

CCA 4R Nutrient Management Specialist Exam

REGION 3 PERFORMANCE OBJECTIVES



Photo: USDA NRCS

**The American Society of Agronomy
International Certified Crop Adviser Program**

Effective 2019

Copyright 2019 – The American Society of Agronomy

TABLE OF CONTENTS

Foreword	4
Notes on Exam Format and Conversions	5
Proficiency Area 1: Nutrient Management Planning	6
<u>Competency Area 1</u> : Roles and Responsibilities of State, Local Public and Private Entities in Nutrient Management Planning	
<u>Competency Area 2</u> : CCA's Responsibility in Integrating 4Rs with a Nutrient Management Plan	
<u>Competency Area 3</u> : Economics of Nutrient Management Planning/Budget for Operation Changes Due to 4Rs	
<u>Competency Area 4</u> : Environmental and Social Risk Analysis	
Proficiency Area 2: Nitrogen	9
<u>Competency Area 1</u> : Determining the Right Source of Nitrogen	
<u>Competency Area 2</u> : Determining the Right Rate of Nitrogen	
<u>Competency Area 3</u> : Determining the Right Timing of Nitrogen Application	
<u>Competency Area 4</u> : Determining the Right Placement/Method of Application for Nitrogen	
<u>Competency Area 5</u> : Environmental Risk Analysis for Nitrogen	
Proficiency Area 3: Phosphorus	12
<u>Competency Area 1</u> : Determining the Right Source of Phosphorus	
<u>Competency Area 2</u> : Determining the Right Rate of Phosphorus	
<u>Competency Area 3</u> : Determining the Right Timing and Placement of Phosphorus Application	
<u>Competency Area 4</u> : Environmental Risk Analysis for Phosphorus	
Proficiency Area 4: Potassium, Sulfur, Calcium, Magnesium and Micronutrients	14
<u>Competency Area 1</u> : Determining the Right Source of Potassium	
<u>Competency Area 2</u> : Determining the Right Rate of Potassium	
<u>Competency Area 3</u> : Determining the Right Timing and Placement/Method of Potassium Application	

Competency Area 4: Determining the Right Source, Rate, Timing, Placement/Method of Application for Sulfur

Competency Area 5: Determining the Right Source, Rate, Timing and Placement of Calcium and Magnesium

Competency Area 6: Determining the Right Source, Rate, Timing and Placement of Micronutrients (B, Cl, Cu, Fe, Mn, Mo, Zn)

Proficiency Area 5: Determining the Right Rate, Timing and Placement of Soil Amendments and their Effects on Management of Nutrients **17**

Competency Area 1: Determining the Proper Source, Right Rate, Timing and Placement of Liming Materials for pH Adjustment

Competency Area 2: Determining the Proper Source, Right Rate, Timing and Placement of Amendments for Saline-Sodic or Sodic Soils

Competency Area 3: Be Aware of Considerations in Using Soil Amendments and Soil/Plant Additives the Role They May Play in Management of Soil and Plant Nutrients

Proficiency Area 6: Management of Manure, Compost, Biosolids, and Wastewater **18**

Competency Area 1: Source of Manure, Compost, Biosolids, and Wastewater

Competency Area 2: Rate, Timing and Placement/Method of Manure, Compost, Biosolids, and Wastewater

Competency Area 3: Whole-Herd or Whole-Flock Total Annual Manure and Nutrient Production

Competency Area 4: Adequacy of the Land Base for Applying Manure, Compost, Biosolids, and Wastewater

Competency Area 5: Crediting the Nutrients in Manure for Crop Production

Competency Area 6: Other Management Considerations

FOREWORD

The International Certified Crop Adviser (ICCA) Program developed the 4R Nutrient Management Specialty (4R NMS) Certification to meet the growing demand for qualified advisers with focused knowledge and skills in nutrient management. Not all CCAs do nutrient management work but focus on other aspects of crop advising. The 4R NM specialty allows those CCAs who advise on nutrient management to become more visible and recognized for their knowledge and skills so they can help meet the need for improved water quality, environmental stewardship and sustainability.

