadequate storage and handling • Application of biosludge, contaminated animal manure, and artificial fertilizers • Unprotected surface and groundwater sources	• Proper storage and handling • Petroleum and chemical containment systems • Proper application and use of animal manure biosludge and artificial fertilizer • Protection of surface and groundwater sources • Conservation buffers and application setbacks

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Resource Concerns

WATER

Sediment

Water Quality Degradation - Sediment

Off-site transport of sediment from sheet, rill, gully, and wind erosion into surface water that threatens to degrade surface water quality and limit use for intended purposes.

What is it?

Wind or water erosion is the physical and chemical wearing of the earth's surface and is a natural ecosystem process. Problems arise when excess fine sediment enters surface water at rates and volumes greater than under natural conditions, resulting in turbidity and sedimentation. Typically, erosion related to human activities generates excessive sediment and should be controlled to acceptable levels.

Why is it important?

Sediment can have a significant impact on water quality and aquatic habitat. Not only does sediment carry nutrients and pesticides that can negatively impact water quality, but the physical characteristics of sediment can clog stream channels, silt in reservoirs, cover fish spawning grounds, and reduce downstream water quality. Sediment makes the water more turbid and restricts light penetration into the water, which impacts the ability of aquatic plants to perform photosynthesis. Suspended sediments can clog the gills of aquatic organisms and cause death. Sediment build up on the stream bottom can lead to the suffocation of fish eggs and macro invertebrates and impact natural spawning. Additionally, with an increased amount of particles in the water, dissolved oxygen levels may be reduced due to elevated water temperatures. Excessive sediment also impacts coastal area water quality as it can smother and kill coral tissue and reduces light levels and food supplied to the coral by symbiotic algae.

What can be done about it?

The issue of excessive sediments for water quality is managed by addressing the source and/or transport of soil. Controlling the source of soil erosion involves maintaining a protective cover on the soil and modifying the landscape to control runoff amounts and rates. Specific practices include growing perennial crops in rotation or as permanent cover, growing cover crops, managing crop residue, shortening the length and steepness of slopes, and increasing water infiltration rates. Controlling the transport of soil into water bodies involves buffers and edge of field treatments. Specific practices include grassed waterways, field borders, filter strips, and riparian forest/herbaceous buffers.

Sediment at a Glance

Problems / Indicators - Cloudy or muddy water, stream/water body soil deposition	
Causes	**Solutions**
• Bare or unprotected soil • Long and steep slopes, • Intense rainfall or irrigation events when residue cover is at a minimum, • Decreased infiltration by compaction	• Residue management • Crop rotations with high biomass crops • Cover crops • Terraces • Strip cropping • Windbreaks • Buffers and filter strips to address the transport of sediment

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Resource Concerns

WATER

Elevated Water Temperature

Water Quality Degradation - Elevated Water Temperature

Surface water temperatures exceed State/Federal standards and/or limit use for intended purposes.

What is it?

Temperature has an important influence on water chemistry. As water temperature rises, there is a corresponding decrease in the availability of oxygen, carbon dioxide, and other gases important to aquatic life. Elevated water temperature also results in increases of dissolved minerals that can further degrade water quality. In some areas, Federal and/or State law regulate the temperature of surface water.

Why is it important?

Water temperature has extremely important ecological consequences. The metabolic rate of organisms rises with increasing water temperatures, resulting in increased oxygen demand. This is coupled with the reduced amount of oxygen that is available as the water temperature increases. During extended periods of warming, water may lose its potential to support healthy populations of fish and other aquatic organisms and may even kill desired species or lead to a change in species diversity. Warm water also has the potential to increase the presence of dissolved toxic substances that may restrict the suitability of water for human use.

What can be done about it?

There is actually very little an individual landowner can do to cool surface waters. Most conservation actions designed to address water temperature issues reduce additions of heat energy. Heat can enter surface water through direct sunlight and by the air directly above the water. Reestablishing or protecting riparian vegetation is often the first step to address water temperature issues. While riparian vegetation does not cool the water, on small water bodies it can block much of the sun and keep the air in direct contact with the water surface cooler. Groundwater inflow and outflow, precipitation, runoff, and evaporation are also responsible for heat energy exchange. Water entering a water body from below ground flows tends to be much cooler than the surface water. Actions that conserve or increase shallow groundwater may increase the amount of cool water entering a water body. The sediment load of a water body also plays a role in water temperature. When the sediment load increases, water tends to spread out over a larger area. Shallow, wide channels provide more surface area for solar energy to enter the stream, potentially increasing water temperature. In addition, turbidity raises water temperature because the suspended particles absorb the sun's heat. Actions to reduce sediment reaching a water body will help reduce warming of surface water.

