Certified Crop Adviser

Performance Objectives
For
South Dakota

2016

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NUTRIENT MANAGEMENT COMPETENCY AREAS

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COMPETENCY AREA 1. Nutrient movement in soil and water

1. Recognize how soil, climatic, and nutrient properties affect movement of a nutrient in soil or water.

COMPENTENCY AREA 2. N, P, K plant requirements

Nitrogen

2. Recognize how soil physical properties affect nitrogen management.

3. Recognize how cropping systems affect legume credit and nitrogen management.

4. Recognize how soil drainage, irrigation, precipitation levels, and potential for water contamination affect nitrogen fertilization.

5. Recognize the analysis, physical form, and handling precautions of each of the following nitrogen fertilizer sources:

    a. Anhydrous Ammonia
    b. Urea
    c. UAN
    d. Ammonium sulfate
    e. Bio-solids

Phosphorus

6. Recognize how soil chemical properties affect phosphorus management.

7. Recognize how cropping systems affect phosphorus management (i.e. tillage, no-till, cover crop).

8. List advantages and disadvantages of phosphorus application methods, placement and sources.

9. Describe the appropriate situations for using the Bray I, Olsen, and Mehlich III extractants for phosphorus.

10. Recognized the analysis, physical form and handling precautions of each of the following phosphorous fertilizer sources:

    a. 18-46-0 (DAP)
    b. 11-52-0 (MAP)
    c. 10-34-0 (APP)
    d. Orthoposphate
    e. Polyposphate

Potassium

11. Recognize how soil physical and chemical properties affect potassium management.

12. Recognize how cropping systems affect potassium management (i.e. tillage, no-till).

13. List advantages and disadvantages of potassium application methods and sources.

COMPETENCY AREA 3. Secondary nutrient and micronutrient plant requirements (Emphasis on S, Zn, Fe, and Cl)

14. Recognize the general deficiency symptoms of the secondary nutrients and the micronutrients.

15. Recognize the importance of soil pH on availability and micronutrient management.

16. List methods of correcting secondary and micronutrient deficiencies.

COMPETENCY AREA 4. Nutrient recommendations

17. Recognize remote sensing techniques for field management zones.

18. Describe the recommended soil sampling and handling procedures for nutrient analysis in South Dakota.

19. Interpret the items on a soil test report.

20. Recognize economic and environmental factors involved in making fertilizer recommendations.

21. Make economically and environmentally sound fertilizer recommendations.

COMPETENCY AREA 5. Plant nutrient sources and application

22. Recognize how fertilizer placements and time of application affect nutrient use efficiency.

23. Recognize how starter fertilizers can cause crop injury.

    a. Salt Index

24. Recognize fertigation principles and techniques.

25. List types (i.e. rotary spreader) of equipment used to apply fertilizers.

26. List procedures used to calibrate fertilizer application equipment.

27. Describe the difference in nutrient content variability and availability for manures biosolids/sludge's, composts and other materials.

28. Identify nutrient losses associated with different methods of manure storage and application.

29. Describe manure sampling and sample handling procedures.

30. Recognize how sludge’s, composts, and other nonconventional products affect the soil and add nutrients for improving crop protection.

31. Recognize nutrient management implications of cover crops (i.e. green manure).

32. Recognize the effects of animal manure source, storage methods and application technology.

COMPETENCY AREA 6. Lime application

33. Recognize how each of the following factors affect lime application:

    a. Type of cropping and tillage systems
    b. Soil type
    c. Soil PH
    d. Lime sources – Municipal Waste Water Treatments, Pell Lime, Ag Lime

COMPENTENCY AREA 7. State laws and rules governing fertilizer and manure use in storage and handling.

34. Describe safety handling procedures and placarding for fertilizer materials. (Hazardous Identification Shipping Placarding)

35. Describe spill reporting requirements.

36. Recognize regulations and agencies controlling fertilizer labeling, storage, licensing, sampling, inspection, analysis, distribution and handling.

37. Describe the appropriate loading and storage procedures for bulk nutrients and manure.

38. Describe regulations regarding permitted livestock facilities in South Dakota.

39. Recognize the security and safety in sales, storage and handling of fertilizer and pesticides.

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Nutrient Management Glossary

Acid soil: A soil that has a pH value less than 7.0.

Agronomic nutrient rate: Amount of nutrients required by a crop for an expected yield, after all the soil, water, plant, and air credits are considered. Agronomic rates consider nutrient credits from all soil tests, legumes, manure residuals, and other nutrient credits supplied from any other source.

Alkaline soil: A soil that has a pH value greater than 7.0.

Ammonium (NH4+): A form of nitrogen that is available to plants from fertilizer and organic matter decomposition.

Ammonium nitrate solution: Non-pressure solution of ammonium nitrate in water usually standardized to 20% nitrogen used for direct application or for making multinutrient liquid fertilizer. Analysis is 20-0-0.

Ammonium phosphate: A group of phosphorus fertilizer manufactured by the reaction of anhydrous ammonia with superphosphoric acid to produce either solid or liquid fertilizer.

Ammonium sulfate: Fertilizer material with an analysis of 21-0-0. It also contains 24% sulfur.

Anaerobic: A condition identified by the absence of oxygen.

Anhydrous ammonia (NH3): Fertilizer in pressurized gas form, made by compressing air and natural gas under high temperature and pressure in the presence of a catalyst. Value is 82-0-0.

Animal unit: 1000 pounds of live animal weight; a term used to determine volumes of animal manure produced.

Anion exchange capacity (AEC): The amount of exchangeable anions that a soil can adsorb at a specific pH, expressed as milliequivalents per 100 g of soil as meg/100g soil or cmol charge/kg. See also CEC.

Application rate: The weight or volume of a fertilizer, soil amendment, or pesticide applied per unit area.

Available nutrient: The form of a nutrient that the plant is able to use. Many nutrients in the soil are in forms the plant cannot use and must be converted to forms available to the plant.

Banded nutrients: Placing fertilizer nutrients in a band near the seed at planting, or surface or subsurface applications of solids or fluids in strips before or after planting.

Base saturation percentage: The proportion of the soil's cation exchange capacity occupied by basic cations.

Bioremediation: The use of biological agents to reclaim soil and water polluted by substances hazardous to human health or the environment.

Biosolid: Any organic material, such as livestock manure, compost, sewage sludge, or yard wastes applied to the soil to add nutrients or for soil improvement.

Buildup and Maintenance: Nutrients applied in order to build up a target soil test level and then maintained by annual addition of the quantity of nutrients expected to be removed in the harvested portion of the crop.

Buffer pH: A soil test procedure whereby the pH of the soil is measured in buffer solution. This measurement is used in estimating the lime requirement of the soil.

Calcitic lime: Limestone consisting of CaCO3 based material with very low magnesium content.

Calcium carbonate Equivalent (CCE): The liming potential of a material as compared to CaCO3.

Cation: An ion that has a positive electrical charge. Common soil cations are calcium, magnesium, hydrogen, sodium, and potassium.

Cation exchange capacity (CEC): The amount of exchangeable cations that a soil can adsorb at a specific pH, expressed as milliequivalents per 100 g of soil per 100 g soil as meq/100g soild, or cmol charge/kg. See also AEC.

Cation exchange sites: Negative charged sites on the surfaces of clays and organic matter.

Chelated molecule: A large, water soluble organic molecule that binds with a free metal ion to form a water soluble compound. This process increases the amount of metal ion or atom dissolved in the water.

Comprehensive nutrient management plan: Conservation practices and management activities which will ensure that both productivity and natural resource protection.

Critical value: The point between sufficiency and deficiency levels for a nutrient.

Crop nutrient requirement: The amount of nutrients needed to grow a specified yield of a crop plant per unit area.

Crop removal rate: The amount of nutrients that are removed from the field in the plant harvest. This would include harvested fruit, grain, forage, and crop residues that are physically removed from the field.

Crop rotation: A planned sequence of crops growing in a regularly recurring succession on the same area of land.

Crop utilization rate: The total amount of nutrients required by the crop to produce both vegetation and grain, including nutrients used to produce roots, stems, crowns, and other unharvested plant parts as well as the harvested portion that is removed from the field.

Crop sequence: The order of crops planted and harvested in a field over a period of time.

Denitrification: The transformation of nitrates or nitrites to nitrogen or nitrogen oxide gas, occurring under anaerobic conditions.

Diammonium phosphate (DAP): Fertilizer containing both nitrogen and phosphorus with an analysis of 18-46-0.

Diffusion: The movement of particles from an area of higher concentration to an area of lower concentration.

Dolomitic Lime: A naturally occurring liming material composed chiefly of carbonates of magnesium and calcium.