Nutrient management is an integrated process that considers not only the agronomic aspects of soil fertility and crop nutrition, but also the social, economic, and environmental relationships with the management system. The 4R concept of nutrient management has been developed and is being implemented world-wide by industry, researchers, government agencies, and farmers and their advisers. It is centered around the goal of building a nutrient management plan that puts the right nutrient sources, at the right rate, at the right time, and in the right place---the 4Rs of nutrient management. 4R nutrient management considers the integration of agronomic practices with economic analysis and environmental interaction, all considered at the local field level, as well as social impacts for the community, and for downstream stakeholders. The CCA 4R Nutrient Management Specialty Area is an additional specialty certification that builds upon the nutrient, soil and water components of the international CCA certification, to demonstrate the CCA's proficiency in working with the 4R concept and building it into nutrient management planning.

Agronomy is a dynamic field where new discoveries and approaches continue to occur at a rapid pace. The ASA and ICCA Program encourages comments and suggestions concerning possible modifications to this first edition of the Region 3 POs for 4Rs Nutrient Management Planning.

Comments should be sent to: ASA, ICCA Program, 5585 Guilford Rd., Madison, WI 53711.

The ASA and ICCA Program would like to thank the many volunteers who contributed to the writing of this document, which were comprised of a broad-based group of professionals from industry, private consulting, government, and academia. This type of program would not be possible without their dedication to the profession of agronomy and the ICCA program.

Notes on Exam Format and Conversions

- The exam that will be written from this set of Performance Objectives (POs) is a specialty exam and thus will contain questions that are more in depth and complex than the exams that were taken to obtain the CCA. Potential examinees should look at the verbs associated with each PO to determine the type of information that may be asked about each topic area. For example, the verb “list” would be considered a much less complex idea than a verb such as “interpret”. The format of the exam will be multiple choice questions with only one correct answer that address scenarios where the examinee will be provided data tables, figures, etc. to work with.
- Examinees should be able to convert between metric and English units and vice versa, as well as understand SI units. Conversion factors will be provided for questions within the exam.

PROFICIENCY AREA 1: NUTRIENT MANAGEMENT PLANNING

NOTE: It is understood that the States within Region 3 don't necessarily have the same legal framework or regulations. The goal for the examinee is to have an understanding of the general premise of the legal framework with regard to Nutrient Management Planning within Region 3. This exam is scenario based and the scenarios will provide information on the legal framework to be considered within the context of the scenario in order to answer questions.

Competency Area 1. Roles and Responsibilities of State, Local Public and Private Entities in Nutrient Management Planning

1. Interpret a CCA's roles and responsibilities in nutrient management planning as described in the following references:
 - a. Fertilizer information from Land Grant institutions such as:
 - i. Oregon State
 - a. <https://catalog.extension.oregonstate.edu/topic/agriculture/fertilizer-guides>
 - ii. Montana State
 - a. <http://landresources.montana.edu/soilfertility/fertilizers.html>
 - c. The Fertilizer Institute 4R Nutrient Stewardship
 - i. <http://www.nutrientstewardship.com/>
 - d. NRCS nutrient management:
 - i. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/?cid=nrcs143_014041
 - e. Animal Waste Management:
 - i. <https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/plantsanimals/mnm/?cid=stelprdb1044732>
 - f. EPA's Site on Animal Feeding Operations:
 - i. <https://www.epa.gov/npdes/animal-feeding-operations-afos>
2. Interpret roles and responsibilities of State, local public and private entities in nutrient management planning.
3. Discuss national, state-specific, and local-specific policies that relate to nutrient management planning.
4. Interpret and understand the planning process under the various State Nutrient Management Regulations, Policies, and Guidelines, if any.
5. Identify responsible parties and their roles in implementing each component of a nutrient management plan following the nutrient management regulations, policies, and guidelines, and the logistics needed to apply the right source of nutrients at the right rate, at the right time, and in the right place.