Elevated Water Temperature at a Glance

Problems / Indicators - Water temperature exceeds legal standard, threatens the health of aquatic organisms, or limits the intended use by the client	
Causes	**Solutions**
• Surface water unprotected from direct sunlight • Little or no groundwater contribution to water body • Sediment laden runoff reaching water body	• Reestablish riparian vegetation • Brush management, residue management, terraces to reduce transpiration, evaporation and/or increase infiltration of upland water • Buffers and filter strips to intercept sediment

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Resource Concerns

Air

Greenhouse Gases

Air Quality Impacts - Greenhouse Gases

Emissions increase atmospheric concentrations of greenhouse gases.

What is it?

Direct and indirect emissions of greenhouse gases (GHGs - primarily CO_2, CH_4, N_2O for agriculture) cause increased concentrations of GHGs in the atmosphere and can cause resultant changes in climate. Greenhouse gases from activities such as crop fertilization (natural and synthetic), tillage and agricultural soils management, manure management, livestock enteric fermentation, internal combustion engines, rice cultivation, and land use conversion contribute to excess agricultural greenhouse gas (GHG) emissions to the atmosphere. A portion of nitrogen fertilizer that is applied to crops and grasslands is volatilized through a complex microbial process (nitrification and denitrification) and emitted to the atmosphere as nitrous oxide (N_2O). Methane (CH_4) is produced as part of the normal digestive processes in animals and through the anaerobic (without oxygen) decomposition of manure and managed waste. The combustion of fossil fuels as an energy source results in direct carbon dioxide (CO_2) emissions to the atmosphere. Soil tillage increases soil organic matter decomposition and releases soil carbon, in the form of carbon dioxide (CO_2), to the atmosphere.

Why is it important?

Greenhouse gas, primarily carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), accumulation in the atmosphere can have a potent impact on the climate. Greenhouse gases absorb and emit infrared radiation resulting in the "greenhouse effect," and can cause changes in climate.

What can be done about it?

There are many opportunities to reduce GHGs in agriculture. Planting and growing trees can provide long term solutions to sequester carbon dioxide (CO_2) from the atmosphere. Reducing tillage increases the ability of the soil to store carbon in the form of organic matter and reduces the release of nitrous oxide (N_2O). The efficient use of nitrogen fertilizer through split applications, soil injections and side-dressing can reduce nitrous oxide (N_2O) emissions. Anaerobic manure handling facilities, such as methane digesters or biogas recovery systems, can capture methane emissions from manure and supply renewable energy. Increasing on-farm energy efficiency and the use of renewable energy sources (solar, wind, and biofuels) can reduce greenhouse gas emissions.

Greenhouse Gases at a Glance

Problems / Indicators - Greenhouse gas emissions	
Causes	**Solutions**
• CO_2 emissions from the use of fossil fuels • CH_4 production from animal operations • CO_2 and N_2O from soil tillage • Loss of carbon from soils and plants • Excessive N_2O emissions from cropping systems	• Renewable energy (solar, wind, biofuels), and better combustion processes and efficiencies • Anaerobic manure handling facilities • Conservation tillage and reduced soil disturbance • Riparian forest buffers • Tree and shrub planting • Nitrogen fertilizer management

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Resource Concerns

Air

Odors

Air Quality Impacts - Odors

Emissions of odorous compounds - VOCs, ammonia, and odorous sulfur compounds - cause nuisance conditions.

What is it?

Agricultural odors are a complex mixture of gases that can evoke a wide range of emotional and physiological responses when encountered via the sense of smell. Many different compounds can be the potential cause of odors from agricultural operations. These compounds can generally be classified as VOCs, ammonia, or odorous sulfur compounds. The three primary sources of odor are manure storage facilities, animal housing, and land application of manure. Other sources can include burning, silage storage, and fertilizer and pesticide applications.

Why is it important?

Odors are mainly a community or individual perception issue; although some odorous compounds can cause health problems when encountered in high concentrations. Greater emphasis on addressing odors is likely to occur in areas that have negative community and individual perceptions of odors, especially in areas with a strong rural/urban interface.

What can be done about it?

