INDIA
CERTIFIED CROP ADVISER

PERFORMANCE OBJECTIVES

CONTENTS

FOREWORD

Throughout history, a nation's success has been directly related to the success of its agriculture. With an ever expanding world population and increasing pressures on the environment, the importance of sound agricultural practice is essential. As agricultural practice becomes more technologically advanced, producers rely more heavily on the advice of others. The Certified Crop Adviser (CCA) Program came into existence to insure that growers receive sound advice and recommendations that are both economically and environmentally sound.

The CCA program is built on the concept that there are bodies of knowledge one must know in order to provide sound advice to producers. This body of knowledge is determined by asking a wide array of agriculturists involved in all aspects of crop production to specify what a Certified Crop Adviser must know. This information is then used to create the following four Competency Areas and their associated Performance Objectives. The document is extensively reviewed and updated by a committee representing both public and private sectors from across India. The revised document is then reviewed by Certified Crop Advisers who provide input on relative importance of the Performance Objectives, and on areas that need to be added or deleted. By mastering the Performance Objectives, one will possess the knowledge that the agricultural industry has deemed important for a Crop Adviser to know.

These Performance Objectives are dynamic, and are upgraded as the needs of the crop production in India evolve. This ensures that the Indian CCA program will remain a viable and useful tool which recognizes the high level of competence displayed by those who choose to earn this designation.

James Vorst

INTRODUCTION

The Certified Crop Adviser (CCA) Performance Objectives outline the knowledge and skill areas that Indian crop advisers have indicated they need in order to effectively carry out their duties. Performance Objectives are the heart of the Certified Crop Adviser Program, as they outline the basic knowledge and skills required by individuals providing advice to crop producers.

The Performance Objectives are divided into four areas of knowledge, or modules. These are: Nutrient Management; Soil and Water Management; Pest Management; and Crop Management. Each module contains several Competency Areas, which identify needed knowledge and skill areas. Within each Competency Area is one or more specific Performance Objective which describes the activity to be performed to demonstrate competency.

Because crop management needs change over time, the modules are regularly reconstructed by a committee of specialists from across India. Their work is evaluated and then modified and approved by practicing crop advisers.

Since the Performance Objectives have been developed over the material that Certified Crop Advisers need to know, they are the base on which the entire CCA program is built. Therefore, mastering the material covered in the Performance Objectives is critical. Certification occurs when minimum competency is demonstrated by passing the CCA examination. All the questions on the Indian exam are based directly on these Performance Objectives. Passing the Minimum Competency exam is the first step in becoming a good crop adviser, as you can then progress on to furthering your skills through continuing education.

Certified Crop Advisers should use the Performance Objectives to identify areas where they need to strengthen their proficiency. To assist in mastering the competencies required by CCA's, a glossary of terms for each module is included. The glossaries are not intended to be all-inclusive, but are to serve as sources of information for both mastering of basic knowledge and skill areas and as a source of information for continuing education.

NUTRIENT MANAGEMENT COMPETENCY AREAS:

1. Basic Concepts of Plant Nutrition
2. Basic Concepts of Soil Fertility
3. Soil Testing and Plant Tissue Analysis
4. Nutrient Sources, Analyses, and Application Methods
5. Soil pH and Liming
6. Management of Sodic Soils
7. Nutrient Management Planning

NUTRIENT MANAGEMENT

EXPERTISE WITHIN EACH COMPETENCY AREA:

COMPETENCY AREA 1. BASIC CONCEPTS OF PLANT NUTRITION

1. List the 16 elements essential for plant nutrition
2. Classify the essential elements as primary, secondary, and micronutrient
3. Describe the functions of each essential element in plants
4. Classify each nutrient as mobile or immobile in the plant and in the soil
5. List chemical uptake forms of each nutrient
6. Describe how nutrient needs change as plant growth progresses from germination to maturity
7. Describe the N, P, K, S, Z, Mn, Fe nutrient deficiency symptoms in rice, wheat, maize, potato, cotton, sugarcane, mustard, cauliflower, tomato, and pearl millet
8. Explain the importance of nutrient balance and interaction on crop growth

COMPETENCY AREA 2. BASIC CONCEPTS OF SOIL FERTILITY

9. Describe the role of the following in supplying nutrients from the soil
    a. soil solution
    b. cation exchange
    c. organic matter
    d. soil minerals
    e. plant residue
10. Describe mass flow, diffusion, and root interception of nutrients
11. Describe how cation exchange capacity (CEC) influences the mobility and availability of the following
    a. Calcium (Ca)
    b. Magnesium (Mg)
    c. Potassium (K)

12. Describe how the following soil characteristics affect nutrient availability and uptake
    a. texture
    b. structure
    c. aeration
    d. moisture
    e. pH
    f. temperature
    g. soil depth

13. Explain how the following affect the fate of N in soil
    a. fixation by clay
    b. ammonification/mineralization
    c. nitrification/ denitrification
    d. volatilization
    e. immobilization
    f. leaching
    g. biological N fixation
    h. plant uptake

14. Describe how the following soil factors affect symbiotic nitrogen fixation
    a. pH
    b. moisture
    c. nitrogen level
    d. presence of correct rhizobia species
    e. phosphorus level
    f. flooding/aeration

15. Describe how the following affect P availability in soil
    a. pH
    b. moisture
    c. organic matter
    d. P fixing capacity
    e. micro-organisms
    f. liming & gypsum amendments
    g. crop grown

16. Describe how the following affect K availability in soil
    a. texture
    b. depth
    c. pH and liming
    d. K bearing minerals
    e. type of clay
    f. soil moisture
    g. source and quality of irrigation water

17. Describe how the following affect availability of secondary and micronutrients in soils
    a. texture
    b. pH
    c. soil type
    d. crop grown