Environmentally sensitive area: Places on the landscape that can be readily impacted by human or natural activity so as to degrade the condition of the site.

Essential plant nutrients: Inorganic elements that are required for growth and development of plants.

Erosion: The wearing away of the land surface by running water, wind, ice, geological agents, or mechanical erosion.

Fertigation: Applying fertilizer through an irrigation system.

Fertilizer: Organic or inorganic material added to a soil to supply one or more nutrients essential to plant growth.

Fertilizer analysis: The composition of a fertilizer, expressed as a percent of total nutrients, for example total N, available phosphoric acid (P_2O_5), and water-soluble potash (K_2O).

Fertilizer suspension: A fluid fertilizer containing dissolved and undissolved plant nutrients. The undissolved nutrients are kept in suspension, usually by swelling type clays.

Field capacity: The amount of water a soil holds after free water has drained because of gravity.

Foliar fertilization: Application of a dilute solution of fertilizer to plant foliage, usually made to supplement soil-applied nutrients.

Green manure: Plant material incorporated into the soil while green or at maturity, for soil improvement.

Guaranteed analysis: Minimal percentages of available nutrients as stated on a fertilizer label.

Gypsum: Calcium sulfate ($CaSO_4 \cdot 2H_2O$) used to supply calcium and sulfur and to improve sodic soils.

Immobile nutrient: A plant nutrient that moves slowly in the soil or plant.

Immobilization: The conversion of an element from the inorganic to the organic form in microbial tissues resulting in that element not being readily available to other organisms or plants.

Impermeable layer: Soil layers, either natural or man-made, that resist penetration by fluids or roots.

Injection: The placement, by mechanical means, below the surface of soil.

Inorganic nitrogen: Mineral forms of nitrogen.

Inorganic phosphorus: A salt of phosphoric acid or any of its anions, usually orthophosphate or polyphosphate.

Leaching: The movement of material in solution along with movement of water through the soil.

Lime fineness: The particle size of limestone determined by the fineness of grinding. The finer the grind, the more reactive the material is in neutralizing acidity.

Lime material: A material capable of neutralizing soil acidity.

Lime purity: The measure of impurities in a given liming material, in order to estimate its neutralizing value.

Liming requirement: The amount of liming material required to change the soil to a specific soil pH.

Load method: Field calibration method to determine manure application rates.

Luxury consumption: The absorption by plants of an essential nutrient in excess of their need for growth. Luxury concentrations in early growth may be used in later growth.

Macronutrient: A nutrient that a plant needs in relatively large amounts. Essential macronutrientsare nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulphur (S).

Manure: Animal excrement or refuse used as a fertilizer. Nutrients vary by animal species and age.

Mass flow: The movement of solutes associated with net movement of water.

Micronutrient: Nutrients that plants need in only small or trace amounts. Boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn) are considered micronutrients.

Mineralization: The conversion of an element by soil organisms from an organic form to an inorganic form.

Mobile nutrient: A nutrient that moves readily in the soil or plant.

Monoammonium phosphate (MAP): A fertilizer composed of ammonium phosphates, resulting from the ammoniation of phosphoric acid. Typically 11% N with an analysis of 11-52-0.

N-based nutrient application: The rate of application of a nitrogen containing material so the desired amount of nitrogen is applied, regardless of the amounts of other nutrients being applied in the material.

Nitrate (NO3-): An inorganic nitrogen form that is very soluble, easily leached from soils, and readily available to plants.

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Nitrification: The process of converting ammonium to nitrate.

Nitrogen: An essential plant nutrient that is part of many compounds including chlorophyll, enzymes, amino acids, and nucleic acids.

Nutrient buildup: An increase in soil test levels of a nutrient due to application of that nutrient.

Nutrient management plan (NMP): A written plan that specifies the utilization of fertilizer, animal manures, and other biosolids.

Organic nitrogen: Nitrogen that is bound with organic carbon and forms organic molecules.

Organic phosphorus: Phosphorus that is bound with organic carbon and forms organic molecules.

Orthophosphate: Inorganic form of plant available phosphorus.

P-based nutrient application: The rate of application of a phosphorus containing material so that the desired amount of phosphorus is applied. Phosphorus is based on balancing the agronomic rate or crop removal rate of the crop with the desired amount of phosphorus contained in a material regardless of the amounts of other nutrients being applied in the material.

P index: An environmental risk assessment tool for assessing the potential for phosphorus movement from agricultural lands. It is usually based on an estimation of potential soil erosion, the phosphorus soil test level, and phosphorus management practices such as rate of application, source of phosphorus, and method of application.

P2O5: Phosphorus pentoxide; designation on the fertilizer label that denotes the percentage of available phosphorus expressed as P2O5.

Phosphorus: Essential nutrient for plants and animals. Component of cell walls, nucleic acids, and energy transfer molecules.

Plant available nitrogen (PAN): A calculated quantity of nitrogen made available during the growing season after application of fertilizer. PAN includes a percentage of the organic nitrogen, a percentage of the ammonium N, and all the nitrate nitrogen in the fertilizer.

Plant residues: Plant material that remains in the field after harvest.

Potash fertilizer: 0-0-60, potassium chloride fertilizer.

Potassium: Often referred to as potash, it is an essential plant nutrient involved in energy metabolism, starch synthesis, and sugar degradation.

Recommended rate, nutrients: Amount of nutrients recommended on a soil test report for a specific crop that meets but does not exceed the crop nutrient requirements. Recommended rates can also include nutrients used for soil test buildup.

Remote sensing: The collection and analysis of data from a distance, using sensors that respond to different heat intensities or light wavelengths.

Rhizobia: Bacteria capable of living symbiotically with higher plants by receiving food and carbon and provide a source of nitrogen to the plant.

Root interception: Method by which ions in the soil are intercepted by root growth.

Runoff: Portion of precipitation, snowmelt, or irrigation that moves by surface flow from an area.

Salt index: Is a measure of the salt concentration that fertilizer induces in the soil solution, especially important for seed-placed fertilizer.

Secondary nutrients: Those macronutrients (calcium, magnesium, and sulfur) used less often as fertilizers than the primary elements.

Sidedress: To apply a fertilizer, pesticide, or soil amendment to one side of a growing plant, either by surface application or injection.

Soil drainage: The process where water is moved either by surface channels or internal pores in the soil profile, usually by action of gravity.

Soil organic matter: The organic fraction of the soil exclusive of undecayed plant and animal residues. Often used synonymously with “humus”.

Soil pH: The degree of acidity or alkalinity of a soil, expressed on a scale from 0 to 14, with 7.0 indicating neutrality, increasing values indicate increasing alkalinity, while decreasing values indicate increasing acidity.

Soil productivity: A measure of the soil’s ability to produce a particular crop or sequence of crops under a specific management system.

Soil reaction: A quantitative term that describes the general degree of acidity or alkalinity of a soil.

Soil sampling: Process of obtaining a representation of an area of the soil or field by collecting a portion of the soil.

a. **Grid sampling:** Multiple soil samples per field based upon equal sized grid pattern of the field.
b. **Zone sampling:** Multiple soil samples per field based upon various types of management zone techniques.
c. **Composite sampling:** One sample per field.

Soil solution: The aqueous liquid phase of the soil and its solutes contained in soil pores.

Soil structure: The combination or arrangement of primary soil particles into secondary soil particle units, or peds.

Soil test: A chemical, physical, or biological procedure that estimates the plant availability of nutrients and soil quality characteristics to support plant growth.

Soil test interpretation: Using soil test report information to manage soil fertility and monitor environmental conditions.

Soil test level: The nutrient content of the soil, as measured by an analysis of a soil sample.

Soil test recommendation: The suggested amount of nutrients to be added to the soil or plant to achieve expected crop yields based on the supplying power of the soil, air, and water.

Soil test phosphorous methods:

a. Olsen method: Used for wide range of soil test pH, especially if above 7.5 pH
b. Bray method: Used for lover range of soil pH, especially if below 7.4pH

Soil texture: The relative proportions of sand, silt, and clay in the soil.

Solvita test: A soil health test for CO_2 soil respiration.

Starter fertilizer: A fertilizer applied in relatively small amounts with or near the seed at planting.

Sufficiency level: a) For interpretation of plant analysis: A nutrient concentration in the plant tissue above which the crop is amply supplied, and below which the crop is deficient. b) For interpretation of soil analysis: A soil test level above which economic responses to applied fertilizer are unlikely to occur.

Subsurface band: To apply nutrients, pesticides, or soil amendments in narrow bands below the

Surface band: To apply nutrients, pesticides, or soil amendments in narrow bands over the surface of the soil.