Many common practices and management activities can help reduce the likelihood of odor impacts from animal operations. Among them are maintaining appropriate moisture content in and on open lot surfaces and using manure management techniques that minimize, recover, or control emitted gases. Windbreaks can be used to diffuse odor from animal confinement areas, and prescribed grazing can be used to minimize manure accumulation. Prescribed grazing and/or development of biofuels can be used as alternatives to burning excess biomass on rangelands. When rangeland burning is necessary, the development and implementation of prescribed burning and smoke management plans promote an efficient and effective burn.

Odors at a Glance

Problems / Indicators - Manure storage facilities, animal housing, manure and land application	
Causes	Solutions
• Confined animal areas • Manure application • Burning	• Moisture management to control dust and odors associated with livestock confinement areas • Manure injection for land application • Managing manure applications to reduce odor impacts • Manure treatments to control ammonia • Prescribed burning management • Windbreaks

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Resource Concerns

Air

Ozone Precursors

Air Quality Impacts - Ozone Precursors

Emissions of ozone precursors - NOx and VOCs - resulting in formation of ground-level ozone that cause negative impacts to plants and animals.

What is it?

Agriculture can be a source of ozone precursor gases, oxides of nitrogen (NOx) and volatile organic compounds (VOCs), which chemically react in the atmosphere producing ground-level ozone (O_3) that can cause negative impacts to plants and animals. Ozone is not directly emitted into the atmosphere. It is formed in the atmosphere through chemical reactions of NOx and VOCs in the presence of sunlight. Biological organisms emit VOCs naturally. The breakdown or decomposition of biological materials such as manure, feed, or mortalities can produce VOCs (through incomplete breakdown/decomposition) and NOx (mainly from the nitrification/denitrification processes). Combustion in on-farm equipment or the burning of biological material produces NOx, and VOCs. Pesticide application can also emit VOCs.

Why is it important?

Although ozone in the upper atmosphere forms a layer that provides protection from ultraviolet radiation, ozone in the lower atmosphere and at ground level can be harmful. Since ozone is an allotrope of oxygen, its similar structure allows it to displace oxygen in the lungs, causing respiratory issues. Ozone is also an eye irritant causing red, itchy eyes. Plants are also affected by ozone. During the gas exchange process, ozone enters the leaves, causing chlorosis and necrosis. This reduces the plant's photosynthetic ability and can result in yield reductions.

What can be done about it?

Activities associated with integrated pest management decrease the use of chemical pesticides and resulting VOC emissions. New or retrofitted engines that offer more complete combustion of fuel can reduce NOx and VOC emissions. Fuels, chemicals, and pesticides should be properly stored. Prescribed burning can be implemented to minimize NOx and VOC emissions from incomplete combustion of fuels, to manage fuel load, and to prevent or reduce wildfires. Alternatives to burning will also reduce VOC and NOx emissions. A comprehensive nutrient management plan can be used to reduce emissions of nitrogen oxides. For animal operations, implementing housecleaning techniques, maintaining moisture content in open lot surfaces, using a liquid manure management system, covering the surface of storage piles, and using feed management or feed additives to minimize intestinal and manure VOC production can reduce the production and emission of ozone precursor gases.

Ozone Precursors at a Glance

Problems / Indicators - Engines, pesticides, burning, tillage, and animal operations	
Causes	**Solutions**
• Chemical storage and application • Combustion (engines, burning) • Animal operations • Manure handling	• Proper chemical storage and integrated pest management • Engine replacement and retrofit • Prescribed burning and alternatives, wildfire risk reduction • Animal housing and surface lot moisture maintenance • Liquid manure systems, manure covers, feed management • Comprehensive nutrient management planning

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Resource Concerns

Air

Particulate Matter

Air Quality Impacts - Particulate Matter

Direct emissions of particulate matter (PM) – dust and smoke – as well as the formation of fine particulate matter in the atmosphere from other agricultural emissions – ammonia, NOx, and VOCs.

What is it?

Particulate matter is classified by its size where PM2.5 and PM10 have an aerodynamic diameter less than 2.5 and 10 micrometers, respectively. PM2.5 is directly emitted to the atmosphere by combustion processes (vehicles, fire) and to a lesser degree by mechanical means such as dust from roads or tillage. PM2.5 is also formed in the atmosphere by chemical reaction of PM precursor gases; oxides of nitrogen (NOx), volatile organic compounds (VOCs) and ammonia (NH_3). Sources of these PM precursor gases can be engines, fertilizer application, and animal operations. Much of PM10 is mechanically generated and directly emitted to the atmosphere by actions that disaggregate the soil such as tillage operations, road and field travel, animal movement, harvesting and wind erosion. Larger PM is typically geologic in origin.