Competency Area 2. CCA's Responsibility in Integrating 4Rs with a Nutrient Management Plan

1. Differentiate between regulated and unregulated nutrient management planning and how 4R nutrient management principles and strategies fit into each.
 - a. Know the **major** regulatory framework agencies and rules within the Northwest Region.
 - b. Know any reporting requirements and approval processes.
2. Be able to advise on the right source(s), at the right rate(s), at the right time(s), and the right place(s) to fit the client's cropping system, climate, soils, and farming situation.
3. Consider the available equipment, labor, and nutrient sources when implementing a 4R nutrient management plan for a given operation.
4. Know the concept of using established and regionally standard soil tests for making nutrient recommendations.
5. Identify the best management practices that should be considered if nutrients need to be applied outside the optimum 4R nutrient management plan.
6. Understand the rationale (agronomic and environmental advantages and consequences) of increasing soil nutrient levels above the crop nutrient response level.
7. Know the components of a 4R nutrient management plan that should be monitored and tracked over time and the impacts of any changes.
8. Analyze various practices in the farm operation that will require updates or adjustments to a 4R nutrient management plan such as:
 - a. cropping system or rotation;
 - b. soil testing;
 - c. plant tissue sampling;
 - d. livestock housing or animal numbers;
 - e. application rate, method, and placement;
 - e. yields;
 - f. equipment;
 - g. technology tools.
9. Understand record keeping requirements and responsibilities and the follow-up process with the operator/client and any or all parties involved.
10. Understand the need for maintaining up to date field map boundaries, records, and field identification systems with government agencies, the client, and the consultant.
11. Understand and explain a CCA's professional risks, responsibilities and mitigating practices related to nutrient management planning.

Competency Area 3: Economics of Nutrient Management Planning/Budget for Operation Changes Due to 4Rs

1. Construct a base financial budget for each crop/field.
2. Evaluate short and long-term changes in benefits, costs and risks of implementing 4R practices including:
 - a. changing fertilizer or manure placement methods;
 - b. changing source of nutrients, including manure;
 - c. freight (logistics of handling fertilizer products or manure);
 - d. use of stabilizers and additives;
 - e. choice of timing changes;
 - f. yield changes;
 - g. alternate cropping options;
 - h. crop insurance (regulations and premiums);
 - i. optimal rate to produce maximum economic return;
 - j. equipment and technology (including precision ag technologies).
3. Estimate the costs for nutrient management plans including: plan preparation, record keeping, soil and plant tissue tests, manure tests, and equipment and labor.
4. Be aware of the potential financial risk of not following a 4R nutrient management plan.

Competency Area 4. Environmental and Social Risk Analysis

1. Recognize why nutrient management is important to the environment and public health.
2. Know why environmental risk analysis is an important component of nutrient management planning.
3. Understand the importance of broader social and local community concerns in nutrient management planning.
4. Know when regulatory requirements may supersede the results of a risk assessment.
5. Recognize the value and limitations of using standard soil test results in environmental risk analysis.
6. Be aware of required anhydrous ammonia safety protocols and training.
7. Understand manure handling health and safety risks e.g., H₂S, timing of incorporation after application.
8. Understand the implications of applying fertilizer or manure to saturated, frozen and/or snow-covered ground.
9. Recognize impacts to downstream surface water and/or groundwater due to fertilizer and/or manure applications.

PROFICIENCY AREA 2: NITROGEN

Competency Area 1. Determining the Right Source of Nitrogen

1. Discuss the most common sources of nitrogen used in the Northwest U.S., including, but not limited to:
 - a. UAN;
 - b. urea;
 - c. anhydrous ammonia;
 - d. ammonium nitrate;
 - e. ammonium sulfate.

2. Determine the right source of nitrogen based on:
 - a. crop type and cropping system (including drainage and irrigation);
 - b. climate (temperature, precipitation);
 - c. soil and landscape characteristics (leaching, runoff potential);
 - d. potential for environmental loss and/or impact (e.g., surface and groundwater, greenhouse gas (GHG) emissions);
 - e. crop stage.

Competency Area 2. Determining the Right Rate of Nitrogen

1. Interpret soil test nitrogen levels in relation to crop yield response, crop quality, and potential environmental impacts.