Surface broadcast: To apply nutrients, pesticides, or soil amendments uniformly over the surface of the soil.

Symbiotic N fixation: Conversion of molecular nitrogen (N2) to ammonia and subsequently to organic nitrogen forms by organisms.

Topdress: To apply fertilizer, pesticides, or soil amendments on the surface.

Total Kjeldahl Nitrogen (TKN): A laboratory procedure to measure organic N and ammonium on soils and plants.

Total nitrogen: The sum of the organic and inorganic forms of nitrogen in a sample.

Toxicity level: A quantity of a material in plants, soil, or water that can harm or impair the physiological function of plants or soil.

Triple Superphosphate: A product that has a guaranteed analysis between 40 and 50% available phosphoric acid. The most common analysis is 0-46-0.

Uptake antagonism: When the excess of one nutrient interferes with the uptake of another nutrient. Usually the nutrients in question may have a similar uptake mechanism by the plant.

Urea: A nitrogen fertilizer that is a white crystalline solid, very soluble in water, which has an analysis of 46-0-0.

Urea Ammonium Nitrate solution (UAN): A non-pressure nitrogen fertilizer solution containing urea and ammonium nitrate in approximately equal proportions dissolved in water. The nitrogen content of the fertilizer solution ranges from 28% to 32%.

Volatilization: The loss of a compound in gaseous form from a solid or liquid phase.

SOIL AND WATER MANAGEMENT

COMPETENCY AREAS

1. **Soil conservation**
2. **Tillage operations and soil characteristics**
3. **Management of saline and sodic soils**
4. **Irrigation**
5. **Water quality**
6. **Soil drainage and water movement in soils**
7. **Cover crops**

COMPETENCY AREA 1. Soil conservation

1. Enumerate steps involved in wind- and water-caused soil erosion.

2. Describe how soil properties, characteristics, landscape and cover affect water runoff and soil erosion.

3. Describe (including advantages, disadvantages, effectiveness) of common erosion control practices, i.e., residue management, contouring, strip cropping, terraces, grass waterways, filter strips, windbreaks and cover crops.

4. Distinguish the difference between and describe practices, related to point and non-point sources of pollution.

5. List physical factors of the soil, which affect rate of erosion.

6. Understand the line-transect method to estimate the percentage of residue.

7. In a given situation, make economically sound management recommendations that will result in soil conservation.

8. Use a soil survey to locate a tract of land (or similar object) and describe its characteristics.

COMPETENCY AREA 2. Water quality

9. Describe how the following agricultural practices affect water quality:
    a. Nutrient placement practices and nutrient placement amounts
    b. Tillage and no-till
    c. Pesticide applications
    d. Drainage
    e. Filter Strips

10. Describe how watershed and site characteristics influence crop management.

11. Describe regulations regarding application of fertilizers, manure, and crop chemicals.
    a. Chemigation and fertigation
    b. Environmentally sensitive areas and aquifers.

COMPETENCY AREA 3. Tillage operations and soil characteristics

12. Recognize how tillage operations and no-till farming influence soil structure and compaction.

13. Recognize how tillage operations influence water movement in soil.
    a. Percolation and infiltration
    b. Evaporation

COMPETENCY AREA 4. Irrigation

14. Recognize how soil physical characteristics influence the selection of land for irrigation.

15. Define the chemical characteristics of irrigation water measured by electrical conductivity and sodium adsorption ratio.

16. Recognize how the electrical conductivity and the sodium adsorption ratio of water affect suitability for irrigation purposes.

17. List factors that influence the rate and timing of irrigation.

18. Describe water quality concerns for irrigation

19. List regulatory agencies controlling surface and ground water use for irrigation.

20. Recognize standard approaches to irrigation scheduling.

21. Recognize the impact of application of sprinkler irrigation water on soil characteristics.

COMPETENCY AREA 5. Management of saline and sodic soils

22. Describe chemical and physical properties of saline, saline-sodic, and sodic soil.

23. Recognize plant responses to saline, saline-sodic, and sodic soils.

24. Recognize crops that are adapted to saline, salilne-sodic, and sodic soils.

25. Recognize how the salt content and sodium adsorption ratio of irrigation water relate to soil salinity and sodicity.

26. List techniques used to improve saline, saline-sodic, and sodic soils.

COMPETENCY AREA 6. Soil drainage and water movement in soils

27. List factors affecting the installation of a surface or tile drainage system.
    a. Topographic
    b. Soil texture
    c. Soil chemistry/salinity
    d. Environmental impact

28. Recognize how cropping and tillage systems are related to soil drainage and plant available water (no-till vs. minimum till vs. conventional tillage practices).

29. Recognize management of wetlands.

COMPENTANCY AREA 7. Cover Crops

30. Describe the purpose of cover crops:
    a. Benefits of cover crops
    b. Types and use of cover crops
    c. Soil fertility
    d. Pest management
    e. Erosion management

31. Describe cover crops in a rotation.

32. Recognize how cover crops support conservation (tillage) systems.

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Soil and Water Management Glossary

A horizon: Mineral soil horizon formed at or near the soil surface. It displays the greatest amount of leaching and is usually higher in organic matter and biological activity than the deeper horizons.

Acid soil: A soil that has a pH value less than 7.0.

Adhesion: The steady and firm attachment of soil particles, plant material, and mico-organisms.

Aggregate, soil: A mass of fine soil particles held together by clay, organic matter, or microbial gums. Aggregates are part of soil structure.

Alkaline soil: A soil that has a pH value greater than 7.0.

Alluvium: A general term for all eroded material deposited by running water including gravel, sand, silt, and clay.

Anion: An ion with a negative charge.

Anion exchange capacity (AEC): The sum total of exchangeable anions that a soil can adsorb at a specific pH. Expressed as centimoles of change per kilogram (cmolc/kg) of soil or milliequivalents per 100 g of soil (meq/100 g soil). (See CEC)

Aquifer: Layers of underground porous or fractured rock, gravel, or sand through which considerable quantities of groundwater can flow and which can supply water at a reasonable rate. May be classified as perched, confined, or unconfined.

Available nutrient: An essential nutrient in forms that a plant can absorb.

Available water: Portion of water in soil that can be readily absorbed by plant roots.

B horizon: The zone of accumulation of materials such as clay, iron, aluminum, and organic matter moving from the above horizons.

Bedrock: Solid, or consolidated, rock lying under the soil.

Biological oxygen demand (BOD): The amount of oxygen required by aerobic microorganisms to decompose the organic matter in a sample of water and used as a measure of the degree of water pollution.

Biosolid: Any organic material, such as livestock manure, compost, sewage sludge, or yard wastes applied to the soil to add nutrients or for soil improvement.

Blocky: Soil structure classification in which aggregates are in the shape of blocks or polyhedrons.

Buffer strip: Areas or strips of land maintained in vegetation and strategically located on the landscape to help control runoff, erosion, and entrap contaminants.

Buffering: The ability of a solution, like the soil solution or irrigation water, to resist changes in pH when acid or alkaline substances are added. Often used when speaking of soil to describe its resistance to pH changes when limed or acidifid.

Bulk density: The mass of oven-dry soil per unit volume, usually expressed as grams per cubic centimeter.

C horizon: Zone of parent material; contains the material from which A and B horizons form.

Calcareous soil: A soil containing significant amounts of naturally occurring calcium carbonate, which fizzes when dilute acid is applied.

Capillary action: Movement of water in the soil through small soil pores.

Carbon-nitrogen (C:N) ratio: The ratio of the mass of carbon to the mass of nitrogen in soil, organic material, or plants.

Cation: An ion with a positive charge.

Cation exchange capacity: The amount of exchangeable cations that a soil can adsorb at a specific pH, expressed as centimoles of charge per kilogram (cmolc/kg) of soil or milliequivalents per 100 g of soil (meq/100 g soil).

Cohesion: The act of, or stat of, similar matter sticking together (such as water-water; plant part-plant part; soil-soil; and etc.)

Clay: 1) The class of smallest soil particles, smaller than 0.002 millimeter in diameter. 2) The textural class with more than 40% clay and less than 45% sand, and less than 40% silt.

Claypan: A dense, compacted layer of clay found in the subsoil that limits or slows the downward movement of water through the soil.

Clean till: May be referred to as conventional tillage. Tillage where all plant residues are covered. Low surface residue levels provide little protection from wind and/or water erosion.

Coliform bacteria: Microorganisms, which typically inhabit the intestines of warm-blooded animals. They are commonly tested for in drinking water analyses to indicate pollution by human or animal waste.