Why is it important?

Particulate matter in the atmosphere can be a human health issue and lead to visibility degradation. It can also impact ecosystems when it deposits out of the atmosphere. The body's natural defenses can filter out larger particles, but smaller particles can get past the nasal passageways getting into the lungs. PM can also create poor visibility which affects transportation (ex. dust or smoke) and federally protected scenic vistas. Deposition may adversely affect ecosystems by causing nuisance dusting, changing pH balance, damaging plants or by adding additional nitrogen to the environment.

What can be done about it?

Reducing field operations by using residue management and precision farming reduces PM. Plants protect soil from disturbance and intercept PM after it is lifted into the atmosphere. Reducing vehicular miles and speed or treating unpaved roads with a suppressant can reduce dust. For combustion sources, smoke management, alternatives to burning, wildfire risk reduction, engine replacement and retrofits reduce PM and PM precursor emissions. For animal operations, cleaning and ventilating livestock houses, maintaining moisture content in open lot surfaces, periodically removing manure, covering the surface of storage piles, and removing feed and manure from storage piles in a manner that minimizes surface disturbance can all reduce PM and PM precursor emissions. Windbreaks can intercept airborne PM and modify the wind patterns such that PM entrainment and transport are reduced.

Particulate Matter at a Glance

Problems / Indicators - Dust, smoke, chemical and fertilizer use, animal activities	
Causes	**Solutions**
• Unpaved roads • Bare/exposed agricultural fields • Operations on agricultural fields • Chemical applications • Combustion (engines, burning) • Animal operations	• Reduce travel/speed and treat unpaved roads • Residue management, precision farming • Wind barriers • Smoke management, wildfire risk reduction • Engine replacement and retrofit • Open lot manure harvesting/removal and coverage • Animal housing maintenance and ventilation

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PLANTS

Resource Concerns

Plant Productivity and Health

Degraded Plant Condition - Plant Productivity and Health

Plant productivity, vigor and/or quality negatively impacts other resources or does not meet yield potential due to improper fertility, management or plants not adapted to site.

What is it?

Plants established in the wrong climate or soil may be under stress and may never thrive, no matter how much fertilizer or water you supply. Natural events, such as drought, or mismanagement can cause plant stress. Plants under stress are more susceptible to disease and insect damage. Symptoms of poor plant vigor and health may include slow growth, discoloration of leaves, wilting or drooping foliage, leaf drop, and/or discolored roots.

Why is it important?

For plants to produce the expected yield, preferred products, or desired environmental outcomes they must be adapted to the site on which they are growing, provided with the appropriate amounts of nutrients, water, and sunshine, and protected from unchecked animal, weed, insect, and disease pests.

What can be done about it?

Management is the key to maintaining plant productivity and health. Check that the desired plant is suited to the climate, soil type, and intended use. Set realistic yield goals based on soil productivity information, historical yield data, climatic conditions, level of management, and/or local research on similar soil and cropping systems. The NRCS Web Soil Survey (http://websoilsurvey.nrcs.usda.gov) is a source of soils information and their limitations for growing various crops. University Extension is a resource for nutritional, cultural, and management practices needed to keep plants healthy and productive. Nutrient management specifies the amount, timing, form, and method of application of nutrients needed to achieve realistic production goals. Integrated pest management specifies techniques to detect, avoid, and treat pests and diseases. Some causes of poor health and vigor may require the use of cover crops, the adoption of new crop rotations, or changes to tillage methods to address soil quality issues, such as soil compaction, poor drainage, low organic matter, or the presence of contaminants in the soil.

Plant Productivity and Health at a Glance

Problems / Indicators - Yield or growth is substantially less than expected, plants are disease and/or pest-ridden, plants fail to thrive	
Causes	**Solutions**
• Plants receive inadequate nutrition during critical growth periods • Plants fail to thrive due to poor soil conditions • Plants wilt, freeze or rot even during normal climate conditions • Plants not adapted to site	• Use nutrient management to address the form, rate, placement, and timing of nutrient application • Consider crop rotations, deep rooted cover crops, drainage, and deep tillage • Consider alternate crops or different plant varieties

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Resource Concerns

PLANTS

Structure and Composition

Degraded Plant Condition - Structure and Composition

Plant communities have insufficient composition and structure to achieve ecological functions and management objectives. Inadequate structure and composition also includes degradation of wetland habitat, targeted ecosystems, or unique plant communities.