2. Understand how to determine the rate of nitrogen needed without a current soil test without causing environmental impacts.

3. Understand the agronomic and environmental risks of applying nitrogen above economic optimums.

4. Assess considerations for nitrogen application rate based on:
 - a. economics;
 - b. weather and climate, including:
 - i. temperature;
 - ii. precipitation amount;
 - iii. rainfall intensity;
 - iv. precipitation patterns;
 - c. stored soil moisture;
 - d. irrigation;
 - e. crop type, cultivar, and growth stage;
 - f. yield potential and targeted use of the crop;
 - g. general equipment capabilities and limitations with respect to application rate.

5. Understand the impacts of hail, frost and other environmental stressors on crop growth and forage quality and application of nitrogen.

6. Evaluate the considerations for nitrogen application rate based on potential losses associated with leaching, denitrification, immobilization, volatilization:
 - a. soil characteristics;
 - b. crop residue conditions;
 - c. topography and runoff;

- d. crop type and growth stage;
 - e. seasonal moisture conditions;
 - f. time of application;
 - g. use of nitrogen stabilizers.
7. Estimate nitrogen credits from:
 - a. previous nitrogen application;
 - b. soil organic matter;
 - c. manure;
 - d. biosolids and other organic amendments;
 - e. irrigation applications (groundwater, surface water, and wastewater);
 - f. previous crops and cropping practices (e.g., cover crops, legumes, fallow).
 8. Be aware of technologies to make ongoing adjustments to the nutrient rates that may have been identified during the 4R nutrient management planning process such as:
 - a. crop canopy sensors;
 - b. normalized difference vegetative index (NDVI);
 - c. soil nitrate and/or ammonium tests;
 - d. plant analysis including post season stalk nitrate test in corn, tissue tests in small grains, and petiole testing in potatoes and sugar beets;
 - e. grain protein;
 - f. Variable Rate Technology (VRT);
 - g. prior yields.

Competency Area 3. Determining the Right Timing of Nitrogen Application

1. Evaluate how the timing of soil nitrogen tests can impact test levels.
2. Estimate the environmental risks in the timing of applying nitrogen based on:
 - a. climate;
 - b. season;
 - c. soil characteristics;
 - d. runoff potential;
 - e. irrigation method;
 - f. leaching potential.
3. Understand the risks of applying nitrogen on saturated, frozen, or snow covered soils.
4. Comprehend how the timing of nitrogen application is dependent upon the nutrient source.
5. Consider the opportunities and risks that split application offers for 4R nitrogen management by crop and its end use quality.
6. Understand how cover crops can affect nitrogen availability in follow-up crops and supplemental nitrogen application timing.
7. Evaluate the principles, appropriate use and impact to timing of nitrogen applications for:
 - a. urease inhibitors;
 - b. nitrification inhibitors;
 - c. controlled and/or slow release nitrogen products.

Competency Area 4. Determining the Right Placement/Method of Application for Nitrogen

1. Comprehend how the source of the nitrogen will determine the best placement or method of application.
2. Consider how the following will impact the proper placement or method of application:
 - a. time of the year;
 - b. climate;
 - c. irrigation method;
 - d. tillage practices;
 - e. available equipment;
 - f. soil characteristics;
 - g. residue management.
3. Understand how crop stage and crop type will determine the placement or method of application.
4. Recognize how planting pattern (narrow or wide row/solid seeded or row crop) will determine the placement or method of application.
5. Understand the role of nitrogen technology products and the considerations for nitrogen placement or method of application for:
 - a. urease inhibitors;
 - b. nitrification inhibitors;
 - c. controlled and/or slow release nitrogen products.
6. Evaluate the role of in-crop application, including fertigation, in 4R nutrient management planning.