18. Recognize how crops and cropping systems influence the following
    a. soil fertility levels
    b. method of applying nutrients
    c. timing of applying nutrients
    d. crop nutrient needs

COMPETENCY AREA 3. SOIL TESTING AND PLANT TISSUE ANALYSIS

A. Soil Sampling and Soil Test Interpretation

19. Describe how to obtain a representative soil sample in the following
    a. field crop
    b. orchard
    c. problem soil

20. Explain how the following affect soil sampling methods
    a. method of previous fertilizer application
    b. nutrient stratification
    c. within-field soil and crop variability
    d. predictive vs. diagnostic sampling

21. Describe how to use soil analysis for
    a. problem solving/diagnosis
    b. nutrient program monitoring
    c. in-season nutrient management
    d. pre-season nutrient planning

22. Indicate how the following may cause variability in soil test results
    a. time of sampling
    b. depth of sampling
    c. type of extraction method used
    d. number of samples per acre/hectare
    e. number of subsamples per sample

23. Compare and contrast the following approaches for making fertilizer recommendations
    a. sufficiency level
    b. critical level
    c. base saturation

24. Recognize how the following affect soil test interpretation

    a. probability of crop response to added nutrients
    b. reported nutrient sufficiency level
    c. results reported as ppm or kg/ha
    d. within-field variability
    e. environmental risk
    f. soil texture

25. Describe how the following affect crop nutrient requirements

    a. Rabi (winter) and Kharif (rainy) season
    b. target yield

Plant Tissue Analysis

26. Recognize how the following terms relate to plant nutrient level

    a. critical value
    b. sufficiency level
    c. luxury consumption
    d. toxicity level

27. Recognize how the following affect plant tissue analysis results

    a. crop species
    b. growth stage
    c. plant part sampled
    d. crop stress level
    e. time of day when sampled
    f. sample handling
    g. method and timing of nutrient application

28. Describe how to use a chlorophyll meter or leaf color chart to assess nitrogen level

COMPETENCY AREA 4. NUTRIENT SOURCES, ANALYSES, AND APPLICATION METHODS

29. Describe how the following serve as plant nutrient sources

    a. commercial fertilizer
    b. phosphogypsum
    c. soil minerals
    d. farmyard manure
    e. poultry manure
    f. vermi-compost
    g. bio-gas slurry
    h. urban/industrial waste
    i. pressmud
    j. plant residue
    k. residual nutrients from fertilizers and manures
    l. bio-fertilizers
    m. composts
    n. green manure and green leaf manure
    o. river and tank sediments
    p. ash

30. List characteristics of the following types of fertilizer

    a. straight
    b. complex
    c. mixed
    d. liquid
    e. customized

31. Describe the role and how to use the following in a nitrogen fertilization program

    a. urease inhibitors
    b. synthetic nitrification inhibitors
    c. natural nitrification inhibitors

32. Describe the physical form and analysis of the following fertilizers

    a. urea
    b. calcium ammonium nitrate
    c. ammonium sulfate
    d. calcium nitrate
    e. single/triple super phosphate
    f. monoammonium phosphate
    g. diammonium phosphate
    h. nitrophosphates
    i. ammonium polyphosphate
    j. potassium chloride
    k. potassium sulfate
    l. potassium nitrate

33. Explain why it is important to use chelated forms of micronutrients

34. Describe the chemical composition and use of each of the following calcium and/or magnesium sources

    a. calcitic lime
    b. dolomitic lime
    c. gypsum
    d. basic slag

35. Convert fertilizer analysis of P and K from elemental to oxide form, and vice versa

36. List sources of the following and their nutrient content

    a. S
    b. Zn
    c. Fe
    d. Mn
    e. B

37. Define the following commercial fertilizer terms

    a. total content
    b. water soluble content
    c. citrate soluble content
    d. fertilizer grade

38. Use fertilizer analysis information and soil test information to calculate fertilizer application rates

39. Use manure analysis information and soil test information to calculate manure application rates

40. Describe how the following affect nutrient availability from manure

    a. physical form
    b. source
    c. moisture content
    d. state of decomposition
    e. method of application
    f. time of application
    g. C:N ratio

41. Describe advantages and limitations of the following fertilizer placement methods

    a. surface broadcast
    b. broadcast incorporated
    c. band
    d. fertigation
    e. foliar
    f. sidedressing
    g. topdressing
    h. point placement
    i. with seeds at seeding

42. Describe how the following influence choice of fertilizer

    a. crop grown
    b. soil properties
    c. time of application
    d. method of application

COMPETENCY AREA 5. SOIL pH AND LIMING

43. Define the following

    a. soil pH
    b. buffering capacity
    c. active and potential acidity
    d. alkalinity
    e. lime requirement
    f. acid forming factors
    g. salt index
    h. acid equivalent fertilizer
    i. electrical conductivity

44. Describe the long term change in soil pH from applying fertilizers

45. Describe how CEC, soil texture, and soil organic matter affect lime requirements

46. Explain how soil pH affects the availability of each nutrient and heavy metals

47. Describe how liming materials increase soil pH

48. Describe how purity, fineness, and Calcium Carbonate Equivalent (CCE) affect neutralizing ability of liming materials

49. Calculate lime application rates to meet liming requirements

COMPETENCY AREA 6. MANAGEMENT OF SODIC SOILS

50. Characterize the following
    a. saline soil
    b. saline-alkali soil
    c. alkali soil
    d. calcareous soil
    e. acid soil

51. Describe how to use the following to reclaim saline soils
    a. source and management of water
    b. drainage
    c. soil amendment
    d. crop and cultivar selection
    e. green manuring

52. Describe how to use the following to reclaim alkali soils
    a. selection of the amendment
    b. determination of amendment requirement
    c. selection of the reclamant crop or cropping system

