

Pennsylvania Certified Crop Adviser Exam

Performance Objectives

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FOREWORD

These Performance Objectives provide guidance to individuals preparing for the Pennsylvania Certified Crop Adviser Exam. They supplement the International Performance Objectives and emphasize certain aspects of nutrient, soil and water, pest, and crop management principles that are of particular importance in Pennsylvania. Exam questions are based on these Performance Objectives and the International Performance Objectives as they apply to providing advice to crop producers in this region.

As is true of the International Performance Objectives, the Pennsylvania Performance Objectives outline the knowledge and skill areas that Certified Crop Advisers in this region have indicated they need in order to effectively carry out their duties. Performance Objectives cover the minimum level of fundamental principles considered essential for effective crop advising. Continuing education programs pursued after individuals achieve certification expand upon these principles and cover with greater rigor the four technical areas as well as changes in science and technology, and topics important to development as a professional. Thus, the Performance Objectives are a first step in the continuing process of professional development.

Major Crops in Pennsylvania			
Corn	Soybean	Wheat	Barley
Oat			
Cover crops: grasses, legumes, brassicas, mixes	Perennial forages legumes: alfalfa, red clover, white clover, birdsfoot trefoil	Perennial forages grasses: orchardgrass, timothy, smooth brome grass, tall fescue, ryegrass, reed canarygrass	Annual forages: sorghum, sudangrass, sorghum x sudangrass hybrids, millet, brassicas

I. NUTRIENT MANAGEMENT

Competency Area 1. Basic Concepts of Soil Fertility and Nutrient Management

1. List the forms of macronutrients that are available to plants.
2. List the forms of the macronutrients that are susceptible to loss.
3. Understand management of boron – alfalfa, zinc in corn (high P corn starter).
4. Recognize how the processes of mass flow, diffusion, and root interception affect nutrient uptake.
5. Distinguish between point and non-point sources of entry into the environment.
6. Recognize how soil climatic, and nutrient properties affect movement of a nutrient in soil or water.
7. Recognize how the loss of nutrients impacts the environment.
8. Recognize the general conditions where there is the potential for deficiency of micronutrients.

Competency Area 2. Liming and N, P, K Plant Requirements

Liming

1. List processes or practices that cause soil pH to change.
2. Describe how liming material characteristics influence lime rate.
3. Calculate the amount of liming material that should be applied to achieve a recommended lime requirement on a soil test report.
4. Describe the neutralizing value, physical properties, and handling precautions of liming materials.

Nitrogen

1. Describe the N uptake pattern for crops grown in Pennsylvania.
2. Describe symbiotic nitrogen fixation.
3. Describe ways nitrogen may be lost from the soil and how to minimize losses.
4. Describe the analysis, physical form and handling precautions of nitrogen fertilizer sources.
5. Understand the role of tile lines in nitrogen management.
6. Recognize the nitrogen supplying capacity of the soil – mineralization, immobilization.

Phosphorus

1. Describe how soil properties affect phosphorus fertilization.
2. Recognize how soil holds phosphorus.
3. Recognize how soil properties, erosion, runoff, and amount, type, and method of application affect P loss and how to minimize losses.
4. Understand soluble phosphorus losses.
5. List the analysis, physical form and handling precautions of phosphorus fertilizer sources.

Potassium

1. Recognize how soil retains potassium.
2. Recognize the role of potassium in animal health.

Competency Area 3. Soil Test Reports and Fertilizer Recommendations

1. Describe soil sampling and handling procedures for conventional and no-till systems.
2. Describe how to sample and submit plant samples for tissue analysis.
3. Interpret the items on a soil test report.
4. List the soil test interpretations categories and their definitions.
5. Recognize the economic and environmental factors involved in making fertilizer recommendations.
6. Given soil test results and recommendation information make/modify a soil test recommendation.
7. Understand the PSNT, chlorophyll meter and late season CSNT.