Colloid: A very tiny particle capable of being suspended in water without settling out. Soil colloids have a charged surface that attracts ions.

Compaction (soil): Increasing the soil bulk density, and decreasing the soil porosity, by the application of mechanical forces to the soil.

Composite soil sample: A soil sample resulting from mixing together many individual samples.

Conservation tillage: A general term for tillage practices that leave crop residues on the soil surface to reduce erosion.

Contaminant: Any physical, chemical, biological, or radiological substance that is above background concentration but does not necessarily cause harm.

Contour: An imaginary line perpendicular to the slope that represents the same elevation.

Contour tillage: Tillage following the contours of a slope, rather than up and down a slope. Helps prevent erosion and runoff.

Crust: A thin layer of poorly aggregated surface soil formed by wetting and drying.

Deep tillage: Tillage deeper than that needed to produce loose soil for a seedbed, usually used to loosen a compacted subsoil.

Denitrification: The transformation of nitrate to gaseous forms of nitrogen, occurring under anaerobic conditions.

Discharge: Flow of surface water in a stream or the flow of ground water from a pipe, spring, ditch, or flowing artesian well.

Drainage: Rate and amount of water removal from soil by surface or sub-surface flow.

Electrical conductivity (EC): A measure of the amount of salts in soil.

Ecosystem: Community of animals and plants and the physical environment in which they live.

Effluent: Discharge or emission of a liquid or gas.

Erosion: The movement of soil by water, wind, or tillage.

Eutrophication: Enrichment of water by nutrients, primarily nitrogen (N) and phosphorus (P), which results in excessive plant growth. Decomposition of this plant material can result in the depletion of oxygen in water, leading to the death of aquatic animals.

Evapotranspiration (ET): Loss of water to the atmosphere from the earth's surface by evaporation and by transpiration through plants.

Fallow: Soil left idle to accumulate water and/or mineral nutrients.

Field capacity: The amount of water a soil holds after free water has drained because of gravity.

Flood plain: Land near a stream that is commonly flooded when the water levels are high. Soil is built from sediments deposited during flooding.

Fragipan: A dense and brittle subsurface layer of soil that is hard.

Friable: The ease by which a moist soil can be crumbled.

Granular: Soil structure where the units are approximately spherical or polyhedral.

Gravitational water: Water that moves through the soil under the influence of gravity.

Ground water: Water in the saturated zone below the soil surface.

Gully: A large channel in the soil, caused by erosion that is deep and wide enough that it cannot be crossed by tillage equipment.

Hardpan: A dense, hard, or compacted layer in soil that slows water percolation and movement of air and obstructs root growth.

Hazardous waste: Solid, liquid, or gaseous substance which, because of its source or measurable characteristics, is classified under state or federal law as potentially dangerous and is subject to special handling, shipping, and disposal requirements.

Heavy metals: Refers to: lead, copper, zinc, mercury, arsenic, cadmium, nickel, and selenium. Some states may list additional metals.

Highly erodible land: A soil mapping unit with an erodibility index of 8 or more.

Horizon (soil): A horizontal layer of soil, created by soil-forming processes, that differs in physical or chemical properties from adjacent layers.

Humus: Highly decomposed organic matter that is dark-colored and highly colloidal.

Hydrologic cycle: Movement of water in and on the earth and atmosphere through processes such as precipitation, evaporation, runoff, and infiltration.

Hygroscopic water: Water held tightly by adhesion to soil particles. Cannot be used by plants and remains in soil after air-drying. Can be driven off by heating.

Infiltration: Entry of water from precipitation, irrigation, or runoff into the soil profile.

Irrigation: Application of water to supplement natural rainfall

Leaching: The downward movement of material in solution by the drainage of water through the soil.

Loading: Amount of a substance entering the environment (soil, water, or air).

Mapping unit (soil): Basis for setting boundaries in a soil map. May include one or more soil series.

Mass flow: The movement of solutes associated with net movement of water.

Massive soil: A structureless soil.

Mineral soil: A soil whose traits are determined mainly by its mineral content; mineral soils contain less than 20 or 30 percent organic matter in the US and Canada, respectively.

Mineralization: The conversion of an element by soil organisms from an organic form to an inorganic form.

Minimum tillage: Tillage methods that involve fewer tillage operations than clean tillage does.

Mottling: Spots of different colors in a soil reflecting whether iron in the soil is reduced (greenish-grey colors when poorly drained) or oxidized (reddish-brown colors when well drained). Usually indicative of cycling between poor and good aeration.

Muck: An organic soil in which the organic matter is mostly decomposed.

Mulch: Natural or artificial layer of plant residue or other material covering the land surface which conserves soil moisture, holds soil in place, aids in establishing plant cover, minimizes temperature fluctuations.

Mulch till: A full-width tillage and planting combination that leaves some plant residues or other material on the soil surface.

Non-point Source (NPS) Contamination: Water contamination derived from diffuse sources such as construction sites, agricultural fields, and urban runoff.

No-till/Direct seeding/Zero-till: Method of growing crops that involves no seedbed preparation prior to planting.

O horizon: A surface soil horizon primarily composed of organic matter.

Organic matter: The organic fraction of the soil exclusive of undecayed plant and animal residues.

Organic soil: Soil containing more than 20 or 30 percent organic matter in the US and Canada, respectively.

Peat: Unconsolidated soil material consisting of undecayed or slightly decayed organic matter that has accumulated underwater where low oxygen conditions inhibit decay.
Ped: A natural soil aggregate, such as a granule or prism.

Permanent wilting point: The soil water content at which most plants cannot obtain sufficient water to prevent permanent tissue damage.

Permeability: Capacity of soil, sediment, or porous rock to transmit water and gases.
pH: Numerical measure of hydrogen ion concentration, with a scale of 0 to 14. Neutral is pH 7, values below 7 are acidic, and values above 7 are alkaline.

Platy: Consisting of soil aggregates that are developed predominantly along the horizons; laminated; flaky.

Point source contamination: Water contamination from specific sources such as leaking underground storage tanks, landfills, industrial waste discharge points, or chemical mixing sites.

Potable: Water that is suitable for drinking.

Preferential flow: The rapid movement of water and its constituents through the soil via large and continuous pores.
Prismatic (columnar): Soil structure where the individual units are bounded by flat or slightly rounded vertical faces. Units are distinctly longer vertically, and the faces are typically casts or molds of adjoining units. Vertices are angular or sub-rounded; the tops of the prisms are somewhat indistinct and normally flat.

Recharge: Downward movement of water through soil to ground water.

Recharge area: Land area over which surface water infiltrates into soil and percolates downward to replenish an aquifer.

Restrictive layer: A nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restricts roots or otherwise provide an unfavorable root environment.

Rill: A channel in the soil caused by runoff water erosion that is small enough to be erased by tillage.

Riparian zone: Land adjacent to a body of water that is at least periodically influenced by flooding.

Runoff: Portion of precipitation, snowmelt, or irrigation, which moves by surface flow from an area.

RUSLE II: Revised Universal Soil Loss Equation: An equation for predicting, A, the average annual soil loss in mass per unit area per year, and is defined as, $A = RKLSCP$, where R is the rainfall factor, K is the soil erodibility factor, L is the length of slope, S is the percent slope, C is the cropping and management factor, and P is the conservation practice factor.

Saline soil: A non-sodic soil containing sufficient soluble salt to adversely affect the growth of most crops.

Saltation – Movement of individual soil particles/small aggregates by wind, in which the particles are lifted as much as 12 inches above the soil surface, then travel a short distance before dropping back to the soil surface. From 50 to 80 percent of total soil transport by wind is by saltation.

SAR: Sodium absorption ration which measures the suitability of water for use in irrigation.

Saturated zone: Portion of the soil or rock profile in which all pores are filled with water.

Sediment: Eroded soil and rock material, and plant debris, transported and deposited by wind or water.

Single grain: A structureless soil in which each particle exists separately as in sand.
Sodic soil: Soil high in sodium and low in soluble salts.

Soil loss tolerance (T value): (i) The maximum average annual soil loss that will allow continuous cropping and maintain soil productivity without requiring additional management inputs. (ii) The maximum soil erosion loss that is offset by the theoretical maximum rate of soil development, which will maintain an equilibrium between soil losses and gains.

Soil structure: The combination or arrangement of primary soil particles into secondary soil particle units, or peds.

Soil survey: The examination, description, and mapping of soils of an area according to the soil classification system.

Soil texture: The relative proportions of sand, silt, and clay.

Solubility: Amount of a substance that will dissolve in a given amount of another substance, typically water.

Solute: A substance that is dissolved in another substance, thus forming a solution.