53. Explain fertilizer management for reclamant crops

COMPETENCY AREA 7. NUTRIENT MANAGEMENT PLANNING

54. Describe how to set a targeted yield goal by using information about
    a. climate
    b. production history
    c. soil productivity
    d. management level
    e. most limiting nutrient

55. Use crop nutrient requirement, crop rotation/sequence, and soil test information to determine crop nutrient needs

56. Define the following
    a. Integrated Nutrient Management (INM)
    b. site-specific nutrient management
    c. fertilizer equivalents of organic sources
    d. organic farming

57. Describe the importance of the following components of an economically and environmentally sound nutrient management plan

    a. maps of facilities, fields, and soils
    b. environmentally sensitive areas
    c. cropping system
    d. targeted yields
    e. results of soil, plant, water, and manure analyses
    f. nutrient budget for each field
    g. review and modification of plan as needed

58. Describe how N and/or P loss from the following affect the environment

    a. erosion
    b. runoff
    c. volatilization
    d. leaching
    e. denitrification

59. Describe how manure storage, handling, and application methods affect nutrient content and availability

Nutrient Management Glossary

Acid soil: A soil that has a pH value of 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 (NH_4^+): 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 supersphosphoric 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.

Anion Exchange Capacity: The sum total of exchangeable anions that a soil can adsorb. Expressed as centimoles of charge per kilogram ($cmol_c/kg$) of soil or milliequivalents per 100 g of soil (meq/100 g of soil).

Application rate: The weight or volume of a fertizer, 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 $CaCO_3$ based material with very low magnesium content.

Calcium Carbonate Equivalent (CCE): The liming potential of a material as compared to $CaCO_3$.

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 as meq/100 g soil, or cmol charge/kg.

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

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: A group of conservation practices and management activities unique to animal feeding operations, which will ensure that both productive as well as natural resource protection goals are achieved.

Critical value: The point between sufficiency and defiency 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 be 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 ($CaSO_4$-$2H_2O$) 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.

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 need in relatively large amounts. Essential macronutrients are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S).

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 (NO_3^-): An inorganic nitrogen form that is very soluble, easily leached from soils, and readily available to plants.

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, based on balancing the agronomic rate or crop removal rate of the crop with the amount of phosphorus contained in a material. This amount is 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.

P_2O_5: Phosphorus pentoxide; designation on the fertilizer label that denotes the percentage of available phosphorus expressed as P_2O_5.

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.

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

Recommended rate: Amount of nutrients recommended on a soil test report for a specific crop that meets but does not exceed the crop nutrient recommendations. 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.

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.

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 to achieve expected crop yields based on the supplying power of the soil, air, and water.

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

Starter fertilization: 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 area unlikely to occur.

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

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 (N_2) 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:

SOIL MANAGEMENT

1. Basic Soil Properties
2. Land Characterization
3. Soil Erosion and Conservation
4. Tillage and Residue Management
5. Soil Management and Environment
6. Management of Problematic Soils

WATER MANAGEMENT

7. Weather and Climate
8. Water and Solute Movement
9. Soil-Plant-Water Relations
10. Irrigation and Drainage
11. Water Quality Management
12. Watershed Management
13. Water Management for Rainfed Areas

SOIL AND WATER MANAGEMENT

EXPERTISE WITHIN EACH COMPETENCY AREA:

SOIL MANAGEMENT

COMPETENCY AREA 1. BASIC SOIL PROPERTIES

Chemical

1. Define anion and cation

2. Define cation exchange capacity (CEC), anion exchange capacity (AEC), and redox potential

3. Explain how the following factors influence CEC
   a. percent of clay
   b. type of clay
   c. percent organic matter
   d. pH

4. Describe the characteristics of the following
   a. acidic soils
   b. sodic soils
   c. saline soils
   d. saline sodic soils
   e. calcareous soils

Physical

5. Define soil texture

6. Determine soil texture by the feel method

7. Define bulk density and particle density

8. Describe how soil texture and structure affect total porosity

9. Explain how the following influence water holding capacity and soil water availability
   a. soil texture
   b. soil structure
   c. organic matter content
   d. Electrical conductivity (EC)
   e. Exchangeable sodium percentage (ESP)

10. Define soil structure.

11. Differentiate the following types of soil structure
    a. blocky
    b. single grain
    c. granular
    d. platy
    e. massive
    f. prismatic/columnar

12. Describe how soil structure and texture affects the following
    a. permeability
    b. root development
    c. water infiltration
    d. aeration
    e. Thermal conductivity
    f. Hydraulic conductivity

13. Describe how soil organisms and soil organic matter affect soil structure

14. Describe how bulk density of soil varies with soil texture and compaction

Biological

15. Describe the beneficial effects of soil organic matter

16. Explain how the following influence soil microbial activity
    a. temperature
    b. moisture
    c. aeration
    d. soil pH
    e. organic matter
    f. salinity
    g. tillage

17. Explain how the C:N ratio affects organic material decomposition

18. Explain the importance of soil macro fauna on soil chemical and physical properties

COMPETENCY AREA 2. LAND CHARACTERIZATION

19. Differentiate O, A, B, and C soil horizons

20. Define parent material

21. Describe how to determine slope of a landscape

22. Identify characteristics of well-drained and poorly-drained soils

23. Explain how the following limit land use

    a. leaching potential
    b. erosion potential
    c. waterlogging potential
    d. proximity to sensitive areas
    e. flood potential

COMPETENCY AREA 3. SOIL EROSION AND CONSERVATION

24. Describe the erosion processes of detachment, transport, and deposition for wind and water erosion

25. Describe the characteristics of the following types of erosion

    a. sheet
    b. rill
    c. gully
    d. surface creep
    e. saltation
    f. suspension

26. Explain how the following affect the rate of erosion by water

    a. duration and intensity of rainfall
    b. soil texture and structure
    c. slope length, steepness, and shape and aspect
    d. vegetative and residue cover
    e. conservation tillage