Competency Area 4. Manure Management

1. Describe how animal density on a farm affects manure management.
2. Calculate manure production from animal inventories.
3. Interpret the items on a manure analysis report.
4. Calculate manure nutrient availability based on handling and application.
5. Calculate manure application rates.
6. Describe how to calibrate a manure spreader.
7. Describe areas that may be environmentally sensitive to manure applications.
8. List options for dealing with excess manure.
9. Recognize how conservation practices and manure management practices are integrated in a nutrient management plan.
10. Understand the differences between nitrogen based plans and phosphorus based plans.
11. Recognize barnyard management problems.
12. List the roles of the public and private organizations that provide manure management assistance.
13. List the publications containing manure management information.
14. Recognize the provisions of the Nutrient Management Act in Pennsylvania.

Competency Area 5. Fertilizer Forms and Application

1. Recognize how fertilizer placement and time of application affect nutrient availability.
2. Describe the impact of the 4R Nutrient Management system on fertilizer programs.
3. Explain variable rate application as it applies to balanced plant nutrition.

II. SOIL AND WATER MANAGEMENT

Competency Area 1. Basic Physical Properties

1. Know the primary processes of soil formation in Pennsylvania and where examples can be found illustrating each.
2. Know the principles of soil health (= soil quality).
3. Understand soil consistency.
4. List typical soil textures common to PA.
5. Recognize types of soil structure found in PA soils.
6. Describe benefits of well-developed soil aggregation.
7. Describe how each of the following factors affects soil structure:
 - a. compaction.
 - b. tillage system.
 - c. organic matter.
 - d. root systems.
 - e. cropping system.
 - f. soil biology.
 - g. inherent soil properties.
8. List common sources of organic matter in PA and ways to maintain the organic matter content of an agricultural soil.
9. Define humus.
10. Describe the relationship between soil organic matter and soil health, soil color and structure.
11. Describe how the carbon:nitrogen (C:N) ratio of soil organic materials may affect soil nitrogen availability to plants.

Competency Area 2. Erosion Processes

1. Recognize and understand the factors used in the water erosion prediction technology models.
2. Explain how conservation practices/BMPs affect sheet, rill, and gully erosion.
3. Differentiate among the types of water erosion.
4. List physical factors which affect the rate of erosion.
5. Understand how the T value influences soil management decisions.
6. Know how to estimate percent residue using the line-transect method.
7. In a given situation, make economically sound management recommendations that will result in soil conservation.

Competency Area 3. Compaction

1. Know effects of soil compaction on soil physical, chemical and biological properties.
2. Explain the influence of axle load and contact pressure on compaction.
3. Know the importance of soil moisture content for compaction.
4. Know how soil texture and corresponding structure influences soil compaction.

5. Know how soil compaction can influence soil structure.
6. Know strategies to reduce subsoil compaction.
7. Know strategies to reduce surface compaction.
8. Know strategies to make the soil environment more resistant to compaction.
9. Know ways to alleviate compaction.

Competency Area 4. Tillage and Residue Management

1. Understand the characteristics (including advantages and disadvantages) of different tillage systems used in PA.
2. Understand the importance of residue cover and minimum levels for sustainability, for example:
 - a. corn stalk residue (non-fragile residue).
 - b. soybean residue (fragile residue).
 - c. cover crop residues.
3. Describe the components of sustainable no-tillage systems.
4. Know ways to manage manure in no-till.
5. Explain tillage decisions based on soil type, slope, manure, weather conditions.
6. Explain the relationship of tillage to residue cover, water contamination, nutrient loss, and pest management.

Competency Area 5. Regulations and Policy

1. Explain the type of soil and water information available from the Manure Management Manual for Environmental Protection, the PA Technical Guide, Agronomy Guide, and Ag Erosion and Sediment Control Manual. Chapter 102.4A of the PA Clean Streams Law.
2. Explain how tillage and manure application are legislated in Pennsylvania: Act 38 Nutrient Management.
3. Understand the T value and how it would be used in management and relates to state and federal regulations with respect to water quality.
4. Know how HEL is defined and how it is used in land management programs.

III. PEST MANAGEMENT

Competency Area 1. Basic Pest Management Practices

1. Recognize examples of cultural, mechanical (where applicable), chemical, and biological pest management.
2. Recognize economic and environmental factors involved in making a pest management recommendation.