Stomate: Opening in the surface of a leaf through which water vapor, carbon dioxide, and oxygen pass.

Surface creep: Movement of sand-sized particles/aggregates by wind, in which the particles roll along the soil surface. Surface creep may account for 7 to 25 percent of total transport by wind.

Suspension: Movement of fine (<0.1 mm) soil particles by wind. The particles are dislodged from the soil surface, are small enough to remain in the air mass for an extended period. From 20 percent to more than 60 percent of an eroding soil may be carried in suspension.

Tillage erosion: The downslope displacement of soil through the action of tillage operations.

Tillage pan: Also known as a plow pan. A subsurface layer of soil having a bulk density that is higher than the layer either above or below it. The compaction is caused by the forces exerted during tillage operations.

Tilth: Physical condition of the soil in terms of how easily it can be tilled, how good a seedbed can be made, and how easily seedling shoots and roots can penetrate.

Volatilization: The loss of a compound in gaseous form.

Water holding capacity: Similar to field capacity; the amount of water a soil holds after free water has drained because of gravity.

Watershed: All land and water that drains runoff to a stream or other surface water body.

Water table: Upper surface of the ground water or layer of soil saturated with water.

Wetlands: An area characterized by periods of inundation, hydric soils, and hydrophytic vegetation.

Wind Erosion Equation (WEQ): An equation for predicting *E*, the average annual soil loss from wind erosion in mass in mass per unit are per year, and is defend as, *E=f(IKLV),* where *f* indicates " a function of", *I* as the soil erodibility index, *K* is the soil surface roughness factor, *C* is the climate factor, *L* is the unsheltered distance, and *V* is the vegetative cover factor.

PEST MANAGEMENT COMPETENCY AREAS

1. **Basic pest management practices**
2. **Management of weeds**
3. **Management of plant diseases**
4. **Management of insects**
5. **Calibration of pesticide application equipment**
6. **Using pesticides in an environmentally sound way**
7. **Integrated pest management**
8. **Pesticide resistance management**

COMPETENCY AREA 1. Basic pest management practices

1. List examples of cultural, chemical, and biological pest management.

2. Describe advantages and limitations of cultural, chemical and biological pest management.

COMPETENCY AREA 2. Management of weeds

3. Identify the following weeds by common name at any stage of growth, and classify each by life cycle:

<u>Grasses and Sedges</u>

a. Giant foxtail
b. Green foxtail
c. Yellow foxtail
d. Barnyardgrass
e. Downy brome
f. Wild proso millet
g. Wild oats
h. Fall panicum
i. Quackgrass
j. Woolly cupgrass
k. Sandbur
l. Yellow nutsedge
m. Foxtail barley
n. Crabgrasses

<u>Broadleaves:</u>

a. Canada thistle
b. Russian thistle
c. Perennial sowthistle
d. Musk thistle
e. Plumeless thistle
f. Bull thistle
g. Giant ragweed
h. Common ragweed
i. Redroot pigweed
j. Pennsylvania smartweed
k. Common lambsquarters
l. Kochia
m. Leafy spurge
n. Field bindweed
o. Common cocklebur
p. Field pennycress
q. Wild mustard
r. Wild buckwheat
s. Hoary cress
t. Wild sunflower
u. Russian knapweed
v. Black nightshade
w. Velvetleaf
y. Buffalobur
z. Common milkweed
aa. Waterhemp
ab. Biennial wormwood
ac. Absinth wormwood
ad. Venice mallow
ae. Blue vervain

4. Recognize factors that affect herbicide carryover.

5. Recognize why/how herbicide resistance and tolerance develop and how to prevent their occurrence.

6. Recognize factors that affect species and genetic shifts in weed populations:
    a. Weed populations
    b. Herbicide use
    c. Tillage

7. List the factors that affect pesticide movement in soils and into surface and ground waters.

8. Recognize statewide regulated noxious weeds.

9. Recognize how state laws impact the management of noxious weeds.

COMPETENCY AREA 3. Management of infectious plant diseases

10. Identify each of the following agronomic diseases by host plant symptoms, and classify each by crops infected and type of causal organism:

    a. Stalk, stem and root rots
    b. Northern corn leaf blight
    c. Pythium seeding rot
    d. Phytophthora root rot
    e. Sclerotinia diseases
    f. Holcus spot
    g. Leaf, stem, stripe, and crown rust
    h. Loose smut
    i. Ergot
    j. Bacterial wilt
    k. Soybean rust
    l. Nematodes
    m. Aster yellows
    n. Rhizoctonia root/crown rot
    o. Barley yellow dwarf
    p. Red leaf of oat
    q. Septoria leaf and glume blotch
    r. Head scab
    s. Wheat streak mosaic
    t. Downy mildew, tan spot
    u. Common leafspot
    w. Ear rots/mold
    x. Ascochyta leaf blight
    y. Bean pod mottle virus
    z. Mycotoxins
    aa. Goss's wilt
    ab. Sudden death syndrome
    ac. Brown stem canker

11. Describe how environmental conditions affect disease development and spread.

12. Recognize how other pests, such as insects and weeds, interact with disease?

13. Describe the basic principles of disease management.
    a. Avoidance/Evasion
    b. Eradication
    c. Therapy
    d. Sanitation

14. Distinguish between systemic and non-systemic/protectant fungicides.

15. Recognize how/why fungicide resistance tolerance develops and how to prevent their occurrence.

COMPETENCY AREA 4. Management of insects

16. Identify the following pests and classify each by feeding habits crops attacked, type of metamorphosis and symptoms of damage on plants:
    a. Grasshopper
    b. Bean leaf beetle adult
    c. Alfalfa weevil larva and adult
    d. Aphids
    n. Hessian Fly
    o. Wheat stem sawfly
    p. Wheat stem maggot
    q. White grub

e. Leafhoppers
f. European corn borer
g. Corn earworm larva
h. Wireworm larva
i. Northern corn rootworm Adult and larva
j. Western corn rootworm Adult and larva
k. Sunflower beetle
l. Black cutworm
m. Two-spotted spider mite
r. Armyworm
s. Red sunflower seed weevil
t. Gray sunflower seed weevil
u. Banded sunflower moth
v. Sunflower moth
w. Soybean aphid
x. Western bean cutworm
y. Palestriped flea beetle
z. Army cutworm
aa. Corn leaf aphid
ab. Spider mites
ac. Orange blossom wheat midge
ad. Japanese beetle adult and larva

17. Describe basic principles of cultural, genetic, chemical, and biological approaches to insect management.

18. Recognize the importance of timing when applying insecticides.

19. Recognize difference in scouting for and managing univoltine and bivoltine European corn borer infestations.

20. Recognize the role of transgenic crops in insect management and the crop insect controlled.

COMPETENCY AREA 5. Calibration of pesticide application equipment

21. Identify and describe the function of the following chemigation equipment components:
    a. Back-flow prevention valve
    b. Pesticide metering device

22. Describe steps involved in calibration of pesticide application equipment.

COMPETENCY AREA 6. Using pesticides in an environmentally sound way

23. Understand state and federal certification and licensing requirements for pesticide applicators and dealers.
    a. Private applicators
    b. Commercial applicators
    c. Uncertified and unlicensed applicators
    d. Pesticide dealers

24. Understand state and federal pesticide product registration requirements and categories.
    a. Emergency exemption registrations
    b. Special local need registrations
    c. Experimental use registrations
    d. Pesticides exempt from federal registration
    e. Regular pesticide product registration
    f. Cancellation and restriction of pesticide registrations

25. Understand state and federal pesticide use requirements.
    a. Storage and handling requirements for bulk and packaged pesticides
    b. Application requirements for pesticides
    c. Recordkeeping requirements for pesticides
    d. Disposal requirements for pesticides

COMPETENCY AREA 7. Integrated pest management

26. Describe principles integrated pest management.

27. Describe general rationale and procedures of scouting crop pests.

28. Define economic threshold (action threshold) and economic injury levels. Describe how they impact pest control decision-making.

29. Describe management strategies for control of stored grain insects.

30. Make economically and environmentally sound pest management recommendations.

COMPETENCY AREA 8. Pesticide resistance management

31. Understand principles of managing resistance.
    a. Site of action (chemistry)
    b. Cultural (crop rotation, density and tillage)

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Pest Management Glossary

Abiotic: Non-living, physical or chemical, includes solar radiation, temperature, humidity, and pH; used in context of an effect, such as abiotic injury.

Action threshold: The pest density at which a pest management tactic must be implemented in order to avoid economic loss.

Active ingredient: The chemical in a formulated product that is responsible for the herbicidal/insecticidal/fungicidal effects as indicated on the product label.