27. Explain how the following affect the rate of erosion by wind

    a. vegetative and residue cover
    b. slope of land
    c. wind velocity
    d. presence of windbreaks
    e. soil surface roughness
    f. soil texture
    g. soil moisture
    h. soil structure

28. Describe how erosion affects the following

    a. crop yield potential
    b. water holding capacity
    c. nutrient content
    d. organic matter content
    e. infiltration
    f. water quality
    g. air quality
    h. water storage capacity of reservoirs

29. Explain how the following decrease erosion

    a. strip cropping
    b. contouring
    c. terraces
    d. grassed waterways
    e. surface residue and conservation tillage
    f. cover crops
    g. row spacing and direction
    h. buffer strips
    i. surface roughness
    j. windbreaks
    k. check dam
    l. land leveling

COMPETENCY AREA 4. TILLAGE AND RESIDUE MANAGEMENT

30. Describe types and objectives of tillage

31. Describe puddling and its objectives

32. Describe effects of puddling on soil physical properties

33. Describe how the following soil characteristics differ between conventional-till and high surface residue management systems

    a. temperature
    b. erosion potential
    c. moisture
    d. organic matter
    e. microbial activity

34. Describe the following conservation tillage systems

    a. mulch-till/reduced-till
    b. no-till/zero-till
    c. permanent raised beds

35. List advantages of zero tillage

36. Explain how to manage crop residue and tillage in rice-wheat cropping systems

37. Describe soil conditions that require chiseling

38. Explain the role of soil mulch in moisture conservation

COMPETENCY AREA 5. SOIL MANAGEMENT AND ENVIRONMENT

39. Describe how soil management practices affect
    a. NH_3, N_2O, CH_4, and CO_2 emissions
    b. carbon sequestration

40. Describe how the following affect air quality
    a. crop residue burning
    b. pesticide application
    c. tillage

41. Explain how the following affect water quality
    a. fertilization
    b. pesticide application
    c. presence of industrial effluents
    d. tillage
    e. irrigation

COMPETENCY AREA 6. MANAGEMENT OF PROBLEMATIC SOILS

42. Describe reclamation procedures for saline and sodic soils

43. List physical limitations of the following
    a. sodic soils
    b. crusting soils
    c. hard pan soils

44. Explain how soil aeration affects water and nutrient uptake in upland crops

45. Describe how to manage the following
    a. crusted soils
    b. sodic soils
    c. erodible soils
    d. hard pan soils

WATER MANAGEMENT

COMPETENCY AREA 7. WEATHER AND CLIMATE

46. Describe how to measure rainfall

47. Explain how rainfall distribution affects crop production

48. Describe how to mitigate frost effects on crops

49. Describe how to mitigate the effects of terminal heat on wheat

50. Describe how microclimate of a field affects crop growth

COMPETENCY AREA 8. WATER AND SOLUTE MOVEMENT

51. Explain how the following interact to influence the Water Cycle
    a. precipitation
    b. irrigation
    c. runoff
    d. soil water storage
    e. evapo-transpiration
    f. deep percolation

52. Describe how the following influence surface runoff
    a. infiltration
    b. landscape position
    c. permeability
    d. surface residue cover
    e. surface roughness
    f. type of vegetative cover

53. Describe how the following influence leaching
    a. infiltration
    b. permeability
    c. soil depth
    d. water holding capacity
    e. texture
    f. structure

COMPETENCY AREA 9. SOIL-PLANT-WATER RELATIONS

54. Define the following soil water terms
    a. saturation percentage
    b. field capacity
    c. permanent wilting point
    d. gravitational water
    e. plant available water

55. Describe how the following factors influence evapo-transpiration
    a. wind
    b. temperature
    c. solar radiation
    d. relative humidity
    e. soil water status
    f. plant canopy
    g. crop residue surface cover

56. List management options that reduce evapotranspiration

57. Explain how soil moisture deficiency affects plant nutrient uptake and availability

58. Define water use efficiency (WUE)

59. Describe how to increase WUE in the following crops

    a. rice
    b. wheat
    c. cotton
    d. maize
    e. sunflower
    f. sugarcane
    g. potato
    h. pearl millet

COMPETENCY AREA 10. IRRIGATION AND DRAINAGE

60. List the water requirement of the following crops

    a. rice
    b. wheat
    c. cotton
    d. maize
    e. sunflower
    f. sugarcane
    g. potato
    h. pearl millet

61. Describe characteristics and efficiencies of the following irrigation methods

    a. furrow
    b. sprinkler
    c. drip/trickle
    d. flood
    e. subsurface

62. List the critical stages of irrigation for the following crops

    a. rice
    b. wheat
    c. cotton
    d. maize
    e. sunflower
    f. sugarcane
    g. potato
    h. pearl millet

63. List characteristics of the following drainage methods

    a. Subsurface drainage
    b. open ditch
    c. bed and furrow

64. Define the following

    a. irrigation water use efficiency
    b. fertigation
    c. field application efficiency

COMPETENCY AREA 11. WATER QUALITY MANAGEMENT

65. Describe water quality parameters for agricultural use

66. Identify the health effects of drinking water containing nitrate-nitrogen above the drinking water standard

67. Explain the harmful effects of contaminated water from drains and industrial effluents on crops and human health

68. Describe factors affecting eutrophication

69. Describe how to manage brackish water for irrigation

COMPETENCY AREA 12. WATERSHED MANAGEMENT

70. Define watershed and describe the concept of watershed management

71. Describe how management of watershed affects the following

    a. runoff and soil erosion
    b. rainwater use
    c. crop diversification
    d. ground water recharge
    e. economic condition of farmers

COMPETENCY AREA 13. WATER MANAGEMENT FOR RAINFED AREAS

72. Describe the following

    a. dryland agriculture
    b. rainfed agriculture
    c. rainwater harvesting
    d. supplemental irrigation

73. Explain how the following increase efficiency of rainfed crop production
    a. strip cropping
    b. selection of drought tolerant crop hybrids or varieties
    c. plant population and spacing
    d. transpiration retardants
    e. leveling of field
    f. seeding depth
    g. field bunds

74. Explain how to conserve soil moisture in dryland areas

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 of less than 7.0.