Competency Area 2. Management of Weeds

1. Identify weeds by common name at any stage of growth, and classify each by life cycle.
 - a. ANNUAL GRASSES
 - i. large crabgrass
 - ii. barnyardgrass
 - iii. downy brome
 - iv. fall panicum
 - v. giant foxtail
 - vi. shattercane
 - b. PERENNIAL GRASSES
 - i. johnsongrass
 - ii. quackgrass
 - c. PERENNIAL GRASS-LIKE PLANTS
 - i. yellow nutsedge
 - d. ANNUAL BROADLEAVES
 - i. common cocklebur
 - ii. common lambsquarters
 - iii. common ragweed
 - iv. burcucumber
 - v. giant ragweed
 - vi. tall moringglory
 - vii. ladythumb
 - viii. Palmer amaranth
 - ix. redroot or smooth pigweed
 - x. velvetleaf
 - xi. yellow rocket
 - xii. eastern black nightshade
 - xiii. horseweed/marestail
 - xiv. common chickweed
 - e. BIENNIALS
 - i. wild carrot
 - ii. bull thistle
 - iii. common burdock
 - f. PERENNIAL BROADLEAVES
 - i. Canada thistle
 - ii. horsenettle
 - iii. pokeweed
2. Recognize factors which may contribute to the success of weeds.
3. Understand the effect of ensiling on weed seed viability.

Competency Area 3. Herbicide Application

1. Define preplant incorporated, preemergence, and postemergence herbicide applications.
2. Define herbicide persistence.
3. Distinguish between contact and translocated type herbicides.
4. Recognize how adjuvants affect herbicide performance.
5. Recognize the importance of timing in herbicide application.
6. Recognize the relationship between plant vigor and herbicide effectiveness in postemergence applications.
7. Identify general plant symptoms caused by major herbicide modes of action.

Common herbicide mode of action classes and examples.

Mode of action (effect on plant growth)	Site of Action	WSSA herbicide group #	Active ingredient or common name	Trade name(s)
Lipid (fatty acid) inhibitor (meristem)	ACCCase enzyme	1	clethodim quizalofop	Select Assure II
Amino acid biosynthesis inhibitor	ALS enzyme	2	chlorimuron imazethapyr cloransulam	Classic Pursuit FirstRate
Seedling growth inhibitor – root & shoot	Microtubule	3	pendimethalin	Prowl
Plant growth regulator	T1R1 (synthetic auxins)	4	2,4-D dicamba	2,4-D Clarity
Photosynthesis inhibitor – mobile	Photosystem II	5	atrazine metribuzin	atrazine TriCor
Amino acid biosynthesis inhibitor	EPSP enzyme	9	glyphosate	Roundup
N-metabolism disrupter (contact)	GS enzyme	10	glufosinate	Liberty
Cell membrane disrupter (contact)	PPO enzyme	14	flumioxazin fomesafen saflufenacil	Valor Reflex Sharpen
Seedling growth inhibitor – shoot	Long-chain fatty acids (LCFA)	15	acetochlor metolachlor pyroxasulfone	Harness Dual Zidua
Pigment inhibitor (bleaching)	HPPD enzyme	27	isoxaflutole mesotrione	Balance Callisto

8. List soil and climatic factors that affect the performance of herbicides.
9. List how crop residue and cover crops can affect herbicide performance.