Acute exposure: Contact with a pesticide or toxin over a short period of time.

Adjuvant: Substance that enhances the effectiveness of a pesticide.

Bacillus thuringiensis (Bt): A naturally occurring organism that can be used as a naturally occurring, or organic pesticide. Transgenic Bt Crops are manipulated to mimic and enhance the affect of naturally occurring Bt.

Bacteria: Unicellular organisms that include free living, saprophytic, and parasitic forms.

Banded pesticides: Pesticide application either over the rows or in-between the rows to reduce the overall application rate per acre.

Beneficial organisms: Organisms that reduce pest numbers or improve soil or plant quality.

Best management practice (BMP): Also called Good Farming Practices. Practices recognized as effective and practical means for producing a crop in an economically and environmentally sound way.

Biological pest control: The process of conserving, augmenting or introducing beneficial living organisms to reduce a pest population or its impacts. It includes the use of insects, nematodes, mites, fungi, bacteria, viruses, plants, vertebrates, and other living organisms.

Biological pesticides: Pesticides derived from living organisms [such as Bt (*Bacillus thuringiensis*)].

Biotic: Pertaining to living organisms.

Broad-spectrum pesticide: Pesticides that are toxic to a wide range of organisms.

Carcinogen: Substance that may initiate cancerous tumor formation in animals.

Chemical pest control: The use of pesticides to reduce a pest population or its impacts.

Chronic exposure: Contact with a pesticide or toxin over a long period of time, usually at low levels.

Common pesticide name: Name given to a specific pesticide active ingredient. Many pesticides are known by a number of trade or brand names, but have only one recognized common name.

Contact pesticide: A pesticide that is toxic to an organism by contact rather than a result of translocation or ingestion.

Crop rotation: Growing crops in a planned sequence.

Cultural pest control: The use of practices other than chemical and biological, and genetically modified organism controls to reduce a pest population or its impacts. Such practices include tillage, row spacing, irrigation, fertility, timely harvest, and all forms of mechanical pest control.

Economic injury level: The pest damage level at which the cost of controlling the pest population equals the value of the crop lost.

Economic threshold (action threshold): Pest density at which control measure should be taken to avoid crop value loss from reaching the Economic Injury Level. By implementing a management strategy when Economic Threshold is reached and keep pest populations from reaching the Economic Injury Level.

Fumigant: Gaseous phase of a pesticide used to destroy insects, pathogens, weed seeds, or other pests in soil or grain bins.

Fungi: Organisms which lack chlorophyll and vascular tissue and range in form from a single cell to a body mass of branched filamentous hyphae that often produce specialized fruiting bodies. Fungi cannot produce their own food.

Genetic resistance, natural: Genetically based mechanisms within host plants which hinder pest development. Genetic resistance may include natural mutations in a host plant without the introduction of genetically modified organisms.

Genetic resistance, modified: Genetically based mechanisms within host plants which hinder pest development. Genetic resistance may include natural mutations in a host plant and/or the introduction of genetically modified organisms.

Good farming practices: See BMP

Herbicide carryover: Occurs when a herbicide does not break down during the season of application and persists in sufficient quantities to injure succeeding crops.

Host: A living organism serving as a food source and refuge for a parasite.

Insect resistance management (IRM): The process of augmenting survival of natural insect populations from transgenic crops or application of a pesticide.

Integrated pest management (IPM): A sustainable approach that combines the use of prevention, avoidance, monitoring and suppression strategies in a way that minimizes economic, health, and environmental risks.

LD50 or LC50: The lethal dose of a substance that kills for 50% of the test organisms expressed as milligrams (mg) per kilogram of body weight. It is also the concentration expressed as parts per million (ppm) or parts per billion (ppb) in the environment that kills 50% of the test organisms exposed.

Mechanical pest control: A component of cultural pest control that uses physical methods to reduce a pest population or its impacts. Mechanical controls include cultivation, hoeing, hand weeding, mowing, pruning, or vacuuming.

Mode of action: The mechanism by which pesticides or biotechnology affects target organisms.

Narrow-spectrum pesticide: Pesticides that act on a limited range of species.

Non-point Source (NPS) Pollution: Contamination derived from diffuse sources such as construction sites, agricultural fields, and urban runoff.

Parasite: An organism which lives on or in another living organism and obtains part or all of its nutrients from that other living organism.

Parasitoid: An insect that feeds on and develops in another insect, and causes death in the host insect.

Parts per billion (ppb)/parts per million (ppm): A means of expressing concentration: parts of analyte per billion/million parts of sample.

Pathogen: Living agents that cause diseases in plants and animals.

Pest: Organism that directly or indirectly causes damage to crops (weeds, diseases, insects, etc.)

Pest density: The number of pests per unit area or plant structure.

Pesticide resistance: The inherited ability of an organism to survive and reproduce following exposure to a dose of pesticide normally lethal to the wild type.

Persistence: Ability of a pesticide to resist degradation as measured by the period of time required for breakdown of a material. Depends on environmental conditions and chemical properties.

Personal protective equipment: Clothing and protective devices required by EPA to be worn by users of pesticide products.

Phytotoxic: Injurious or toxic to plants.

Plant disease triangle: Diagrammatic representation of the three key factors contributing to plant diseases: 1) susceptible hosts, 2) pathogen presence, 3) proper environmental conditions.

Plant parasitic nematodes: Microscopic, non-segmented roundworms that usually survive in soil, and invade plant roots.

Point source pollution: Contamination from specific identifiable source.

Postemergence: Applied after emergence of the specified weed or planted crop.

Preemergence: Applied to the soil surface prior to emergence of the specified weed or planted crop.

Preplant incorporated (PPI): Applied and tilled into the soil before seeding or transplanting.

Race or strain: Organisms of the same species and variety that differ in their ability to parasitise varieties of a given host, or that differ in their reaction to pesticides.

Recommended rate (pesticide): The amount of pesticide recommended to control a selected pest.

Reduced-risk pesticides: These are pesticides which: 1) reduce pesticide risks to human health; 2) reduce pesticide risks to nontarget organisms; 3) reduce the potential for contamination of valued, environmental resources.

Re-entry interval: A time period set by EPA that restrict individuals from entering a pesticide-treated area.

Refugia: Areas, untreated with pesticides, or segregated from genetically modified crops, provided to preserve susceptible populations of pests.

Resistance, pest: Genetic ability to avoid, repel, or limit attach of a pest allowing it to survive and reproduce. Resistance may be natural, or accomplished through genetic or transgenic manipulation. Pest resistance has more ability to survive and reproduce than pest tolerance.

Resistance, pesticide: The ability of an organism to survive and reproduce following exposure to pesticide from an inherited or transgenic trait normally lethal to the wild type.

Resistance, transgenic: The ability of a plant, animal or organism to survive and reproduce following exposure to pest, pesticide or environmental factor as developed for a transgenic trait normally damaging or lethal to the conventional or wild type.

Pesticide: An agent used to destroy pests.

Sampling: Any valid method to determine a representative value for a field parameter.

Scouting: Sampling or observing crops to determine levels of pest populations and disease; also used to assess crop health and yield potential, and levels of beneficial insects.

Selectivity: Pesticides that are toxic primarily to the target pest (and perhaps a few related species), leaving most other organisms, including natural enemies, unharmed.

Selection pressure: An action, event, or chemical that preferentially allows survival of one group over another.

Setback: The distance from sensitive areas, such as surface water, wetlands, or tile drain inlets, where no pesticides are to be applied.

Site of action (mode of action): How a pesticide (herbicide, insecticide, fungicide, etc.) affects the target pest.

Spray drift: Movement of airborne spray droplets of a pesticide outside the intended area of application.

Surfactant: A material that favors or improves the emulsifying, dispersing, spreading, wetting, or other surface modifying properties of pesticides in solution.

Systemic: Not localized; movement away from the area of application to other plant tissues through translocation.

Tank mix: A mixture of two or more compatible pesticides intended for simultaneous application.

Tolerance, pest: The inherited ability of a species to survive and reproduce after pesticide treatment. Also refers to the ability of a crop to yield satisfactorily in presence of pests or adverse environmental conditions. Tolerance has less ability to survive and yield than pest resistance.

Toxicity: Degree to which a pesticide is poisonous; the ability of a substance to interfere adversely with the vital processes of an organism.

Trade name: Name given to a product sold by a company to distinguish it from similar products made by other companies.

Transgenic resistance: The ability of a plant, animal, or organism to survive and reproduce following exposure to a pest, pesticide, or environmental factor as developed form a transgenic train normally damaging or lethal to the conventional or wild type.