Competency Area 5. Environmental Risk Analysis for Nitrogen

1. Understand nitrogen management decisions as they affect water quality (groundwater and surface water).
 - a. Eutrophication.
 - b. Aquatic life.
 - c. Drinking water quality relative to the standards.
2. Evaluate management strategies that will reduce nitrogen loss impacts to air, including ammonia volatilization and nitrous oxide emissions.
3. Identify the role of nitrogen management in greenhouse gas (GHG) emissions and particulate matter development.
4. Evaluate the influence of environmental impacts of nitrogen on surface and groundwater resources based on:
 - a. soil characteristics;
 - b. topography;
 - c. location of and within the watershed;
 - d. buffers;
 - e. riparian areas/zones;
 - f. irrigation water re-use pits.

PROFICIENCY AREA 3: PHOSPHORUS

Competency Area 1. Determining the Right Source of Phosphorus

1. Identify the most common sources of fertilizer phosphorus used in the Northwest US.
2. Understand considerations to determine the right source of phosphorus.

Competency Area 2. Determining the Right Rate of Phosphorus

1. Interpret how soil test phosphorus levels relate to crop yield response and potential environmental impacts.
2. Understand how to determine the rate of phosphorus needed without a current soil test minimizing environmental impacts.
3. Evaluate different soil test phosphorus extraction methods.
 - a. Bray
 - b. Olsen
 - c. Mehlich III
4. Explain how nutrient stratification in no till or wide placed fertilizer bands for row crops may influence the soil sampling approach for phosphorus.
5. Justify phosphorus application rate based on:
 - a. soil test results;
 - b. soil characteristics including leaching;
 - c. topography and runoff;
 - d. crop conditions, crop type, and growth stage;
 - e. application method (broadcast or banded).
6. Comprehend the concepts of build and maintain, sufficiency, and removal philosophies.
7. Recognize phosphorus credits from:
 - a. manure, biosolids, and other organic amendments;
 - b. wastewater.
8. Justify the potential need to adjust the phosphorus application rate based on historic phosphorus use.
9. Understand how phosphorus placement affects availability.

Competency Area 3. Determining the Right Timing and Placement of Phosphorus Application

1. Understand the mechanisms of phosphorus losses.
 - a. Runoff.
 - b. Leaching.
 - c. Tile drainage.
 - d. Wind erosion.
2. Comprehend the relationship between tillage practices/system on phosphorus management.

3. Know the importance of the following in determining the optimal timing and placement or method of application of phosphorus:
 - a. precipitation (intensity, type, and duration);
 - b. snowmelt and frozen soil;
 - c. crop uptake.
4. Understand the effects of timing and placement on short and long term crop response.
 - a. Seed row.
 - b. Side band.
 - c. Mid row.
 - d. Broadcast.
 - e. Foliar.
 - f. Rooting structure.
5. Identify the implications and interactions of banding phosphorus with other nutrients.
6. Compare reduction strategies and management for offsite movement of
 - a. particulate phosphorus loss due to soil erosion,
 - b. dissolved phosphorus loss.

Competency Area 4. Environmental Risk Analysis for Phosphorus

1. Recognize how to use water quality vulnerability or risk assessment tools (e.g. Nutrient Management Plans) on a site specific basis for phosphorus nutrient planning.
2. Be able to evaluate how changing a specific phosphorus management strategy will affect the outcome of a risk assessment.
3. Evaluate management strategies and Best Management Practices (BMPs), which will reduce phosphorus loss to surface water and groundwater.
 - a. tile drainage
 - b. buffer strips
 - c. cover crops
 - d. application strategies
 - e. use of riparian areas and wetlands
4. Understand how to use drainage water management to reduce phosphorus nutrient losses to surface water.
 - a. tile drainage
 - b. surface water drainage
 - c. irrigation tailwater and drainage ditches
5. Recognize how a tillage system (including no-till) affects environmental losses of phosphorus.
6. Compare the differences in soil, topography, and location of watersheds (e.g. local, regional, national) on the environmental impacts of phosphorus on surface and groundwater resources.
7. Know the role of phosphorus, including legacy phosphorus, in the eutrophication process and the potential consequences of eutrophication.