Competency Area 4. Management of Infectious Plant Diseases

1. List the types of disease causing organisms.
2. Describe basic principles of disease development.
3. Corn diseases - Identify corn diseases by symptoms, study biology of the pathogen and be able to discuss management options.
 - a. root and seedling rots
 - b. grey leaf spot
 - c. northern corn leaf blight
 - d. anthracnose
 - e. ear rots
 - f. stalk rots
4. Soybean diseases - Identify soybean diseases by symptoms, study biology of the pathogen and be able to discuss management options.
 - a. root and seedling rots
 - b. brown spot
 - c. frog-eye leaf spot
 - d. white mold
 - e. stem rots (brown stem rot, stem canker, soybean sudden death)
 - f. pod rots (phomopsis, purple seed stain)
5. Small grains diseases - Identify small grains diseases by symptoms, study biology of the pathogen and be able to discuss management options.
 - a. root rots (fusarium)
 - b. powdery mildew
 - c. barley yellow dwarf virus
 - d. leaf blotch complex
 - e. rusts (leaf rust and stripe rust)
 - f. fusarium head blight (head scab)
 - g. smuts
6. Alfalfa diseases - Identify alfalfa diseases by symptoms, study biology of the pathogen and be able to discuss management options.
 - a. root rots (fusarium, aphanomyces, phytophthora)
 - b. blackstem
 - c. leaf spots (common spot, lepto leaf spot)
7. Identify diseases that may be associated with the production of mycotoxins in the crop, and subsequent contamination of feed and food products.
8. Recognize symptoms of abiotic plant disorders (including non-target herbicide injury and nutrient imbalance).
9. Distinguish between systemic and non-systemic fungicides.
10. Recognize how application method, mode of action, and timing may affect fungicide efficacy.
11. Understand the resources available to help diagnose plant diseases, including the Penn State Plant Disease Clinic, as well as print and digital references.

Competency Area 5. Management of Arthropods and Mollusks

1. Recognize complete and gradual metamorphosis.
2. Identify primary arthropod and mollusk pests and classify each by feeding habits, crops attacked and type of metamorphosis.
 - a. Corn
 - i. western corn rootworm
 - ii. European corn borer
 - iii. black cutworm
 - iv. true armyworm
 - v. gray garden slug
 - b. Soybean
 - i. soybean aphid
 - ii. brown marmorated stink bug
 - iii. gray garden slug
 - c. Wheat
 - i. cereal leaf beetle
 - ii. Hessian fly
 - iii. true armyworm
 - iv. aphids
 - d. Alfalfa
 - i. alfalfa weevil
 - ii. potato leafhopper
3. Identify beneficial organisms, classify them as a parasite, predator, or pathogen, and be able to discuss their importance in pest population regulation.
4. Understand the relationship between field characteristics and pest occurrence.
5. Distinguish between contact insecticides, stomach poisons, and systemic insecticides.
6. Recognize the importance of timing of application.
7. Recognize how the factors of tank, pH, weather, new plant growth, inherent molecule stability and spray coverage affect longevity and effectiveness of an insecticide application.

Competency Area 6. Pesticide Formulations and Labels

1. Recognize physical characteristics of various pesticide formulations.
 - a. Solutions, emulsions suspensions
 - i. Emulsifiable concentrates (EC or E)
 - ii. Wettable powders (WP or W)
 - iii. Soluble liquid (S or SL)
 - iv. Dry flowables (DF), water-dispersible granules (WDG or WG) or dispersible granules (DG)
 - v. Flowables (F or FL)
 - vi. Suspension concentrates (SC)
 - vii. Aqueous suspension (AS)
 - viii. Suspoemulsion (SE)
 - ix. Microencapsulated (ME or MT) or capsule suspension (CS)
 - x. Granules (G)
 - xi. Pellets (P)
2. Recognize the types of information found on a pesticide label.

Competency Area 7. Pesticide Application Equipment

1. Identify and describe the functions of granular applicator components.
2. Identify and describe the function of sprayer components.
3. Describe pattern form, relative droplet size, proper pattern, overlap, and primary uses of the following nozzle types:
 - a. standard flat-fan
 - b. even (E) flat-fan
 - c. low-pressure flat-fan
 - d. extended-range (XR) flat-fan
 - e. off-center (OC) flat-fan
 - f. twin-orifice (TJ) flat-fan
 - g. flood
 - h. turbulence chamber
 - i. venturi-type
 - j. hollow-cone
 - k. full-cone
 - l. boomless flat spray
4. Describe how to determine nozzle wear.
5. List physical factors affecting output during application of granular pesticides.
6. Understand spray drift and distinguish between particle drift and volatility, and understand volatilization and conditions that favor it.
7. List physical factors affecting output during spraying of pesticides, and define when conditions are favorable for spray drift.
8. Describe methods to estimate ground speed during pesticide application.
9. Recognize relationship between spray boom height and nozzle spacing.
10. Describe procedures used to adjust output of a granular applicator or sprayer.
11. Use calibration factors of gallons per acre, gallons per minute, width of nozzle spacing, and ground speed to demonstrate how to set up and calibrate a sprayer.
12. Understand issues with tank and components contamination from previous pesticide applications.