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. Expressed as centimoles of charge per kilogram ($cmol_c/kg$) of soil or millequivalents per 100 g of soil (meq/100 g soil).

Aquifier: 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 acidified.

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

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 concomitantly 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.

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. Pans may be caused by compaction, clay, or chemical cementation.

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 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, and 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.

Percolation: Downward movement of water through soil or rock.

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.

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.

WEQ: An equation for predicting *E*, the average annual soil loss from wind erosion in mass per unit area per year, and is defined as, $E = f(IKCLV)$, where *f* indicates “a function of”, *I* is 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.

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

PEST MANAGEMENT COMPETENCY AREAS:

1. Basic Concepts of Pest Management

2. Sampling and Monitoring

3. Identification

4. Decision-Making Guidelines

5. Pest Management Strategies

6. Environmental Stewardship

7. Health and Safety

8. Management Strategies for Key Pests of Major Cropping Systems

PEST MANAGEMENT

EXPERTISE WITHIN EACH COMPETENCY AREA:

COMPETENCY AREA 1. BASIC CONCEPTS OF PEST MANAGEMENT

Principles of Integrated Pest Management (IPM)

1. Define IPM

2. Describe how to use the following strategies to construct an effective IPM program
   a. Prevention
   b. Avoidance
   c. Monitoring
   d. Pest Management

3. Describe how to use the following steps of an IPM program
   a. sampling and monitoring
   b. identification
   c. determining need for control
   d. threshold value
   e. evaluating control options
   f. implementation
   g. evaluation and record-keeping

4. List economic and environmental advantages of using IPM

5. Explain factors that limit the use of IPM

Pest-Ecosystem Interactions

6. Explain how the following factors affect insect pest population development
   a. natural enemy complex
   b. host plants
   c. initial pest population
   d. soil characteristics
   e. agronomic practices
   f. temperature, rainfall, relative humidity, and wind
   g. crop and cropping system

7. Explain how the following insect characteristics influence their ability to cause damage
   a. developmental time and seasonal period of activity
   b. reproduction rate and number of generations per season
   c. overwintering and oversummering characteristics
   d. feeding habits
   e. type of metamorphosis
   f. dispersal and movement characteristics

8. Explain how environment, host plant, and pathogen interact to cause plant disease

9. Describe how the following plant pathogens infect, survive, and disperse
    a. fungi
    b. bacteria
    c. nematodes
    d. viruses

10. Describe how temperature and moisture affect survival of pathogens that are
    a. soil borne
    b. residue borne
    c. found in or on live plant hosts

11. Describe how the following affect the ability of weeds to survive and be competitive
    a. growth rate
    b. seed production
    c. seed dormancy
    d. reproduction method
    e. light, temperature, moisture, and humidity
    f. life cycle
    g. physical characteristics of the weed

12. Explain competitive interactions of crops and weeds

COMPETENCY AREA 2. SAMPLING AND MONITORING

13. List advantages and limitations of the following insect sampling methods
    a. direct observation
    b. sweep nets/drop cloths
    c. insect traps

14. Explain how the following aid in monitoring pests
    a. weather data
    b. level of infestation or infection
    c. time of year
    d. time of day
    e. crop growth stage
    f. pest development stage

15. Describe how to obtain a representative sample from the following pest distribution patterns
    a. clumped
    b. uniform
    c. border effect
    d. random

16. Explain how to prepare and ship samples of the following to a laboratory for identification/evaluation

    a. weeds
    b. insects
    c. diseased plants or plant parts
    d. soil for nematode analysis

17. Explain why supporting information is important when submitting a sample for identification/evaluation

18. List advantages and disadvantages of the following to monitor pest infestation and/or infection

    a. roving pest surveillance
    b. remote sensing
    c. forecasting models
    d. GPS/GIS

COMPETENCY AREA 3. IDENTIFICATION

19. Classify insect pests into the following categories

    a. monophagous
    b. polyphagous
    c. oligophagous

20. Classify weeds into the following categories

    a. ephimerales
    b. annuals
    c. biannuals
    d. perennials

21. Classify plant diseases into the following categories

    a. fungi
    b. bacteria
    c. viruses
    d. phytoplasma

22. Explain how to use the following to help identify a pest

    a. cropping history
    b. crop grown
    c. time of year/crop stage
    d. weather conditions
    e. symptoms and patterns of damage
    f. distinguishing characteristics of pest
    g. distribution in field

23. Use the following to identify mites and types of insects
    a. type and number of legs
    b. type of mouth parts
    c. wing characteristics
    d. life cycle

24. Identify the following insects in the adult stage
    a. aphids
    b. beetles
    c. leafhoppers/plant hoppers
    d. mites
    e. moths/butterflies
    f. thrips
    g. true bugs
    h. whiteflies
    i. fruitflies
    j. termites
    k. scales
    l. mealybugs

25. Identify the following insects in the larval stage
    a. borers
    b. tobacco caterpillar
    c. bollworms

26. Identify the following diseases
    a. seedling decay
    b. leaf spot
    c. leaf blight
    d. bacterial blight
    e. mosaic
    f. leaf curling
    g. rusts
    h. foliar diseases
    i. powdery mildew
    j. downy mildew
    k. smuts
    l. bunts
    m. cankers
    n. dry root rots
    o. wet root rots
    p. wilts

27. Identify root knot nematode and lesion nematode

28. Identify the following weed species in rice-wheat cropping systems

    a. Ammania baccifera L.
    b. Avena ludoviciana Dur.
    c. Casuelia axillaris Roxb.
    d. Chenopodium album L.
    e. Cyperus iria L.
    f. Echinochloa colona Link.
    g. Echinochloa crus-galli L.
    h. Melilotus indica L.
    i. Rumex dentatus L.