PROFICIENCY AREA 4: POTASSIUM, SULFUR, CALCIUM, MAGNESIUM, AND MICRONUTRIENTS

Competency Area 1. Determining the Right Source of Potassium

1. Know the availability/potential deficiency of potassium in the Region 3.
2. Identify the most common sources of potassium used in the Region 3.
3. Understand considerations that may be used to determine the right source of potassium, sulfur, calcium, magnesium, and micronutrients based on:
 - a. crop type;
 - b. tillage and cropping system;
 - c. crop growth stage;
 - d. soil test or tissue test;
 - e. timing and placement of application.
4. Understand how managing the 4Rs for potassium, sulfur, calcium, magnesium, and micronutrients may influence nitrogen and phosphorus losses to surface water and groundwater.

Competency Area 2. Determining the Right Rate of Potassium

1. Interpret how soil/tissue test potassium levels relate to crop yield response and potential environmental impacts.
2. Understand how to determine the rate of potassium needed without a current soil test minimizing environmental impacts.
3. Describe how potassium rates may be affected by soil characteristics, which may include:
 - a. cation exchange capacity (CEC);
 - b. organic matter;
 - c. texture;
 - d. clay type.
4. Be aware of the contribution of potassium from:
 - a. previous potassium application;
 - b. previous crop residue management;
 - c. manure;
 - d. biosolids;
 - e. wastewater.
5. Be able to explain the impact of timing and placement on the rate of potassium applied.
6. Recognize how environmental conditions, including soil temperature and moisture, may modify the need for potassium.

Competency Area 3. Determining the Right Timing and Placement/Method of Potassium Application

1. Know how the timing and method of potassium application can impact crop response.
2. Recognize toxicity concerns with excessive rates of seed row placed potassium and potassium in conjunction with nitrogen.

3. Explain considerations to determine the proper placement and method of application of potassium based on the:
 - a. crop type;
 - b. cropping system;
 - c. methods of tillage.

4. Recognize the options for placement and method of application of potassium based on current potassium.
 - a. soil test levels
 - b. soil texture
 - c. plant growth stage

Competency Area 4. Determining the Right Source, Rate, Timing and Placement/Method of Sulfur

1. Understand the availability/potential deficiency of sulfur in the Region 3.

2. Understand how to determine the rate of sulfur needed without a current soil test minimizing environmental impacts.

3. Identify the most common sources of sulfur in Region 3.
 - a. Sulfate based (recognizing solubility differences) including gypsum.
 - b. Elemental (recognizing particle size, dispersibility, and oxidation rate).
 - c. Liquid ammonium thiosulfate (ATS).
 - d. Combined sulfate and elemental products.
 - e. Irrigation water.
 - f. Recognize the reduced contribution from atmospheric sulfur.
 - g. Recognize interactions among sources, timing and placements.

4. Understand considerations that may be used to determine the right source of sulfur based on:
 - a. crop type;
 - b. tillage and cropping system;
 - c. crop growth stage;
 - d. soil/tissue test;
 - e. timing and placement of application.

5. Know how managing the 4Rs for sulfur influences nitrogen and phosphorus losses to surface water and groundwater.

6. Explain considerations that may be used to determine the right rate of sulfur:
 - a. source of sulfur;
 - b. crop type;
 - c. tillage and cropping system;
 - d. crop growth stage;
 - e. soil/tissue test;
 - f. timing and placement of application;
 - g. irrigation;
 - h. atmospheric deposition of sulfur.

Competency Area 5. Determining the Right Source, Rate, Timing and Placement of Calcium and Magnesium

1. Understand the availability/potential deficiency of calcium and magnesium in the Region 3.
2. Identify the most common sources of calcium and magnesium used in Region 3.
3. Recognize considerations that may be used to determine the right sources of calcium and magnesium based on:
 - a. crop type;
 - b. tillage and cropping system;
 - c. crop growth stage;
 - d. soil/tissue test;
 - e. timing based on nutrient availability;
 - f. placement/method of application.
4. Understand how managing the 4Rs for calcium and magnesium may influence nitrogen and phosphorus losses to surface water and groundwater.
5. Identify considerations to determine the proper rate, timing and placement/method of calcium and magnesium based on the:
 - a. crop type;
 - b. cropping system;
 - c. crop growth stage;
 - d. soil/tissue test;
 - e. timing of application based on nutrient availability;
 - f. placement/method of application.