Competency Area 8. Pesticide Resistance

1. List factors influencing development of pesticide resistance and define cross resistance.
2. List ways to prevent the occurrence of pesticide resistant pathogens, insects and weeds.
3. List ways to manage pesticide resistant pathogens, insects and weeds once they have occurred.

Competency Area 9. Integrated Pest Management

1. Understand the philosophy of integrated pest management.
2. Understand the relation between the economic injury level, economic threshold, and general equilibrium position of an organism's population.
3. List steps in carrying out an IPM program.
4. Understand why it is important to sample pest populations and the need for using an adequate sample size to estimate an organism's population level.

5. List types of pest monitoring methods and the advantages and disadvantages of each.
6. Understand when and how to scout for different pests in relation to crop development.
7. Understand the types and significance of plant injury/plant response relationship.
8. List the variables used to calculate the economic injury level (EIL) and understand how the EIL varies when any one variable value changes.
9. Understand the term pest status, the types of pest status, and how pest status influences the form of an IPM program.
10. Understand the limitations and strengths of the integrated pest management approach.

Competency Area 10. Using Pesticides in an Environmentally Sound Way

1. Recognize how movement of a pesticide in soil or into water may be affected by various factors.
2. Know which soil property or pesticide characteristic would most likely retard or restrict the movement or leaching of a pesticide.
3. Be able to identify conditions that affect pesticide volatilization.
4. Describe how pesticide degradation is affected by soil moisture and soil temperature.
5. Describe the purpose of FIFRA.
6. Recognize general provisions of FIFRA.
7. List penalties for violation of FIFRA provisions.
8. Know which types of records must be kept by private pesticide applicators in Pennsylvania.
9. Know to whom restricted use pesticides can be sold.
10. Be able to explain the restricted entry interval (REI) associated with the Worker Protection Standard.
11. Understand impacts of preharvest interval (PHI) on other management decisions, such as harvest or crop use.
12. Understand the proper way to dispose of pesticides and containers.
13. List SARA regulations that pertain to pesticide dealers.

Competency Area 11. Protecting Humans Against Pesticide Exposure

1. List pesticide modes of entry into the human system.
2. Distinguish between chronic and acute poisoning effects.
3. Recognize general symptoms of acute poisoning.
4. List possible chronic effects of poisoning.
5. Recognize general procedures to follow if pesticide gets on skin, in eyes, in mouth or stomach, or if inhaled.
6. Identify the best source of information concerning level of pesticide toxicity, handling precautions, first aid procedures, and other pesticide safety information.

7. Describe protective gear used during mixing and application of pesticides.
8. Describe proper cleanup procedures for PPE and application equipment.
9. Describe safe storage.
10. Recognize procedures to follow when a spill occurs.

IV. CROP MANAGEMENT

Note: References to “crops” are those listed in the table of major crops found in the Foreword to this document.

Competency Area 1. Identification of Seed and Vegetative Stages for Crops Grown in PA

1. Be able to identify the seed and mature plant of each crop.
2. Describe how crops respond to soil fertility, pH, and soil drainage.
3. List the recommended soil pH ranges for major agronomic crops.
4. Describe how temperature generally affects the growth and development of crops.
5. Describe how extremes of temperature generally affect the growth and development of a crop.
6. Describe how the water needs of a crop typically change during growth and development.
7. Describe the adaptation of major agronomic crops to extremes of precipitation.
8. Recognize the effects of day length (photoperiod) and temperature (vernalization) on flowering.
9. Define the term growing degree day (GDD) and describe how it is used in crop production systems.