What is it?

A stand of plants and associated organisms (bacteria, fungi, animals) that share a defined area or environment lack the diversity, density, distribution patterns, and three-dimensional structure necessary to produce the preferred products or desired environmental outcomes.

Why is it important?

If landowners hope to achieve their production or environmental objectives, it is critical that they understand and work with the processes that affect structure and composition of plant communities. The interaction between plants, other organisms, and environmental factors such as soil, climate, and topography influence how a plant community functions to cycle nutrients, capture and release water, protect and build soil, nurture wildlife, or produce usable products.

What can be done about it?

Addressing inadequate structure and composition is a complex problem that varies with the natural plant community that is desired. All human activities have the potential to impact natural communities, whether it is land use changes, drainage activities, controlling fires, or the introduction of different animal and plant species. Activities can include removal of unwanted plants to provide more space for desired species to increase in number or size. Desired plants can be reintroduced that are missing from the community. Practices such as grazing, mowing, fertilization, and burning can be used to promote and/or repress growth of target plants to attain the desired structure and composition.

Structure and Composition at a Glance

Problems / Indicators - Inadequate structure and composition	
Causes	**Solutions**
• Stress, disease and/or mismanagement reduces and/or eliminates key components of plant community • Plant community is allowed to grow to late succession stage and fails to produce desired habitat for wildlife and/or insects that depend on early succession habitat • Invasive species outcompete desired plants creating a monoculture • Loss of fire regime	• Employ or modify use of cultural practices (e.g., grazing, burning, mowing) • Treat or remove vegetation to reestablish desired habitat • Control invasive species, reestablish desired plant community, and utilize integrated pest management techniques to maintain stand

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Resource Concerns

PLANTS

Plant Pests

Degraded Plant Condition - Plant Pests

Excessive pest damage to plants including that from undesired plants, diseases, animals, soil borne pathogens, and nematodes.

What is it?

Plants provide food for many forms of life. Human beings and grazing animals depend on plants for food. It is important to note that large numbers of other much smaller creatures, such as insects and their larvae, also feed on plants. Other plants, fungi, bacteria, and viruses use plants as a host during part of their life cycle. Generally, these interactions are normal, predictable, and benign. However, we apply the term "pest" to any animal, insect, bacteria, or virus when any of these interactions become unbalanced and unacceptable plant damage results. Pests can also take the form of any organism that competes for space, nutrients, or water (e.g., weeds). Heat, drought, wind, sun, and cold create stress on plants that make them more susceptible to pests. Pests can vary from place to place, crop to crop, year to year.

Why is it important?

For plants to produce the expected yield, preferred products, or desired environmental outcomes, they must be protected from unchecked animal, weed, insect, and disease pests.

What can be done about it?

Management is the key to keeping damage from plant pests within tolerable limits. Integrated Pest Management is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense treatments. Set Thresholds - Before taking any pest control action, set a point at which pest populations or environmental conditions indicate that pest control action must be taken. Monitor and Identify Pests - Not all insects, weeds, and other living organisms require control. Identify pests accurately so appropriate control decisions can be made in conjunction with action thresholds. Prevention - As a first line of pest control, manage to prevent pests from becoming a threat. Rotate crops and select pest-resistant varieties. Control - If pest control is required, evaluate control methods for effectiveness and risk. Use less risky pest controls first, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring indicates controls are not working, additional pest control methods such as targeted spraying of pesticides should be used. Use broadcast spraying of non-specific pesticides only as a last resort.

Plant Pests at a Glance

Problems / Indicators - Animal, insect, and/or disease damage, or competition from common weeds or invasive plants substantially reduces yield or growth	
Causes	**Solutions**
• Plants suffer from attacks by pests or disease • Weeds or invasive plants out compete desired crop • Plants are weak or not thriving	• Use Integrated Pest Management to employ early detection, avoidance, and treatment of pests • Consider brush management, vegetative weed control, mulching, or prescribed grazing or burning • Use plants adapted to climate and soils

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Resource Concerns

PLANTS

Wildfire Hazard

Degraded Plant Condition - Wildfire Hazard

Accumulated plant residue (biomass) creates wildfire hazards that pose risks to human safety, structures, plants, animals, and air resources.

What is it?

All plants produce litter from leaves, stalks, or stems. Normally, this residue is either left to decompose and nourish the next generation of plants and animals, or it is harvested and used for straw, mulch, bio-fuel, pulp, etc. When the rate of utilization and/or decomposition is slower than the rate of biomass production, residues can accumulate to the point of becoming a fire hazard.