Competency Area 6. Determining the Right Source, Rate, Timing and Placement of Micronutrients (B, Cl, Cu, Fe, Mn, Mo, Zn,)

1. Understand the availability / potential deficiency of micronutrients in the Region 3.
2. Identify the most common sources of micronutrients used in Region 3.
3. Recognize considerations that may be used to determine the right source of micronutrients based on:
 - a. crop type;
 - b. tillage and cropping system;
 - c. crop growth stage;
 - d. soil/tissue test;
 - e. timing and placement of application.
4. Identify considerations to determine the proper source, rate, timing and placement of micronutrients based on the:
 - a. crop type and variety;
 - b. cropping system;
 - c. crop growth stage;
 - d. soil/tissue test;
 - e. timing of application.

PROFICIENCY AREA 5: Determining the Right Rate, Timing and Placement of Soil Amendments and their Effects on Management of Nutrients

Competency Area 1: Determining the Proper Source, Right Rate, Timing and Placement of Liming Materials for pH Adjustment

1. Understand reasons to use liming materials.
2. Be aware of suitability of sources of liming materials:
 - a. industrial byproducts used for liming;
 - b. ag liming materials;
 - c. wood ash;
 - d. cost/benefit;
 - e. contaminants;
 - f. particle size;
 - g. calcium carbonate equivalent (CCE).
3. Understand considerations to determine the proper rate, timing and placement of liming materials (e.g. agricultural lime, industrial byproducts, and wood ash) based on:
 - a. target pH by crop;
 - b. soil test pH and buffer pH, and magnesium;
 - c. timing of application;
 - d. method of application;
 - e. major nutrient contribution from lime.
4. Understand the likely duration of efficacy of a liming application based on crop rotation, nitrogen, and other fertilizer inputs.

Competency Area 2. Determining the Proper Source, Right Rate, Timing and Placement of Amendments for Saline-Sodic or Sodic Soils

1. Gypsum
 - a. Understand the soil and site properties where gypsum use is beneficial.
 - b. Indicate the additional requirements and mechanisms for remediation of saline-sodic or sodic soils when using gypsum.
 - c. Understand the limitations of gypsum as a soil amendment.
2. Elemental Sulfur
 - a. Understand soil properties that are conducive to effective elemental sulfur application.
 - b. Indicate the additional requirements and mechanisms for remediation of saline-sodic or sodic soils when using elemental sulfur.
 - c. Know the conversion factor from gypsum to sulfur.
 - d. Understand the limitations of elemental sulfur as a soil amendment.

Competency Area 3. Be Aware of Considerations in Using Soil Amendments and Soil/Plant Additives and the Role They May Play in Management of Soil and Plant Nutrients

1. Understand the role the following amendments can play in nutrient management and soil health.
 - a. Biochar.
 - b. Humic materials.
 - c. Sugar lime (byproduct of sugar refinement).
 - d. Gypsum.
2. Understand and know the different classes of soil/plant additives:
 - a. biological;
 - b. nutritional;
 - c. enzymes/proteins;
 - d. health, environmental, and efficacy requirements.

PROFICIENCY AREA 6: MANAGEMENT of MANURE, COMPOST, BIOSOLIDS, and WASTEWATER

Competency Area 1. Source, of Manure, Compost, Biosolids and Wastewater

1. Know the availability of manure, compost, biosolids and wastewater.
2. Know the most common sources of manure, compost, biosolids and wastewater.
3. Understand considerations that may be used to determine the right source of manure, compost, biosolids, and wastewater based on:
 - a. crop type;
 - b. tillage and cropping system;
 - c. crop growth stage;
 - d. soil test or tissue test;
 - e. analysis of manure, biosolids and wastewater;
 - f. timing and placement of application.
4. Describe how managing the 4Rs for manure, compost, biosolids and wastewater influences nitrogen and phosphorus losses to surface water and groundwater.