Competency Area 2. Crop Staging, Growth and Development

1. Be aware of which anatomical features of major crops occur at which developmental stages.
2. Use staging systems of corn, soybeans, and small grains to identify stage of growth at any time between emergence and physiological maturity.
3. Use staging systems to identify growth stages of forage legumes.
4. Describe how frequency and timing of harvest affects forage yield and quality, stand longevity, food reserves, and stand persistence.
5. Describe the locations and functions of meristems used for regrowth in forage legumes and forage grasses.
6. Recognize relationships between the growth and development of crops and management practices (i.e., fertilization, irrigation, pesticides).

Competency Area 3. Tillage systems

1. Recognize how environmental factors and management practices influence the selection of a tillage system.
2. Identify tillage implements and describe their functions in a tillage system.
3. Describe the timing and sequence of tillage operations in an intensive tillage system and a reduced tillage system.
4. Compare and contrast fall and spring tillage.
5. Describe the advantages and limitations of an intensive tillage system and a reduced tillage system.
6. Describe the functions and operation of a no-till planter.
7. Describe the timing and sequence of operations in a no-till system.

8. List the advantages and limitations of a no-till system.
9. Describe characteristics of residue associated with each type of tillage system.

Competency Area 4. Hybrid vs. Cultivar and Crop Seed

1. Distinguish between a hybrid and a cultivar.
2. Differentiate between natural selection and genetically engineered seed sources.
3. List the characteristics used in selecting a hybrid or cultivar.
4. Recognize how storage time, handling, and storage conditions may affect seed quality.
5. Define seed dormancy and hard seed.
6. Describe seed tests used to determine seed viability (germination) and vigor.
7. Define PLS.
8. Calculate % Pure Live Seed (PLS) values when given percent purity and percent germination.
9. Calculate the amount of seed needed for a field when given the seeding rate and the %PLS value.

Competency Area 5. Seeding Date Factors

1. Describe factors which determine when to seed corn, soybeans, small grains and forages.
2. Understand consequences and recognize signs of seeding too early or too late.

Competency Area 6. Seeding Rates and Pattern Factors

1. List recommended seeding rates for major crops.
2. List factors that influence the seeding rate of major crops.
3. List factors that influence the planting pattern of major crops and understand characteristics that make them adapted to high or low density.
4. List methods to seed small grains and forage crops.
5. Explain why forage crop establishment is more difficult than the establishment of grain crops.
6. List advantages and disadvantages of seeding pure grass or legume forage stands vs. mixed stands.

Competency Area 7. Seeding Depth Factors

1. List recommended seeding depths for major crops.
2. Understand how crops respond to depth of planting and determine if the depth of planting is the cause of poor emergence or stand establishment.
3. Recognize conditions which would cause recommended seeding depth to be altered.

Competency Area 8. Crop Damage, Mortality and Factors Influencing Replanting Decisions

1. Describe the type of damage hail, frost, flooding, drought, and wind can cause in corn, soybean, small grain and forage crops.
2. Understand conditions and be able to describe when major crops are most susceptible to specific environmental stresses.
3. Describe climatic and plant factors which influence a plant's ability to resume growth after being damaged.

4. Determine when crop damage would justify replanting.
5. Recognize damage due to herbicide carryover, drift, and/or improper application at different stages of crop growth and development while scouting.

Competency Area 9. Cropping Systems

1. Recognize how fallow is used in crop production.
2. List advantages and limitations of growing cover crops and companion crops in a cropping system.
3. Compare and contrast single crop systems and crop rotations.
4. Describe double cropping.
5. Describe advantages and disadvantages of cover crops.

Competency Area 10. Forage Harvesting and Preservation Factors

1. Understand the basic process of ensiling crops.
2. Describe how crop factors affect the ensiling process.

Competency Area 11. Pasture Systems

1. Recognize the advantages and disadvantages of forage grass and legume species for pasture.
2. List factors that influence the selection of grass and legume species for pastures.
3. Describe the seasonal yield distribution of grass and legume pasture species.
4. Recognize the difference between continuous and rotational grazing.
5. List the management factors that influence the productivity of continuous and rotational grazed pastures.
6. Describe animal unit and estimate the area required for pasturing various classes of livestock on pastures with varying productivity.