Why is it important?

While fire is an important and often beneficial part of the natural ecosystem, uncontrolled or "wild" fire poses a threat to life, health, and property. In addition, the secondary effects of wildfires, including erosion, landslides, introduction of invasive species, and changes in water quality, are often more disastrous than the fire itself.

What can be done about it?

The amount of flammable biomass can be reduced to decrease the incidence of wildfires; the distribution of biomass can be manipulated to influence the direction and rate at which wildfires spread; and precautionary steps can be taken to protect life and property to lessen the impacts of wildfires.

Wildfire Hazard at a Glance

Problems / Indicators - Excess biomass, biomass distribution, lack of preparedness	
Causes	**Solutions**

• Overstocked forest increases the risk of fire outbreak
• Unbroken expanse of flammable biomass increases the risk of the spread of fire
• Lack of a plan on how to respond to fire increases risk to life and property
	• Thin excess trees and brush
	• Treat or remove vegetation, debris, and detritus
	• Create and implement a wildfire plan:
	  • post fire control agency phone numbers
	  • locate and map water sources
	  • map out evacuation routes
	  • equip vehicles with fire fighting tools

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Resource Concerns

ANIMALS

Habitat Degradation

Inadequate Habitat for Fish and Wildlife - Habitat Degradation

Quantity, quality or connectivity of food, cover, space, shelter and/or water is inadequate to meet requirements of identified fish, wildlife or invertebrate species.

What is it?

Because of deficient habitat, upland, wetland and/or aquatic organisms may lack: adequate food and proper nutrition to grow, maintain health, and reproduce; shelter from adverse environmental conditions; protection from predators; environmental features necessary for a particular life need; space to locate a mate, obtain sufficient food and water, and rest; and quality or quantity of water sufficient to support proper metabolism and maintain health.

Why is it important?

Perhaps the greatest threat to fish, wildlife, and invertebrate species is the destruction of their habitat. The availability and arrangement of food, cover, shelter, water, and space determine the number of organisms that a region can support, which is also known as carrying capacity. Increasing carrying capacity is critical to attaining long-term population stability. Conserving existing habitat and restoring habitat shortcomings improves the odds that fish and wildlife communities will thrive. When landowners keep wildlife communities intact, less regulatory intervention is required to ensure the survival of individual species.

What can be done about it?

Landowners can address some habitat shortcomings on their property by providing food plots, nest boxes, brush piles, watering facilities, etc. However, maintaining a sustainable population often requires cooperation of multiple landowners. Simply having considerable amounts of food, cover, or water does not ensure a sustainable wildlife population. Within any area, large quantities of potential food, water, or cover may go unused because they are too far apart in relation to the customary travels of the animals in an area. An animal could travel a long distance to find water if necessary, but it would do little good if the animal was preyed upon along the way. Properly arranging the habitat components across a landscape is important to ensure that each component benefits the species of concern. Accomplishing this goal requires an understanding of the specific habitat needs of the managed species.

Habitat Degradation at a Glance

Problems / Indicators - Loss of habitat to support desired wildlife species	
Causes	**Solutions**
• Insufficient shelter/cover • Insufficient food • Insufficient water quantity or quality • Fragmented habitat	• Nest boxes or platforms, brush piles, rock piles, root wads • Food plots and/or leave portions of crop fields unharvested • Watering facilities, • Buffers, hedgerows, windbreaks, and similar plant structures

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Resource Concerns

ANIMALS

Feed and Forage

Livestock Production Limitation - Feed and Forage

Feed and forage quality or quantity is inadequate for nutritional needs and production goals of the kinds and classes of livestock.

What is it?

Livestock require five major classes of nutrients: energy, protein, minerals, vitamins, and water. All five are essential for normal health and production. Next to water, the greatest requirement is for energy, followed by protein, with minerals and vitamins needed in very small amounts. Without adequate energy from feed or forage, utilization of all other nutrients is impaired.

Why is it important?

Providing sufficient feed and forage helps to ensure animal health and performance. To sustain the resource base, it is critical to balance the required feed and kind of forage with the number and type of animals in the operation. Stocking rates and timing must be adjusted and supplements provided, as needed, for livestock grazing pasture or rangeland. Improving animal feed and forage can improve livestock productivity and farm income.

What can be done about it?