Competency Area 2. Rate, Timing and Placement/Method of Manure, Compost, Biosolids and Wastewater

1. Interpret how soil test levels relate to crop yield response and potential environmental impacts.
2. Describe how rates may be affected by soil characteristics, which may include:
 - a. cation exchange capacity (CEC);
 - b. organic matter;
 - c. texture;
 - d. clay type.

3. Know considerations to determine the proper source, rate, timing and placement based on the:
 - a. crop type and variety;
 - b. cropping system;
 - c. crop growth stage;
 - d. soil test or tissue test;
 - e. timing of application;
 - f. method of application;
 - g. relative balance of available nutrients.
4. Understand the relationship of pesticide, antibiotic, heavy metals, or other residuals that would lead to issues with manure, compost, biosolids, and wastewater applications.

Competency Area 3. Whole-Herd or Whole-Flock Total Annual Manure and Nutrient Production

1. Recognize differences in calculating animal units and be able to calculate the total number of animal units in an operation given appropriate information.
2. Be aware of software and/or tables to estimate the total amount of manure produced in a year by an operation.
3. Know the pros and cons of operation specific nutrient tests versus book values with respect to developing a nutrient/manure management plan.
4. Calculate the total nitrogen and phosphorus in the manure produced by an operation in a year using published or test values of manure nutrients.
5. Be aware of record keeping to measures for the total manure produced by an operation in a year.

Competency Area 4. Adequacy of the Land Base for Applying Manure, Compost, Biosolids, and Wastewater

1. Understand the risk of loss of nutrients (N, P) from a field, how it may be assessed, and how it may exclude some fields from receiving manure, compost, biosolids, and wastewater and/or required setbacks.
2. Evaluate the adequacy of the cropland available for spreading manure, biosolids, and wastewater by comparing the total available product to the land base.
3. Understand restrictions on crops, vegetables, or forages based on application of manure, biosolids or wastewater due to build-up of nutrients, metals, pathogens, and salinity.
4. Be aware of local or state level ordinances regarding odor and insect issues from manure, etc. applications.

Competency Area 5. Crediting the Nutrients in Manure for Crop Production

1. Be able to use the availability factors for the nitrogen (current and previous applications), phosphorus and potassium in manure as outlined in the documentation available in your state.
2. Know how to credit the phosphorus and potassium in manure for the crop requirements recommended by soil tests using the nutrient recommendations of the documentation available in your state. Understand how to adjust manure spreading rates accordingly for each field.
3. Evaluate the strengths and weaknesses of each tool listed below and the situations in which it is appropriate to use each tool:
 - a. fall and/or spring soil nitrate test;
 - b. pre-sidedress soil nitrate test;
 - c. plant tissue test;
 - d. post-season stalk nitrate for corn;
 - e. small grain protein content;
 - f. residual nutrients (P, K, S, and micronutrients);
 - g. nutrient balance.

Competency Area 6. Other Management Considerations

1. Understand practices that contribute to lodging and how this is related to the 4Rs NM concepts.
2. Explain the relationship between manure and/or fertilizer application and grass tetany.
3. Recognize the contribution of soluble salts to soils and crops from fertilizer, manure, compost, biosolids and wastewater.
4. Understand the restrictions on heavy metal accumulation when using manure, compost, biosolids, wastewater, and fertilizers.
5. Discuss unique considerations of manure, compost, biosolids and wastewater application in terms of runoff risk of nutrients and pathogens.
 - a. Edge of field effects.
 - b. Downstream impacts.
 - c. Tillage and incorporation.
 - d. Use of buffer and filter strips.
 - e. Management of adjacent riparian areas.
 - f. Timing of application, including
 - i. frozen soil.
 - ii. snow covered soil.
 - iii. heavy rain events.
 - g. Placement of manure in accordance with setback requirements.

6. Explain the relationship between manure and other organic amendments and soil organic matter content.
7. Understand water quality and method of application with wastewater on
 - a. soil N;
 - b. soil P;
 - c. SAR;
 - d. EC;
 - e. bicarbonates.