Transgenic (bioengineered organisms): Plants, animals or other organisms that contain DNA derived from a foreign plant or animal or other organism.

Translocation: Actively moved within and between plant tissues and organs.

Trap crop: A crop that attracts and concentrates insect pests.

Vapor drift: The movement of chemical vapors from the area of application.

Viruses: Non-cellular parasites/pathogens comprised of a protein shell and a simple genetic core, usually RNA in plant viruses.

Weed: A plant out-of-place.

Worker protection standard: EPA regulations requiring protective clothing and practices designed to protect users of pesticides by reducing pesticide exposure.

CROP MANAGEMENT COMPETENCY AREAS

1. **General crop adaptation**
2. **Soil management used for seedbed preparation of row crops, small grains, and forages**
3. **Seeding date factors**
4. **Seeding rates and pattern factors of major crops**
5. **Seeding depth factors**
6. **Crop damage, mortality, and factors influencing replanting decisions**
7. **Cropping systems**
8. **Identification of crops in both seed and vegetative states**
9. **Growth and development stages of major agronomic crops**
10. **Crop improvement and biotechnology**
11. **Precision agriculture**

COMPETENCY AREA 1. General crop adaptation

1. Describe how crops respond to the following factors:

    a. Soil fertility levels
    b. Soil pH
    c. Soil drainage

2. List the recommended soil pH ranges for agronomically important crops in South Dakota.

3. Describe adaptation of crops to prevailing climate conditions.
    a. Precipitation
    b. Temperature
    c. Sunlight/day length

COMPETENCY AREA 2. Soil management systems used for seedbed preparation of row, small grain and forage crops

4. Recognize how environmental and management factors influence the selection of a tillage system.

5. Identify the following implements and describe their functions in conventional tillage system:

    a. Moldboard plow
    b. Chisel plow
    c. Disk-chisel
    d. Heavy disk
    e. One-pass tool
    f. Light disk
    g. Field cultivator
    h. Harrows
    i. Culti-packer
    j. Strip tiller
    k. Vertical tillage

6. Describe the timing and sequence of tillage operations in conventional tillage system.

7. Describe advantages and disadvantages of fall vs. spring tillage.

8. Describe the advantages and limitations of conventional tillage system.

9. Identify implements used and describe their function in a strip-till system.

10. Describe the advantages and limitations of a strip-till system.

11. Describe the functions and operation of a no-till planter.

12. Describe the timing and sequence of operations in a no-till system.

13. List the advantages and limitations of a no-till system.

COMPETENCY AREA 3. Seeding date factors

14. Describe factors which determine when to seed corn, soybeans, small grains, pulse crops, oilseeds and forages.

15. Recognize consequences of seeding too early or too late.

COMPETENCY AREA 4. Seeding rates and pattern factors of major crops (e.g., corn, soybean, wheat, sunflower, alfalfa)

16. List factors that influence the seeding rate of major crops.

17. List factors that influence the planting method and patterns of major crops.

18. Explain why forage crop establishment is more difficult than the establishment of grain crops.

19. List recommended seeding rates for major crops.

20. List advantages and disadvantages of seeding pure grass or legume stand vs. mixed stands.

21. Recognize how difference in seedling characteristics influence emergence of major crops.

COMPETENCY AREA 5. Seeding depth factors

22. List recommended seeding depths for major crops.

23. Recognize how crops respond to depth of planting.

24. Recognize conditions that affect seeding depth.

COMPETENCY AREA 6. Crop damage, mortality, and factors influencing replanting decisions.

25. Describe the types of damage that pesticide drift, hail, frost, drought, and wind can cause corn, soybean, small grain and forage crops.

26. Describe climatic and plant factors, which influence a plant's ability to resume growth after being damaged.

27. Determine when crop damage would justify replanting.

COMPETENCY AREA 7. Cropping systems

28. List advantages and limitations of growing cover crops and companion crops in a cropping system.

29. Compare and contrast annual crop vs. continuous crop rotation systems. (Example: disruption of pest cycles).

COMPETENCY AREA 8. Identification of crops in both seed and vegetative states

30. Identify the seed and mature plant of each of the following crops:

    a. Alfalfa
    b. Barley
    c. Buckwheat
    d. Canola
    e. Corn
    f. Field Peas
    g. Flax
    h. Intermediate wheatgrass
    i. Kentucky bluegrass
    j. Millet
    k. Oats
    l. Orchardgrass
    m. Red clover
    n. Reed canarygrass
    o. Rye
    p. Safflower
    q. Smooth bromegrass
    r. Sorghum (grain & forage)
    s. Soybean
    t. Sunflower
    u. Wheat
    v. Lentil
    w. Chickpea

COMPETENCY AREA 9. Growth and development stages of major agronomic crops

Plant Staging

31. Describe systems for staging corn, soybeans, and small grains.

32. Use staging systems to identify the stage of growth at any time between emergence and physiological maturity.

33. Describe systems used to stage forage legumes and grasses.

34. Recognize how growth stages influence susceptibility of major crops to specific environmental stresses (e.g. moisture stress, temperature stress).

Harvesting and regrowth of forage

35. Describe how frequency of harvest is related to forage yield and quality.

36. Describe how frequency and timing of harvest affects stand longevity, food reserves, and stand persistence.

37. Describe the locations and functions of meristems used for regrowth in forage legumes and forage grasses.

Management factors related to the morphology, growth, and development of major crops

38. Relate morphological features of major crops to developmental stages.

39. Recognize relationships between the growth and development of major crops and management factors.

COMPETENCY AREA 10. Crop improvement and biotechnology

42. Describe genetic issues regarding bio-technology traits.

    a. Development of genetically modified organisms
    b. Expression of bio-technology traits

43.

44. List the regulatory agencies and processes governing biotechnology.
    a. Identify U.S. regulatory agencies
    b. Describe regulatory agency bio-tech responsibilities
    c. Describe bio-tech permitting process

45. Describe Plant Variety Protection Act, seed patents and how they relate to:

    a. Production of bio-tech crops
    b. Sales of bio-tech crops
    c. End-product import and export requirements of bio-tech crops
    d. Legal production and use restriction of bio-tech crops

46. Describe agronomic management strategies of genetically modified crops.

    a. Pest resistance management
    b. Cross-pollination and isolation
    c. Drift to non-target crops
    d. Implications of volunteer genetically modified plants

47. Explain and define biotechnology terms.

    a. GMO: Genetically modified organisms
    b. Bt: An abbreviation for Bacillus thureingiensis
    c. Bio-tech: The science of bio-technology
    d. IRM: Insect resistance management of bio-tech crops regulated by the Environmental Protection Agency (EPA)
    e. IPM: The science of integrated pest management in crops

COMPETENCY AREA 11. Precision agriculture

40. Describe how the following cause variability in fields.
    a. Slope
    b. Soil texture
    c. Historical use
    d. Drainage

41. Describe how to use the following to measure variability.
    a. Grid sampling
    b. Yield monitoring
    c. E.C. measurement
    d. Remote sensing
    e. Management zone sampling

42. Describe how to use the following in managing variability.
    a. Geographic Information System (GIS)
    b. Variable nutrient and pesticide applications
    c. Variable seeding, type and amount

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Crop Management Glossary

Accuracy: The ability of a measurement to match the actual value of the quantity being measured.

Aerial biomas: The mass of a specific plant above the soil or hydroponic solution surface.

Allelopathy: Any harmful effect of one plant or microorganism on other organisms through the production and release of chemical compounds into the environment.

Annual, summer: Plants whose seeds germinate in the spring, the plants produce seed and die the same fall

Annual, winter: Plants whose seeds germinate in the fall, the plants produce seed in the spring and die in the summer.

Anther: The pollen-bearing male portion of a stamen.

Anthesis: The time of flowering in a plant.

Applied Information Technology: Using advanced information technology to make better decisions in crop, soil, and environmental management systems.

Biennial plant: A flowering plant that takes 12-24 months to complete the life cycle. It grows vegetative the first year and reproduces the second year.

Biomass: The mass of a specific plant or plant part in a given area, usually expressed as weight or volume per unit area.

Boot stage: A grass growth stage when an inflorescence is enclosed by the sheath of the uppermost leaf, just prior to inflorescence emergence.

Biotechnology (bio-tech): The science of engineering biological organisms.

Clean till: Tillage where all plant residues are covered to prevent growth of all vegetation except that of the crop being produced.

Companion crop: More than one crop sown to enhance development of a another crop, or improve soil and/or environmental conditions.

Competition: The simultaneous demand by two or more organisms for limited environmental resources.

Continuous cropping: Growing a crop in a field every year.