Applying the principles of forage production for livestock requires an understanding of how plants interact with soil and climate, as well as understanding the nutritional needs of the animals. Prescribed Grazing is the management of grazing land to adjust intensity, frequency, timing, and duration of grazing and/or browsing to meet the desired objectives for the plant communities and the grazing and/or browsing animal. A proper system manages animal number, grazing distribution, and length and time of grazing periods to provide grazed plants sufficient recovery time for regrowth and plant health. Feed and forage balance sheets and forage growth curves are used to make decisions about stocking rates and timing of grazing rotations based on plant growth and animal demands. Fencing and placement of livestock water can facilitate proper grazing management. Conservation practices, such as Forage and Biomass Planting and Forage Harvest Management, provide guidance to improve the forage base to support the prescribed grazing system.

Feed and Forage at a Glance

Problems / Indicators - Feed and forage not adequate to support the livestock operation	
Causes	**Solutions**
• Insufficient livestock feed • Overstocking of livestock • Inadequate distribution of livestock grazing • Poor feed quality • Weed, insect, or disease problems	• Prescribed grazing systems • Adequate water distribution • Production of high quality feed and forage • Forage analysis for nutrient quantity and quality

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Resource Concerns

ANIMALS

Livestock Shelter

Livestock Production Limitation - Livestock Shelter

Livestock lack adequate shelter from climatic conditions to maintain health or production goals.

What is it?

Natural vegetation or landscape features are not adequate to provide shelter for livestock during periods of severe climatic circumstances.

Why is it important?

Livestock performance is reduced during periods of high heat or extreme cold weather. Providing sufficient shelter to offset these climatic conditions can be beneficial to animal performance and health. Without adequate upland shelter, livestock may seek shelter in low-lying areas, such as streams, which may cause riparian area deterioration and/or water quality issues.

What can be done about it?

Shelters or windbreaks can be provided using natural vegetation or constructed sanctuaries to give animals sufficient protection from harsh climatic conditions. When livestock shelter is constructed or planted with ample buffer distances from riparian areas or water bodies, and in locations not susceptible to runoff and erosion, environmental risks associated with livestock concentration are minimized. Further, use of portable structures that are periodically moved helps prevent areas of heavy use and increased erosion possibilities.

Livestock Shelter at a Glance

Problems / Indicators - Vegetative, landscape, and/or structural options for livestock shelter do not exist; livestock are exposed to severe climatic conditions	
Causes	**Solutions**
• Exposure to extreme wind and cold in system that supports tree growth • Historical shelterbelt is partially functioning • Exposure to extreme wind and cold in area where plant options are limited or temporary shelter is preferred	• Permanent windbreak establishment using native or naturally occurring plant materials • Renovate partially existing shelter belt • Portable season-long fabricated shelter

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Resource Concerns

ANIMALS

Livestock Water

Livestock Production Limitation - Livestock Water

Quantity, quality, and/or distribution of drinking water are insufficient to maintain health or production goals for the kinds and classes of livestock.

What is it?

Water is an important but often overlooked nutrient for livestock. Water makes up over 98 percent of all molecules in the body and is necessary for regulation of body temperature, growth, reproduction, lactation, digestion, lubrication of joints, eyesight, and as a cleansing agent. Livestock water requirements are influenced by several factors, including rate of gain, pregnancy, lactation, activity, type of diet, feed intake, and environmental temperature.

Why is it important?

Water quality for livestock consumption can be detrimental based on several parameters, such as nitrates, sulfates, salinity, bacteria, pH, pesticides, and total dissolved solids. Water quantity and distribution of suitable water sources can affect livestock based on the basic need to meet daily intake requirements and issues related to grazing patterns and travel distance to water that may result in surplus/deficient forage availability and excessive/insufficient plant utilization. All of these ultimately affect livestock health and resource stability.

What can be done about it?

Water quality concerns, for both livestock health and the environment, can be addressed by limiting livestock access to ponds and water bodies or by installing watering facilities. Proper layout of water facilities will provide more even distribution of grazing that will enhance forage utilization. Animals do not graze or utilize areas that are remote from water sources and the size of the facility should be designed to avoid crowding. Having watering sites as evenly distributed as possible in a grazing system will help circumvent overused or underused areas of the pasture.

Livestock Water at a Glance

Problems / Indicators - Lack of water, poor water quality, poor distribution can affect livestock health	
Causes	**Solutions**
• Water availability is limited • Spring area trampled by livestock • Livestock in stream or pond creating potential health concerns	• Inventory, evaluate, and plan watering system for livestock type • Develop spring for livestock water and outlet for wet area for native plants and wildlife • Establish select watering points and construct watering facilities to move livestock away from streams and ponds

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Resource Concerns

ENERGY

Equipment and Facilities

Inefficient Energy Use - Equipment and Facilities

The inefficient use of energy increases costs and dependence on non-renewable energy sources.