29. Identify the following weed species in cotton-wheat cropping systems

    a. Asphodelus tenuifolius Dur.
    b. Avena ludoviciana Dur.
    c. Chenopodium album L.
    d. Dactyloctenium aegyptium Beauv.
    e. Digitaria ciliaris (Retz.) Koel.
    f. Echinochloa colona Link.
    g. Melilotus indica L.
    h. Spergula arvensis L.
    i. Trianthema portulacastrum L.

30. Identify the following weed species in pearlmillet-mustard cropping systems

    a. Asphodelus tenuifolius Cav.
    b. Cenchrus ciliaris L.
    c. Chenopodium album L.
    d. Cynodon dactylon (L) Pers.
    e. Dactyloctenium aegyptium Beauv.
    f. Digera arvensis Forsk.
    g. Orobanche aegyptiaca Pers.
    h. Spergula arvensis L.
    i. Trianthema portulacastrum L.
    j. Trigonella polycerata L.

31. Identify the following weed species of orchards

    a. Cynodon dactylon (L) Pers.
    b. Cyperus rotundus L.
    c. Imperata cylindrical (L) Beauv.
    d. Sorghum halepense L.
    e. Trianthema portulacastrum L.

32. Identify the following weed species of vegetables

    a. Chenopodium album L.
    b. Coronopus didymus Sw.
    c. Cyperus rotundus L.
    d. Dactyloctenium aegyptium Beauv.
    e. Echinochloa colona Link.
    f. Eragrostis tenella (P) Beauv.
    g. Melilitus indica L.
    h. Poa annua L.
    i. Rumex dentatus L.
    j. Trianthema portulacastrum L.

33. Use the following plant characteristics to identify weeds

    a. cotyledons
    b. arrangement, shape, and vein pattern of leaves
    c. ligules
    d. auricles
    e. hairiness
    f. shape, color, and size of seed
    g. stem shape
    h. root system
    i. inflorescence

COMPETENCY AREA 4. DECISION-MAKING GUIDELINES

34. Define economic threshold, economic injury level, and action threshold level

35. Describe how natural enemies impact pest population projections

36. Use information about the following to make pest management decisions

    a. pest and vector history
    b. pesticide history
    c. level of resistance
    d. cropping history
    e. current crop pest/defender data from monitoring and scouting
    f. external input level
    g. soil, weather, and crop condition
    h. cost of control
    i. crop value

COMPETENCY AREA 5. PEST MANAGEMENT STRATEGIES

Generic

37. Define host plant resistance

38. Define transgenic crops

39. Explain how transgenic crops selectively control pests

40. Explain the role of susceptible refuge host populations in managing insect resistance

41. List advantages and limitations of incorporating multiple traits into crops through transgenic techniques

Cultural and Mechanical

42. Explain how the following influence pest management decisions
    a. cropping sequence
    b. inter/trap cropping
    c. row spacing and plant population
    d. planting date
    e. harvest date
    f. tillage
    g. crop residue
    h. nutrient status
    i. water resources
    j. variety selection
    k. weed management
    l. labor availability
    m. availability of mechanical tools

43. Describe methods to minimize introducing pests into fields

44. Describe the concept of critical weed free period

Biological

45. Explain the concept of biological control

46. Identify the following biological control agents
    a. lacewings
    b. ground beetles
    c. lady bird beetles
    d. minute pirate bugs
    e. nabids
    f. parasitic wasps
    g. predatory mites
    h. spiders
    i. syrphidfly larvae
    j. ants
    k. crickets

47. Explain advantages and limitations of using biological control agents in crop production

48. Define bio-pesticide

49. List production practices that support conservation of natural enemies

Chemical

50. Explain how the following pesticide characteristics affect pesticide selection
    a. mode of action
    b. chemical and physical properties
    c. toxicity to non-target organisms
    d. efficacy on target organisms
    e. environmental hazard
    f. persistence
    g. selectivity
    h. phytotoxicity to crop
    i. succeeding crops

51. Explain how the following affect pesticide selection
    a. existing or potential pesticide resistance
    b. economics
    c. application method
    d. field history
    e. pest identification, stage, and level of infestation
    f. weather conditions
    g. crop growth stage
    h. label restrictions
    i. pre-harvest intervals
    j. environmental risks

52. Define multiple and cross resistance

53. Describe how the following affect pest resistance
    a. selection pressure
    b. resistance mechanisms
    c. pest reproduction methods

54. Describe how to manage pest resistance to herbicides, insecticides, and fungicides

55. Distinguish contact and systemic pesticides

56. Describe characteristics of the following pesticide formulations
    a. emulsifiable concentrates
    b. wettable powders
    c. granules
    d. water soluble

57. Define maximum residue level (MRL)

58. Describe how to calibrate a sprayer and calculate a pesticide concentration

59. List type of equipment to use for pesticide applications

60. Describe the spray patterns for the following nozzle types
    a. flood jet
    b. flat fan
    c. triple action nozzle

61. List factors that increase the risk of crop injury from pesticides

62. Explain how the following affect pesticide coverage
    a. wind speed
    b. nozzle type
    c. boom height and configuration
    d. evaporation rate and spray viscosity
    e. spray pressure
    f. spray volume
    g. ground speed
    h. surfactants

63. Explain how to manage spray drift

64. Identify plant injury symptoms caused by the following mode-of-action groups
    a. photosynthesis inhibitors
    b. cell membrane disruptors
    c. growth regulators
    d. pigment inhibitors
    e. root/shoot growth inhibitors
    f. amino acid synthesis inhibitors
    g. ALS inhibitors