Cover crop: A crop grown to: 1) protect the soil from erosion during periods when it would otherwise be bare; 2) scavenge excess nutrients from a previous crop to prevent nutrient loss; or both.

Crop management zone: A sub-region of a field that has a relatively uniform combination of yield limiting factors where a single level of crop management is appropriate.

Crop residue: Plant material remaining in the field after harvest.

Crop rotation: The practice of growing different crops in a planned regular sequence on the same land.

Cropping pattern: The yearly sequence and spatial arrangement of crops, or crops and fallow, in a given area.

Cultivar: A variety, strain, or race that has originated and persisted under cultivation, or was specifically developed for crop production.

Day neutral crop: A crop whose flowering is not influenced by day or night length.

Desiccation: The removal of moisture from a material.

Determinate plant: A plant that initiates flowering based on day length, with the change from vegetative to reproductive growth over a relatively short time.

Double cropping: The practice of consecutively producing two crops of either like or unlike commodities on the same land within the same year.

Dough stage: Stage of seed development at which the endosperm is pliable, like dough, defined as the time when 50% of the seeds on an inflorescence have dough-like endosperm.

Drift, pesticide: The movement of a chemical pesticide going off-target to an adjoining field.

Evaporation: The process in which a liquid is changed into a gas.

Evapotranspiration: The loss of water from a given area by both evaporation from plant and soil surfaces, and transpiration from plants.

Fallow land: Land not being used to grow a crop, but on which plant growth is controlled with tillage or herbicides. Used to store water, control weeds, and increase available soil nutrients.

Fibrous root system: A plant root system having a large number of small, finely divided, widely spreading roots, but no large individual roots; common with grass species.

Flag leaf: The uppermost leaf on a fruiting grass stem. The leaf immediately below the inflorescence.

Flowering stage: The physiological stage when anthesis occurs in a plant, or flowers are visible in nongrass plants.

Genetically Modified Organism (GMO/GM): Plants, animals, or other organisms that contain DNA derived from a foreign plant, animal or other organism. See also transgenic

Geographic coordinates: The system of latitude and longitude that defines the location of any point on the earth's surface.

Geographic Information Systems (GIS): A computer system for measuring and relating Environmental, topographical, vegetative and crop data to positions on Earth’s surface.

Germination: The resumption of growth of a seed embryo after a period of dormancy. Requires a favorable environment of adequate water, oxygen, and suitable temperature.

Germination test: A method to measure seed viability, when place under favorable environmental conditions.

Global Positioning System (GPS): A system that uses a number of orbiting satellites to identify a location on Earth, based on longitude, latitude, and altitude.

Green manure: Living plant material incorporated into the soil while green for soil improvement.

Growing Degree Unit (GDU): Heat accumulation, calculated by subtracting a base temperature from an average of the maximum and minimum daily temperatures for an area.

Growth regulator: A substance that when applied to plants either inhibits, stimulates, or otherwise modifies the growth process.

Harvest index: The quantity of harvestable biomass produced per unit of total biomass.

Harvest population: The number of harvestable plants per unit area remaining at the end of a growing season.

Heading: The developmental stage of a grass plant from initial emergence of the inflorescence from the boot until the inflorescence is fully emerged.

Hybrid: First generation progeny resulting from the controlled cross-fertilization between individuals that differ in one or more genes.

Identity-preserved (IP) crop: A crop in which specific genetic traits are known to exist.

Indeterminate plant: Plant whose flowering is not affected by day length, and continues vegetative growth after reproductive growth has begun.

Inflorescence: The flowering part of a plant or arrangement of flowers on a stalk.

Inoculant: A seed or soil additive, typically some type of bacteria or fungi, that enhances plant growth and development.

Intercropping: Growing two or more crops together in the same field at the same time.

Irrigation efficiency: The ratio of the amount of water actually consumed by a crop or stored in the root zone on an irrigated area to the amount of water applied to the area.

Least Significant Difference (LSD): A statistical range test used to determine true differences among treatment means.

Lodging, root: Condition in which stalks or stems fall due to a weak root system, root damage, or soil condition.
Lodging, stalk: Condition in which stalks or stems break or fall above the soil surface, because of weak stalk, damage, or weather events.

Long day crop: Crop in which flowering occurs when night length is less than the crop's required critical length.

Maturity: The physiological developmental stage when a plant reaches maximum dry matter production, yield, or desirable maturity.

Milk stage: In grain, the stage of development following pollination in which the endosperm appears as a whitish liquid like milk.

Monoculture: Growing the same crop continuously in the same field, year after year.

Nano-science: The science studying minute or "nano" substances and their affects on biological organisms. "Nano" used in a combining form meaning a 1,000,000,000th part of a billionth of a specified unit.

Nurse crop: A crop sown with another crop, especially one that will emerge and develop slowly.

Open pollinated: Plants pollinated by the wind, insects, birds or animals, and not by human manipulation.

Organic farming: Crop production systems that do not use synthetic pesticides, fertilizers. Or genectically modified products.

Panicle: A grass inflorescence, the main axis of which is branched, and whose branches bear loose flower clusters.

Perennial plant: Plants that have vegetative structures that allow them to live more than 2 years.

Photoperiodism: The growth and flowering response of plants in relation to changes in the length of daylight hours.

Physiological maturity: Plant growth stage representing the end of reproductive development, where the maximum dry weight has been accumulated.

Pollination: The transfer of pollen from the anther to the stigma of a flower.

Pollen drift: The movement of plant pollen to non-target areas.

Precision: The ability of a measurement to be consistently reproduced.

Precision agriculture: Using the best technologies to identify and manage in-field soil and crop variability to improve production and economic return.

Pure live seed: Percentage of pure germinating seed, calculated as: pure seed percentage x germination percentage/100.

Radicle: The first root of a plant that elongates during germination of a seed and forms the primary root.

Randomization: A random arrangement of treatments or plots, in order to obtain representative data for an experiment.

Relay cropping: A system in which one crop is planted into a standing crop prior to harvest of the established crop, which does not hinder the yield of either crop.

Remote sensing: The collection and analysis of data from a distance, often using sensors that respond to different heat intensities or light wavelengths.

Replication: Repeating plots or treatments in an experiment in order to increase precision.

Resistance, pest: Genetic ability to avoid, repel, or limit attack by a pest allowing it to survive and reproduce. Resistance may be natural, or accomplished through genetic or transgenic manipulation. Pest resistance has more ability to survive and reproduce than pest tolerance.

Resistance, pesticide: The ability of an organism to survive and reproduce following exposure to pesticide from an inherited or transgenic trait normally lethal to the wild type. Pesticide resistance has more ability to survive and reproduce than pesticide tolerance.

Resistance, transgenic: The ability of a plant, animal, or organism to survive and reproduce following exposure to a pest, pesticide, or environmental factor as developed for a transgenic trait normally damaging or lethal to the conventional or wild type.

Rhizobium: Bacteria which fix atmospheric nitrogen in nodules on the roots of legume plants.

Root biomas: The mass of a specific plant below the soil or hydroponic solution surface.

Self pollinated: A plant pollinated by its own pollen.
Short day crop: A crop in which flowering is initiated when the crop's critical night length is exceeded.

Stigma: The female part of a flower where pollen is deposited.

Taproot: The primary root of a plant formed in direct continuation with the root tip or radicle of the embryo. Forms a thick, tapering main root from which arise smaller, lateral branches.

Tilth: Physical condition of the soil that defines how easily it can be tilled, how good a seedbed can be made, and how easily seedling shoots and roots can penetrate.

Tolerance: The inherited ability of a species to survive, reproduce and yield satisfactorily in the presence of pests, pesticides, or adverse environmental conditions. Tolerance has less ability to survive and reproduce than a species with resistance.

Transgenic: Plants or animals that contain DNA derived from a foreign plant or animal.

Variable Rate Technology (VRT): The ability to vary the application of crop production inputs based on criteria for crop response or soil conditions. Allows for the targeted application of inputs at varying rates across a field.

Variety: A taxonomic subdivision of selectively bred individuals that are distinct, uniform, and stable, that are often referred to as a cultivar when registered for use.

Vegetative: 1) The non-reproductive parts of plants. 2) The non-reproductive stage of plant development.

Vernalization: Exposure of germinating seeds or plants to low temperatures to induce flowering.

Vertical tillage: Vertical disk type tillage, either shallow or deep (usually shallow) that aids in seedbed preparation and crop residue breakup.

Viability: A measure of the potential for seeds to germinate, grow, and develop normally under favorable conditions.

Yield map: The pattern of crop yield in a field based on data collected using a yield sensor on a harvester, and geographic positioning of these yield values using a Global Positioning System.