What is it?

Inefficient energy use occurs whenever facilities, equipment, or machinery operate more hours than needed to meet production goals. It may also occur when facilities, equipment, or machinery become worn out, outdated, or are poorly controlled or maintained.

Why is it important?

High energy prices have put considerable pressure on the U.S. economy. High input costs and the inability to set prices leave the agricultural sector with limited options to be economically viable. Reducing energy use helps our nation to be energy independent and reduces costs, helping producers stay competitive in the marketplace.

What can be done about it?

There are two ways to reduce energy related production costs: 1) increase energy efficiency of the operation and 2) increase use of energy sources produced on the farm. For increased energy efficiency, NRCS Energy Estimator and Assessment tools gauge potential energy savings for a wide variety of efficiency upgrades. If these tools show energy saving opportunities, or if there are concerns about energy use and cost, NRCS staff will likely recommend an energy audit. During an energy audit, energy experts evaluate the farming operation and recommend changes to improve energy use. Common recommendations include changes to lighting, ventilation, heating and cooling of livestock facilities, drying/curing, milk cooling, irrigation pumping, and manure handling. An energy analyst evaluates the age and condition of facilities, equipment, and machinery, and how they are operated and maintained. For on-farm renewable energy, the Energy tools provide a similar gauge of renewable energy resources. NRCS staff can help identify ways, for example, to better use solar and wind resources, take advantage of geothermal or micro-hydropower potential, and use waste for bio-energy to leverage increased efficiency efforts.

Equipment and Facilities at a Glance

Problems / Indicators - Unacceptably high energy costs	
Causes	**Solutions**
• Unvented, propane-fired heated systems • Throttling valves to control water flow • Using incandescent or T12 lights • Inefficient motors and farm equipment	• Convert to radiant heating • Add variable frequency drive pump • Upgrade inefficient pump and/or motor • Upgrade to T8, LED, or CFL lighting • Renewable energy sources • Low pressure irrigation systems

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Resource Concerns

ENERGY

Field Operations

Inefficient Energy Use - Field Operations

The inefficient use of energy increases costs and dependence on non-renewable energy sources.

What is it?

Inefficient energy use occurs whenever equipment or machinery operates more hours than needed to meet production goals. It may also occur when equipment or machinery becomes worn out, outdated, or poorly controlled.

Why is it important?

High energy prices have put considerable pressure on the U.S. economy. High input costs and the inability to set prices leave the agricultural sector with limited options to be economically viable. Reducing energy use helps our nation to be energy independent and reduces costs, helping producers stay competitive in the marketplace.

What can be done about it?

Money can be saved and energy dependency can be reduced by improving the efficiency of field operations, and by adopting practices that help reduce energy-intensive inputs, such as soil amendments, fertilizers, or pesticides. For improved efficiency, Natural Resources Conservation Service (NRCS) staff will most likely start by evaluating field operations used to till, plant, cultivate, and harvest crops. This assessment helps identify steps to take to reduce field operations or improve efficiency. The NRCS Residue Management Energy Estimator tool can be used to estimate potential energy savings associated with changes in tillage, cultivation, and fertilizer use. By using a guidance system on tractors and equipment, application overlaps can be reduced and application rates can be optimized to account for variability in soil types, elevation, soil chemistry, fertility, and productivity within fields. These steps can reduce the need for fuel, fertilizer, herbicide, and insecticide, and save money. For reduced inputs, adoption of Integrated Pest Management techniques of prevention, avoidance, monitoring, and suppression can reduce pesticide and fuel use and lower environmental risk. Substituting manure for commercial fertilizer, or using nitrogen-fixing legumes as cover crops or in crop rotations can reduce the use of fossil fuel-based commercial fertilizer. Tractor operations are likely to increase, but usually money is saved. Overall energy use is lower because less natural gas will be used to produce commercial nitrogen fertilizer (that was not purchased).

Field Operations at a Glance

Problems / Indicators - Unacceptably high energy costs	
Causes	**Solutions**
• Unnecessary trips across the field • Overlap when applying fertilizer, pesticides • High use of commercial fertilizer	• Convert to conservation tillage • Global positioning system guided spraying equipment • Incorporate nitrogen-fixing legumes into rotation or as cover crop

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