65. Explain the importance of the following when applying herbicides to herbicide-resistant crops
    a. identifying the field
    b. matching the correct herbicide with the hybrid/variety
    c. scouting

66. List sources of information on banned and restricted pesticides

67. Describe the toxicity and persistence of the following insecticide families
    a. organophosphates
    b. carbamates
    c. synthetic pyrethroids
    d. neonicotinoids

68. Describe how the following fungicide characteristics affect their use
    a. contact or systemic
    b. pre or post infection timing
    c. seed, soil, or foliar applied
    d. broad spectrum or narrow spectrum

COMPETENCY AREA 6. ENVIRONMENTAL STEWARDSHIP

69. Identify information found on a pesticide label

70. Describe how pesticides affect soil and water quality

71. Describe the following Worker Protection Standards for handling pesticides
    a. Re-Entry Interval (REI)
    b. information exchange requirements
    c. Personal Protective Equipment (PPE)
    d. emergency assistance requirements
    e. oral and posted warning requirements
    f. site decontamination procedures

72. Explain how the presence of endangered species or species at risk affect pesticide selection and application

COMPETENCY AREA 7. HEALTH AND SAFETY

73. List pesticide modes of entry into the human system

74. Define chronic and acute pesticide poisoning

75. Recognize symptoms of acute pesticide poisoning

76. List possible chronic effects of pesticide poisoning

77. Describe procedures to follow if a pesticide gets on skin, eyes, mouth, or stomach, or is inhaled

78. List protective gear to use while mixing and applying pesticides

79. Describe proper cleanup procedures for application equipment and protective gear

80. Describe proper procedures for disposing of pesticides and pesticide containers

81. Explain how to store pesticides safely and securely

82. List procedures for handling a pesticide spill

COMPETENCY AREA 8. PEST MANAGEMENT STRATEGIES

83. Develop a program to manage insect pests of cotton, paddy rice, sugarcane, and vegetable crops

84. Describe how to manage rice and wheat diseases

85. Describe how to manage weeds in direct-seeded paddy rice

86. Describe how to manage herbicide-resistance in wheat

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.

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.

Cultural pest control: The use of practices other than chemical and biological 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: Genetically based mechanisms within host plants which hinder pest development.

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.

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 (usually water) 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 affect target organisms.

Monophagous insects: Insects which confine themselves to a single species of plant, e.g. mulberry, silkworm, pink bollworm, ball weevil, citrus butterfly.

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.

Oligophagous insects: Insects that characteristically feed on a group of botanically related plants usually within a single plant family, e.g. diamondback moth, spotted bollworm

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 expression 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.

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.

Polyphagous insects: Insects that accept many plants from a diverse range of plant families, e.g. helicoverpa armigera, locust, hairy caterpillars, termites, cutworms

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.

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 restricts individuals from entering a pesticide-treated area.

Refugia: Areas, untreated with pesticides, provided to preserve susceptible populations of 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.

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: 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.

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: An organism whose genome has been modified to incorporate pest resistance by the introduction of external DNA sequences into the germ line or gene transfer from outside the normal range of sexual compatibility.

Transgenics (bioengineered organisms): Plants or animals that contain DNA derived from a foreign plant or animal.

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.

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. Cropping Systems

2. Variety and Hybrid Selection

3. Crop Establishment

4. Crop Growth, Development, and Diagnostics

5. Applied Information Technologies

6. Harvest and Storage

7. Managing Production Risk

8. Farm Mechanization

CROP MANAGEMENT

EXPERTISE WITHIN EACH COMPETENCY AREA:

COMPETENCY AREA 1. CROPPING SYSTEMS

1. Describe the following farm management systems
    a. contract farming
    b. cooperative farming
    c. corporate farming
    d. traditional farming

2. List characteristics of the following farming systems
    a. chemical intensive farming
    b. low external input farming
    c. organic farming
    d. conservation agriculture
    e. crop-livestock systems
    f. agroforestry systems

3. List the fifteen agroclimatic zones in India

4. Describe characteristics of the following cropping systems
    a. monocropping
    b. crop rotation
    c. intercropping
    d. mixed cropping
    e. relay cropping

5. Describe the role of the following in a cropping system
    a. fallow
    b. green manure crops
    c. cover crops
    d. companion/trap crops
    e. crop rotation

6. Explain how cropping sequence in a rotation influences the following
    a. tillage options
    b. residue management
    c. moisture availability
    d. nutrient availability
    e. pest management
    f. crop yield
    g. soil health

7. Describe how the following differ in conventional and conservation tillage systems
    a. seed placement
    b. stand establishment
    c. fertilizer placement
    d. crop rooting patterns
    e. soil temperature and moisture
    f. soil health
    g. canopy temperature
    h. pest dynamics

8. Define allelopathy

COMPETENCY AREA 2. VARIETY AND HYBRID SELECTION

9. Define variety and hybrid

10. Explain why variety diversification is important in crop production

11. Describe how the following influence variety or hybrid selection
    a. crop duration/growing season
    b. yield potential
    c. soil and climate
    d. yield stability among years and locations
    e. pest resistance and tolerance
    f. herbicide sensitivity
    g. harvestability
    h. end use and value added traits

12. Define farmer participatory variety selection (PVS)

13. Describe how to conduct an on-farm demonstration

14. Explain why randomization and replication are important in field trials

15. Use least significant difference (LSD) values to interpret differences among treatments

COMPETENCY AREA 3. CROP ESTABLISHMENT

Seed Quality

16. Define nucleus seed, breeder seed, foundation seed, certified seed, and truthfully labeled seed

17. Use seed tag information to determine seed quality

18. Define induced and forced dormancy

19. Describe how pre and post harvest conditions influence seed quality

20. List advantages and limitations of seed treatments

21. Describe advantages and limitations of using bio-inoculants/bio-fertilizers

22. Explain how storage time, handling, and storage conditions affect quality of bio-inoculants/bio-fertilizers

23. Describe how to apply seed treatments

24. Describe uses and limitations of the standard germination test

25. Differentiate between grain used for seed and grain used for marketing

26. Use purity and germination information to calculate a seeding rate

Planting Practices

27. Describe characteristics of the following seeding techniques
    a. zero tillage
    b. surface seeding
    c. raised bed planting
    d. conventional tillage
    e. direct seeding
    f. drum seeding
    g. transplanting

28. List the advantages and limitations of transplanting and direct seeding of rice

29. Describe how the following affect seed germination
    a. soil temperature
    b. soil moisture
    c. seed/fertilizer contact
    d. seed soil contact

30. Describe how the depth of planting and soil crusting affects crop emergence

31. Identify factors that influence planting date

32. Identify consequences of seeding earlier or later than optimum

33. Describe how the following affect seeding rates
    a. planting method
    b. soil tilth
    c. soil moisture and temperature
    d. crop residue
    e. seed size
    f. seed quality
    g. seed metering device

34. Describe advantages and limitations of applying fertilizer at seeding

35. Explain how to determine plant population in a field

36. Differentiate seeding rate, plant population, and harvest population

COMPETENCY AREA 4. CROP GROWTH, DEVELOPMENT, AND DIAGNOSTICS

37. Differentiate crop growth and development

38. Describe the following crop growth stages
    a. germination
    b. emergence
    c. vegetative
    d. flowering
    e. seed development
    f. physiological maturity

39. Describe how temperature and moisture extremes affect crops at the growth stages listed in #38.

40. Describe how day length affects flowering in short day, long day, and day neutral crops

41. Locate the growing points in grasses and broadleaf plants

42. Describe how the following affect crop canopy closure
    a. row spacing
    b. plant population
    c. plant growth habit

43. Differentiate the following
    a. summer annual
    b. winter annual
    c. biennial
    d. perennial

44. Describe how the following soil factors affect crop root growth

    a. pH
    b. moisture and temperature
    c. texture and structure
    d. nutrient status
    e. fertilizer placement
    f. soil borne pests
    g. compaction
    h. aeration

45. Describe how the following factors differ for tap and fibrous root systems

    a. nutrient uptake
    b. water uptake
    c. erosion control
    d. soil aggregation
    e. ability to penetrate compacted layers

46. Describe how the following affect the economies of replanting/gap filling

    a. expected date of replanting
    b. population of surviving plants
    c. pesticides applied
    d. stand uniformity
    e. pest pressure

47. Use information about the following to diagnose a cropping problem

    a. pattern of problem in the field
    b. cropping history
    c. field preparation
    d. weather information
    e. management practices
    f. equipment function
    g. neighboring crop management

COMPETENCY AREA 5. APPLIED TECHNOLOGIES

48. Define the following precision agriculture terms

    a. global positioning systems (GPS)
    b. remote sensing
    c. geographic information systems (GIS)
    d. variable rate technology (VRT)
    e. crop management zone

49. Describe how the following affect yield variability in a field
    a. soil texture
    b. soil organic matter
    c. land topography
    d. previous management
    e. salinity and alkalinity
    f. nutrient status and pH
    g. drainage

50. Read and use a land-use map

51. Describe how to use a handheld GPS unit to locate a field site

COMPETENCY AREA 6. HARVEST AND STORAGE

52. Describe how the following factors influence when to harvest
    a. crop/grain moisture percentage
    b. variety or hybrid characteristics
    c. end use
    d. weather
    e. pest damage
    f. soil moisture
    g. crop lodging

53. Describe how the following influence crop/grain quality in storage
    a. ambient temperature
    b. ambient moisture
    c. ambient aeration
    d. sanitation of storage facilities
    e. crop condition and grain moisture before storage
    f. post-harvest handling
    g. length of storage time
    h. type and method of storage
    i. pest management

54. Explain how to maintain varietal purity of crop at planting, harvest, delivery, and storage

COMPETENCY AREA 7. MANAGING RISK IN CROP PRODUCTION

55. Describe how to use the following to manage production risk
    a. crop selection
    b. variety or hybrid selection
    c. planting and harvest date
    d. tillage and crop establishment
    e. pest and nutrient management
    f. water management
    g. harvest conditions
    h. record keeping
    i. weather information
    j. crop insurance

56. Describe how the following affect crop management decisions
    a. crop prices
    b. input costs and availability
    c. availability and skill of labor
    d. equipment
    e. custom hiring services
    f. weather
    g. cash flow
    h. crop insurance
    i. government farm incentive programs
    j. field proximity to sensitive areas
    k. time constraints
    l. pest threat
    m. access to knowledge and market
    n. availability of roads, electricity, irrigation
    o. size of the holding

COMPETENCY AREA 8. FARM MECHANIZATION

57. Explain how mechanization differs for small and large farms

58. Describe the effect of mechanization on labor productivity and cost

59. Describe the machines/implements/equipment used for
    a. precision land leveling
    b. tillage/seed bed preparation
    c. planting/seeding
    d. intercultivation
    e. irrigation/fertigation
    f. plant protection
    g. fertilizer application
    h. harvest and post harvest processing and storage

60. Explain the importance of customized service/service providers for mechanization

Crop Management Glossary

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

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.

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

Companion crop: A crop sown with another crop, especially one that will emerge and develop slowly. Also called a nurse crop.

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.

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): See also transgenic. A living entity that has been modified or transformed through recombinant DNA technology.

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 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 placed 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 in small amounts 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 developmental stage when a plant reaches maximum dry matter production, yield, or desirable quality.

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.

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 or fertilizers

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.

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 by genetic manipulation.

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

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

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 and reproduce after pesticide treatment. Also refers to the ability of a crop to yield satisfactorily in presence of pests or adverse environmental conditions.

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.

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.